

Tapping into linguistic rhythm: Summary of statistical analyses and best-fit models

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Section 3.2. Annotator agreement

```
##
## Pearson's product-moment correlation
##
## data: data0$annotator_1 and data0$annotator_2
## t = 595.6, df = 39, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
## 0.9998962 0.9999709
## sample estimates:
## cor
## 0.999945

## [1] -0.002350901

## [1] 0.007166244
```

Section 4.1. Motor activity in SMS vs. NMR

i. One-sample Kolmogorov-Smirnov tests for NMR

```
##          S1          S2          M1          M2          L1          L2
## D 0.2030399 0.1478367 0.1352294 0.2702486 0.3463238 0.2882722
```

ii. One-sample Kolmogorov-Smirnov tests for SMS

```
##          S1          S2          M1          M2          L1          L2
## D 0.2795753 0.2912242 0.1823565 0.1193687 0.07250568 0.1271021
```

Section 4.2. Landmark comparisons

Factor “landmark” has 5 levels: vowel onset, syllable onset, maxE, maxD, LAM

```
## Single term deletions using Satterthwaite's method:
##
```

```

## Model:
## log(absasync) ~ landmark + (1 + landmark | participant) + (1 | sentence)
##      Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)
## landmark 61.312  15.328      4 125.74  13.889 2.07e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: log(absasync) ~ landmark + (1 + landmark | participant) + (1 |
##      sentence)
##      Data: data1
## Control:
## lmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlsminb",
##      starttests = FALSE, kkt = FALSE))
##
## REML criterion at convergence: 15120.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -7.0217 -0.4354  0.2571  0.7086  1.4662
##
## Random effects:
##  Groups      Name                Variance Std.Dev. Corr
## participant (Intercept)          0.0117669 0.10848
##              landmarkintmax      0.0014881 0.03858  0.99
##              landmarkmaxD         0.0002964 0.01721 -1.00 -1.00
##              landmarkmaxE         0.0006468 0.02543  0.84  0.91 -0.88
##              landmarksyllable     0.0069708 0.08349 -1.00 -1.00  1.00 -0.88
## sentence   (Intercept)          0.0040647 0.06375
## Residual                1.1036209 1.05053
## Number of obs: 5130, groups: participant, 29; sentence, 6
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    3.365e+00  4.648e-02 1.870e+01  72.414 < 2e-16 ***
## landmarkintmax  1.028e-01  4.717e-02 4.346e+02   2.179  0.02987 *
## landmarkmaxD    4.186e-02  4.595e-02 1.646e+03   0.911  0.36245
## landmarkmaxE    1.459e-01  4.638e-02 1.092e+02   3.145  0.00214 **
## landmarksyllable 3.319e-01  4.884e-02 1.124e+02   6.795 5.42e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) lndmrkn lndmrD lndmrE
## landmrkntmx -0.415
## landmarkmxD -0.524  0.476
## landmarkmxE -0.451  0.496  0.488
## lndmrksyllb -0.602  0.409  0.492  0.436

```

Section 4.3. Probability of a tap in the SMS task

Reference of metrical_status is 0 (weak), compared to 1 (strong) and 2 (accented)

```

## Single term deletions
##
## Model:
## SMS ~ metrical_status + S2S + (1 | participant)
##           npar      AIC      LRT   Pr(Chi)
## <none>           750.75
## metrical_status    2 771.42 24.6756 4.383e-06 ***
## S2S                1 754.23  5.4849  0.01918 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Generalized linear mixed model fit by maximum likelihood (Laplace
## Approximation) [glmerMod]
## Family: binomial ( logit )
## Formula: SMS ~ metrical_status + S2S + (1 | participant)
## Data: data
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 1e+05))
##
##           AIC      BIC   logLik deviance df.resid
##       750.7    776.2   -370.4    740.7     1184
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -7.5216  0.1617  0.2188  0.3368  1.4077
##
## Random effects:
##  Groups      Name      Variance Std.Dev.
## participant (Intercept) 1.459    1.208
## Number of obs: 1189, groups: participant, 29
##
## Fixed effects:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)      2.2621     0.3007   7.524 5.32e-14 ***
## metrical_status1  0.9972     0.3037   3.283 0.00103 **
## metrical_status2  0.9812     0.2182   4.498 6.88e-06 ***
## S2Slow           -0.4702     0.1983  -2.371 0.01775 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) mtrc_1 mtrc_2
## mtrcl_stts1 -0.198
## mtrcl_stts2 -0.260  0.272
## S2Slow      -0.436  0.080  0.074

```

Section 4.4. SMS accuracy

```

## Single term deletions using Satterthwaite's method:
##
## Model:
## log(abs_async) ~ log(risetime) + musicality + (1 + log(risetime) | participant) + (1 | sentence)
##              Sum Sq Mean Sq NumDF DenDF F value   Pr(>F)
## log(risetime) 7.6294  7.6294      1  1044  6.2262 0.01274 *

```

```

## musicality      6.3385  6.3385      1 1044  5.1728 0.02315 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: log(abs_async) ~ log(risetime) + musicality + (1 + log(risetime) |
##      participant) + (1 | sentence)
##      Data: data
## Control:
## lmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlsminb",
##      starttests = FALSE, kkt = FALSE))
##
## REML criterion at convergence: 3198.8
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.8085 -0.4744  0.2448  0.7382  1.3368
##
## Random effects:
##      Groups      Name              Variance Std.Dev.  Corr
##      participant (Intercept)    0.000e+00 0.000e+00
##                  log(risetime) 5.197e-11 7.209e-06  NaN
##      sentence    (Intercept)    0.000e+00 0.000e+00
##      Residual              1.225e+00 1.107e+00
## Number of obs: 1047, groups:  participant, 29; sentence, 6
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)  2.979e+00 1.960e-01 1.044e+03 15.202  <2e-16 ***
## log(risetime) 1.072e-01 4.295e-02 1.044e+03  2.495   0.0127 *
## musicality   -1.355e-02 5.958e-03 1.044e+03 -2.274   0.0231 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) lg(rs)
## log(risetime) -0.967
## musicality    -0.185  0.000

```

Section 4.5. Anticipation in SMS

```

## Single term deletions using Satterthwaite's method:
##
## Model:
## signed_async ~ log(risetime) + riseslope + serial_order + (1 + log(risetime) + riseslope | participant)
##              Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)
## log(risetime) 44253   44253      1  41.71 17.7614 0.0001311 ***
## riseslope     31469   31469      1  80.00 12.6305 0.0006403 ***
## serial_order  13242   13242      1 704.58  5.3149 0.0214331 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: signed_async ~ log(risetime) + riseslope + serial_order + (1 +
##   log(risetime) + riseslope | participant) + (1 | sentence)
##   Data: data
## Control:
## lmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlminb",
##   starttests = FALSE, kkt = FALSE))
##
## REML criterion at convergence: 11182.4
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.40263 -0.70614 -0.01529  0.63493  2.94164
##
## Random effects:
##   Groups             Name             Variance Std.Dev. Corr
## participant (Intercept)      464.0949  21.5429
##              log(risetime)    20.7073   4.5505  -0.94
##              riseslope         0.5861   0.7656  -0.65  0.87
## sentence   (Intercept)       53.1966   7.2936
## Residual                2491.5347  49.9153
## Number of obs: 1047, groups: participant, 29; sentence, 6
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)   30.1942    11.0217   39.2950   2.740 0.009205 **
## log(risetime)  -9.7028     2.3023   41.7086  -4.214 0.000131 ***
## riseslope      -1.6082     0.4525   79.9975  -3.554 0.000640 ***
## serial_order    1.6717     0.7251  704.5778   2.305 0.021433 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) lg(rs) risslp
## log(risetime) -0.891
## riseslope     -0.305  0.156
## serial_ordr   -0.126 -0.182  0.267

```

Correlation of rise-time and rise-slope

```

##
## Pearson's product-moment correlation
##
## data: data_sentence$rise.time and data_sentence$rise.slope
## t = -0.74809, df = 39, p-value = 0.4589
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
## -0.4115314  0.1958783
## sample estimates:
##      cor
## -0.1189397

```

Section 4.6. Number of repetitions in SMS

i. Repetition cycle during which participants preferred to start tapping

```
## [1] 3

##    0%  25%  50%  75% 100%
##    1    2    3    3   11
```

ii. Repetition cycle during which participants started tapping on the first trial

```
## [1] 3

##    0%  25%  50%  75% 100%
##    1    2    3    4   10
```

iii. Repetition cycle during which participants started tapping on the last trial

```
## [1] 2

##    0%  25%  50%  75% 100%
##    2    2    2    3    6
```

iv. Number of tapping cycles until participants reached their personal point of stability

```
## [1] 5

##    0%  25%  50%  75% 100%
##    1    3    5    7   13
```

v. Factors influencing the beginning of tapping

```
## Cumulative Link Mixed Model fitted with the Laplace approximation
##
## formula: as.factor(first_tap_cycle) ~ confident_beat_tapping + musicality +
##          task_order + (1 | participant) + (1 | sentence)
## data:    data2
##
## link threshold nobs logLik AIC niter max.grad cond.H
## probit equidistant 174 -265.33 544.66 444(1335) 1.20e-05 1.6e+03
##
## Random effects:
## Groups Name Variance Std.Dev.
## participant (Intercept) 1.1982 1.0946
## sentence (Intercept) 0.1176 0.3429
## Number of groups: participant 29, sentence 6
##
## Coefficients:
## Estimate Std. Error z value Pr(>|z|)
## confident_beat_tapping -0.002297 0.149162 -0.015 0.988
```

```
## musicality          -0.003701  0.043365 -0.085    0.932
## task_order          0.688338  0.440087  1.564    0.118
##
## Threshold coefficients:
##           Estimate Std. Error z value
## threshold.1 -0.65217   1.09314  -0.597
## spacing      1.10998   0.07332  15.138
```

v. Factors influencing the point of stabilising

Number of tapped cycles as the dependent variable

```
## Cumulative Link Mixed Model fitted with the Laplace approximation
##
## formula: as.factor(change_point_cycle_own) ~ confident_beat_tapping +
##          musicality + task_order + (1 | participant) + (1 | sentence)
## data:    data2
##
## link threshold nobs logLik AIC niter max.grad cond.H
## probit equidistant 174 -428.65 871.29 481(964) 2.88e-04 1.8e+03
##
## Random effects:
## Groups Name Variance Std.Dev.
## participant (Intercept) 0.02742 0.1656
## sentence (Intercept) 0.02168 0.1472
## Number of groups: participant 29, sentence 6
##
## Coefficients:
##           Estimate Std. Error z value Pr(>|z|)
## confident_beat_tapping 0.01085 0.05632 0.193 0.847
## musicality 0.02327 0.01643 1.417 0.157
## task_order 0.02515 0.16557 0.152 0.879
##
## Threshold coefficients:
##           Estimate Std. Error z value
## threshold.1 -0.97445 0.41723 -2.336
## spacing 0.32214 0.02048 15.733
```

Number of perceived cycles as the dependent variable

```
## Cumulative Link Mixed Model fitted with the Laplace approximation
##
## formula: as.factor(change_point_cycle_total) ~ confident_beat_tapping +
##          musicality + task_order + (1 | participant) + (1 | sentence)
## data:    data2
##
## link threshold nobs logLik AIC niter max.grad cond.H
## probit equidistant 174 -438.96 891.93 460(923) 3.84e-03 2.0e+03
##
## Random effects:
## Groups Name Variance Std.Dev.
## participant (Intercept) 0.09034 0.3006
## sentence (Intercept) 0.02762 0.1662
```

```
## Number of groups: participant 29, sentence 6
##
## Coefficients:
##               Estimate Std. Error z value Pr(>|z|)
## confident_beat_tapping 0.01426    0.06453  0.221    0.825
## musicality             0.02222    0.01882  1.180    0.238
## task_order             0.24180    0.19010  1.272    0.203
##
## Threshold coefficients:
##               Estimate Std. Error z value
## threshold.1 -1.03003    0.47808 -2.155
## spacing      0.33313    0.02055 16.214
```

Section 4.7. Task comparisons

i. ITI

ITI refers to inter-tap intervals, IOI to inter-onset intervals

```
## Single term deletions using Satterthwaite's method:
##
## Model:
## log(tap_ITI) ~ task * log(vowel_IOI) + task * log(spontaneous_right_mean_ITI) + (1 + log(vowel_IOI)
##               Sum Sq Mean Sq NumDF DenDF F value
## task:log(vowel_IOI)      0.23411 0.23411      1 310.78 6.9274
## task:log(spontaneous_right_mean_ITI) 0.14577 0.14577      1 310.78 4.3134
##               Pr(>F)
## task:log(vowel_IOI)      0.008912 **
## task:log(spontaneous_right_mean_ITI) 0.038634 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula:
## log(tap_ITI) ~ task * log(vowel_IOI) + task * log(spontaneous_right_mean_ITI) +
## (1 + log(vowel_IOI) | participant) + (1 | sentence)
## Data: data3
## Control:
## lmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlsminb",
## starttests = FALSE, kkt = FALSE))
##
## REML criterion at convergence: -69.1
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -3.7442 -0.6425 -0.0380  0.6763  4.2702
##
## Random effects:
## Groups      Name                Variance Std.Dev. Corr
## participant (Intercept)      1.258504 1.1218
##              log(vowel_IOI)  0.024494 0.1565  -1.00
## sentence    (Intercept)      0.003881 0.0623
```



```
## Residual 0.033794 0.1838
## Number of obs: 348, groups: participant, 29; sentence, 6
##
## Fixed effects:
## Estimate Std. Error df t value
## (Intercept) 1.65438 1.11971 26.84920 1.478
## taskNMR 0.38306 0.60312 310.77729 0.635
## log(vowel_IOI) 0.61303 0.12891 5.65748 4.756
## log(spontaneous_right_mean_ITI) 0.13402 0.13955 33.41163 0.960
## taskNMR:log(vowel_IOI) -0.22464 0.08535 310.77729 -2.632
## taskNMR:log(spontaneous_right_mean_ITI) 0.12955 0.06238 310.77730 2.077
## Pr(>|t|)
## (Intercept) 0.15117
## taskNMR 0.52582
## log(vowel_IOI) 0.00367 **
## log(spontaneous_right_mean_ITI) 0.34379
## taskNMR:log(vowel_IOI) 0.00891 **
## taskNMR:log(spontaneous_right_mean_ITI) 0.03863 *
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
## (Intr) tskNMR l(_IOI l(___I tNMR:(_I
## taskNMR -0.269
## lg(vwl_IOI) -0.635 0.254
## lg(s___ITI) -0.771 0.143 0.000
## tNMR:(_IOI) 0.207 -0.768 -0.331 0.000
## tNMR:(___IT 0.172 -0.640 0.000 -0.223 0.000
```

ii. CV of ITI

```
## Single term deletions using Satterthwaite's method:
##
## Model:
## tap_CV ~ task + (1 + task | participant) + (1 | sentence)
## Sum Sq Mean Sq NumDF DenDF F value Pr(>F)
## task 0.13373 0.13373 1 28 6.515 0.01644 *
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: tap_CV ~ task + (1 + task | participant) + (1 | sentence)
## Data: data3
## Control:
## lmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nllminb",
## starttests = FALSE, kkt = FALSE))
##
## REML criterion at convergence: -270.6
##
## Scaled residuals:
## Min 1Q Median 3Q Max
## -2.49108 -0.68947 0.07773 0.69278 2.48593
```

```

##
## Random effects:
##   Groups      Name      Variance Std.Dev. Corr
## participant (Intercept) 0.011507 0.10727
##           taskNMR      0.005959 0.07720 -0.53
## sentence   (Intercept) 0.005917 0.07692
## Residual                0.020526 0.14327
## Number of obs: 348, groups: participant, 29; sentence, 6
##
## Fixed effects:
##           Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)  0.47298    0.03874  9.88296  12.209 2.78e-07 ***
## taskNMR      -0.05363    0.02101 28.00033  -2.552  0.0164 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr)
## taskNMR -0.331

```