Spacek et al., 2021, Figure 5 Supplement-1

Figure 5-Supplement 1a

Effect of locomotion state on signal-to-noise ratio (SNR)

```
# Random intercept for neurons,
# random intercept for experiments, nested in series
lmer.5_S1a = lmer(snr ~ run + (1 | uid) + (1 | sid/eid),
                  data = tbab %>% drop_na(snr))

display(lmer.5_S1a)
```

```
## lmer(formula = snr ~ run + (1 | uid) + (1 | sid/eid), data = tbab %>%
##     drop_na(snr))
##             coef.est coef.se
## (Intercept)  0.16     0.02
## run         -0.01     0.01
##
## Error terms:
##  Groups   Name        Std.Dev.
##  uid      (Intercept) 0.09
##  eid:sid  (Intercept) 0.03
##  sid      (Intercept) 0.04
##  Residual             0.06
## ---
## number of obs: 260, groups: uid, 66; eid:sid, 22; sid, 10
## AIC = -542.9, DIC = -582.9
## deviance = -568.9
```

```
anova(lmer.5_S1a)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##       Sum Sq  Mean Sq NumDF  DenDF F value  Pr(>F)
## run 0.014326 0.014326     1 177.14  4.2596 0.04049 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

SNR locomotion: 0.15
SNR sitting: 0.16
n = 66 neurons from 6 mice

Figure 5-Supplement 1b

Effect of locomotion state on mean peak width

```
# Random for neurons,
# random intercept for series
lmer.5_S1b = lmer(meanpkw ~ run + (1 | uid) + (1 | sid),
                  data = tbab %>% drop_na(meanpkw))

display(lmer.5_S1b)
```

```
## lmer(formula = meanpkw ~ run + (1 | uid) + (1 | sid), data = tbab %>%
##     drop_na(meanpkw))
##             coef.est coef.se
## (Intercept) 0.07     0.00
## run         0.01     0.00
##
## Error terms:
##  Groups   Name        Std.Dev.
##  uid      (Intercept) 0.01
##  sid      (Intercept) 0.01
##  Residual             0.01
## ---
## number of obs: 204, groups: uid, 56; sid, 10
## AIC = -1030.4, DIC = -1079.3
## deviance = -1059.9
```

```
anova(lmer.5_S1b)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##        Sum Sq   Mean Sq NumDF DenDF F value    Pr(>F)
## run 0.0027359 0.0027359     1 146.2  13.216 0.0003837 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Mean peak width running: 0.075
Mean peak width sitting: 0.068
n = 56 neurons from 6 mice

Figure 5-Supplement 1c

Relation between firing rate RMI and burst ratio RMI

```
# Remove outliers
tb_clean <- tb %>% filter(meanburstratio < 0.99 & meanburstratio > -0.99)

# Random intercept for neurons,
# random intercept for experiments, nested in series
lmer.5_S1_c = lmer(meanburstratio ~ meanrate + (1 | uid) + (1 | sid/eid),
                   data = tb_clean %>% drop_na(meanburstratio, meanrate))

display(lmer.5_S1_c)
```

```
## lmer(formula = meanburstratio ~ meanrate + (1 | uid) + (1 | sid/eid),
##     data = tb_clean %>% drop_na(meanburstratio, meanrate))
##             coef.est coef.se
## (Intercept) -0.34     0.10
## meanrate     0.41     0.21
##
## Error terms:
##  Groups   Name        Std.Dev.
##  uid      (Intercept) 0.12
##  eid:sid  (Intercept) 0.05
##  sid      (Intercept) 0.27
##  Residual             0.21
## ---
## number of obs: 107, groups: uid, 57; eid:sid, 22; sid, 10
## AIC = 30.8, DIC = 10.2
## deviance = 14.5
```

```
anova(lmer.5_S1_c)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##          Sum Sq Mean Sq NumDF  DenDF F value  Pr(>F)
## meanrate 0.1529  0.1529     1 94.656  3.5986 0.06088 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Slope of 0.41 ± 0.43 (95-% confidence interval)
n = 57 neurons from 6 mice

Figure 5-Supplement 1d

Relation between firing rate RMI and sparseness RMI

```
# Random intercept for neurons,
# random intercept for experiments, nested in series
lmer.5_S1_d = lmer(spars ~ meanrate + (1 | uid) + (1 | sid/eid),
                   data = tb %>% drop_na(spars, meanrate))

display(lmer.5_S1_d)
```

```
## lmer(formula = spars ~ meanrate + (1 | uid) + (1 | sid/eid),
##     data = tb %>% drop_na(spars, meanrate))
##             coef.est coef.se
## (Intercept) -0.09     0.02
## meanrate    -0.11     0.05
##
## Error terms:
##  Groups   Name        Std.Dev.
##  uid      (Intercept) 0.06
##  eid:sid  (Intercept) 0.07
##  sid      (Intercept) 0.02
##  Residual             0.07
## ---
## number of obs: 129, groups: uid, 65; eid:sid, 22; sid, 10
## AIC = -212.7, DIC = -245
## deviance = -234.8
```

```
anova(lmer.5_S1_d)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##            Sum Sq  Mean Sq NumDF  DenDF F value  Pr(>F)
## meanrate 0.020771 0.020771     1 94.406  4.1333 0.04486 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Slope of -0.11 $\pm$ 0.11 (95%-confidence interval)
n = 65 neurons from 6 mice

Figure 5-Supplement 1e

Relation between firing rate RMI and reliability RMI

```
# Random intercept for neurons,
# random intercept for experiments, nested in series,nested in mice
lmer.5_S1e = lmer(rel ~ meanrate + (1 | uid) + (1 | mid/sid/eid),
                  data = tb %>% drop_na(rel, meanrate))

display(lmer.5_S1e)
```

```
## lmer(formula = rel ~ meanrate + (1 | uid) + (1 | mid/sid/eid),
##     data = tb %>% drop_na(rel, meanrate))
##             coef.est coef.se
## (Intercept) -0.14     0.07
## meanrate     0.59     0.19
##
## Error terms:
##  Groups        Name        Std.Dev.
##  uid           (Intercept) 0.18
##  eid:(sid:mid) (Intercept) 0.06
##  sid:mid       (Intercept) 0.05
##  mid           (Intercept) 0.09
##  Residual                  0.28
## ---
## number of obs: 125, groups: uid, 65; eid:(sid:mid), 22; sid:mid, 10; mid, 6
## AIC = 97, DIC = 71.8
## deviance = 77.4
```

```
anova(lmer.5_S1e)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##          Sum Sq Mean Sq NumDF DenDF F value   Pr(>F)
## meanrate 0.7587  0.7587     1 66.71  9.7807 0.002613 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Slope of 0.59 ± 0.38 (95%-confidence interval)
n = 65 neurons from 6 mice

Figure 5-Supplement 1f

Relation between firing rate RMI and SNR RMI

```
# Random intercept for neurons,
# random intercept for experiments, nested in series
lmer.5_S1f = lmer(snr ~ meanrate + (1 | uid) + (1 | sid/eid),
                  data = tb %>% drop_na(snr, meanrate))

display(lmer.5_S1f)
```

```
## lmer(formula = snr ~ meanrate + (1 | uid) + (1 | sid/eid), data = tb %>%
##     drop_na(snr, meanrate))
##             coef.est coef.se
## (Intercept) -0.13     0.04
## meanrate     0.55     0.09
##
## Error terms:
##  Groups   Name        Std.Dev.
##  uid      (Intercept) 0.09
##  eid:sid  (Intercept) 0.13
##  sid      (Intercept) 0.04
##  Residual             0.12
## ---
## number of obs: 129, groups: uid, 65; eid:sid, 22; sid, 10
## AIC = -83.1, DIC = -110.8
## deviance = -103.0
```

```
anova(lmer.5_S1f)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##           Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)
## meanrate 0.48921 0.48921     1 105.16  36.027 2.806e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Slope of 0.55 ± 0.18 (95%-confidence interval)
n = 65 neurons from 6 mice

Figure 5-Supplement 1g

Relation between firing rate RMI and peak width RMI

```
# Random intercept for mice
lmer.5_S1g = lmer(meanpkw ~ meanrate + (1 | mid),
                  data = tb %>% drop_na(meanpkw, meanrate))

display(lmer.5_S1g)
```

```
## lmer(formula = meanpkw ~ meanrate + (1 | mid), data = tb %>%
##     drop_na(meanpkw, meanrate))
##             coef.est coef.se
## (Intercept) 0.03     0.02
## meanrate    0.12     0.07
##
## Error terms:
##  Groups   Name        Std.Dev.
##  mid      (Intercept) 0.03
##  Residual             0.11
## ---
## number of obs: 102, groups: mid, 6
## AIC = -148.9, DIC = -177.8
## deviance = -167.4
```

```
anova(lmer.5_S1g)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##            Sum Sq  Mean Sq NumDF  DenDF F value  Pr(>F)
## meanrate 0.033279 0.033279     1 19.742  3.0096 0.09836 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Slope of 0.12 ± 0.14 (95%-confidence interval)
n = 56 neurons from 6 mice

Figure 5-Supplement 1h

Distributions of eye position variability, separated by locomotion state

```
# Random intercept for series
lmer.5_S1h = lmer(std_xpos_cross ~ run + (1 | sid),
                  data = tbh %>% drop_na(std_xpos_cross))

display(lmer.5_S1h)
```

```
## lmer(formula = std_xpos_cross ~ run + (1 | sid), data = tbh %>%
##     drop_na(std_xpos_cross))
##             coef.est coef.se
## (Intercept) 2.94     0.24
## run         1.50     0.24
##
## Error terms:
##  Groups   Name        Std.Dev.
##  sid      (Intercept) 0.52
##  Residual             0.91
## ---
## number of obs: 60, groups: sid, 10
## AIC = 178.3, DIC = 165.4
## deviance = 167.8
```

```
anova(lmer.5_S1h)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##     Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)
## run 33.965  33.965     1 49.434  40.625 5.985e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Locomotion: mean eye position standard deviation of 4.45 (95%-confidence interval)
Sitting: mean eye position standard deviation of 2.94
n = 30 experiments from 6 mice

Figure 5-Supplement 1i

Relation between locomotion effects on eye position variability and firing rate variability

```
# Random effect of experiment, units partially crossed
lmer.5_S1i = lmer(relrmi ~ iposrmi + (1 | uid),
                  data = tib %>% drop_na(relrmi, iposrmi))

display(lmer.5_S1i)
```

```
## lmer(formula = relrmi ~ iposrmi + (1 | uid), data = tib %>% drop_na(relrmi,
##     iposrmi))
##             coef.est coef.se
## (Intercept)  0.05     0.05
## iposrmi     -0.46     0.19
##
## Error terms:
##  Groups   Name        Std.Dev.
##  uid      (Intercept) 0.21
##  Residual             0.28
## ---
## number of obs: 125, groups: uid, 65
## AIC = 93.5, DIC = 73
## deviance = 79.3
```

```
anova(lmer.5_S1i)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##          Sum Sq Mean Sq NumDF  DenDF F value  Pr(>F)
## iposrmi 0.46306 0.46306     1 108.53  5.9177 0.01662 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Slope of -0.46 $\pm$ 0.38 (95%-confidence interval)

Expected difference in reliability RMI corresponding to a 1 standard deviation difference in eye position σ RMI is -0.084, the standard deviation of the residuals is 0.28.

n = 65 neurons from 6 mice