

Spacek et al., 2021, Figure 1

Figure 1f

Feedback effects on firing rate

```
# We fit a random-intercept, random-slope model with two random effects:
# (1) Neurons (uid) can have different baseline firing rates,
# and the effect of feedback can vary across neurons.
# (2) Mean firing rates are allowed to differ across experiments (eid),
# which are nested within recording sessions (sid),
# which are nested within animals (mid).

lmer.1f = lmer(rates ~ feedback + (1 + feedback | uid) + (1 | mid/sid/eid),
              data = tb %>% drop_na(rates))

display(lmer.1f)

## lmer(formula = rates ~ feedback + (1 + feedback | uid) + (1 |
##   mid/sid/eid), data = tb %>% drop_na(rates))
##           coef.est coef.se
## (Intercept) 10.48      2.23
## feedback      3.23      0.78
##
## Error terms:
## Groups      Name          Std.Dev. Corr
## uid         (Intercept) 10.30
##            feedback      6.28   -0.23
## eid:(sid:mid) (Intercept) 2.58
## sid:mid      (Intercept) 1.42
## mid          (Intercept) 3.91
## Residual                    6.36
## ---
## number of obs: 45192, groups: uid, 65; eid:(sid:mid), 24; sid:mid, 11; mid, 6
## AIC = 296402, DIC = 296393.8
## deviance = 296389.2

anova(lmer.1f)

## Type III Analysis of Variance Table with Satterthwaite's method
##           Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)
## feedback 691.49  691.49     1 63.214  17.077 0.0001075 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Feedback: mean firing rate of 13.7 spikes/s
Suppression: mean firing rate of 10.5 spikes/s
n = 65 neurons from 6 mice
```

Figure 1g

Feedback effects on burst ratio

```
# Random-intercept, random-slope for single neurons,  
# random intercept for experiments.  
# Variability across series and mice is close to zero,  
# including random intercepts for those gives singular fits.  
  
lmer.1g = lmer(burstratios ~ feedback + (1 + feedback | uid) + (1 | eid),  
             data = tb %>% drop_na(burstratios))  
  
display(lmer.1g)  
  
## lmer(formula = burstratios ~ feedback + (1 + feedback | uid) +  
##       (1 | eid), data = tb %>% drop_na(burstratios))  
##           coef.est coef.se  
## (Intercept)  0.09      0.01  
## feedback    -0.04      0.01  
##  
## Error terms:  
## Groups   Name          Std.Dev. Corr  
## uid      (Intercept)  0.11  
##          feedback     0.08    -0.90  
## eid      (Intercept)  0.01  
## Residual                0.10  
## ---  
## number of obs: 43037, groups: uid, 65; eid, 24  
## AIC = -71234.3, DIC = -71279.5  
## deviance = -71263.9  
  
anova(lmer.1g)  
  
## Type III Analysis of Variance Table with Satterthwaite's method  
##           Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)  
## feedback 0.19754 0.19754     1 63.983  17.935 7.463e-05 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
  
Feedback: mean burst ratio of 0.05  
Suppression: mean burst ratio of 0.09  
n = 65 neurons from 6 mice
```

Figure 1h

Feedback effects on sparseness

```
# Random-intercept, random-slope for single neurons,  
# random intercept for experiments, nested within series  
lmer.1h = lmer(spars ~ feedback + (1 + feedback | uid) + (1 | sid/eid),  
              data = tbhi %>% drop_na(spars))
```

```
display(lmer.1h)
```

```
## lmer(formula = spars ~ feedback + (1 + feedback | uid) + (1 |  
##   sid/eid), data = tbhi %>% drop_na(spars))  
##           coef.est coef.se  
## (Intercept)  0.45      0.04  
## feedback    -0.10      0.02  
##  
## Error terms:  
## Groups   Name          Std.Dev. Corr  
## uid      (Intercept)  0.19  
##          feedback     0.11    -0.42  
## eid:sid  (Intercept)  0.04  
## sid      (Intercept)  0.08  
## Residual                0.07  
## ---  
## number of obs: 248, groups: uid, 65; eid:sid, 24; sid, 11  
## AIC = -284.8, DIC = -323.2  
## deviance = -312.0
```

```
anova(lmer.1h)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method  
##           Sum Sq Mean Sq NumDF DenDF F value  Pr(>F)  
## feedback 0.17017 0.17017     1 62.994   33.74 2.24e-07 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Feedback: 0.35

Suppression: 0.45

n = 65 neurons from 6 mice

Figure 1i

Feedback effects on reliability

```
# Random-intercept, random-slope for single neurons,  
# random intercept for experiments, nested within series  
lmer.1i = lmer(rel ~ feedback + (1 + feedback | uid) + (1 | sid/eid),  
              data = tbhi %>% drop_na(rel))  
  
display(lmer.1i)  
  
## lmer(formula = rel ~ feedback + (1 + feedback | uid) + (1 | sid/eid),  
##      data = tbhi %>% drop_na(rel))  
##              coef.est coef.se  
## (Intercept)  0.18      0.02  
## feedback    -0.03      0.01  
##  
## Error terms:  
## Groups   Name          Std.Dev. Corr  
## uid      (Intercept)  0.11  
##          feedback     0.02    -0.96  
## eid:sid (Intercept)  0.05  
## sid      (Intercept)  0.02  
## Residual                0.04  
## ---  
## number of obs: 248, groups: uid, 65; eid:sid, 24; sid, 11  
## AIC = -590.4, DIC = -635.9  
## deviance = -621.2  
  
anova(lmer.1i)  
  
## Type III Analysis of Variance Table with Satterthwaite's method  
##              Sum Sq Mean Sq NumDF DenDF F value    Pr(>F)  
## feedback  0.034617  0.034617     1  63.101  17.782 8.058e-05 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
  
Feedback: 0.15  
Suppression: 0.18  
n = 65 neurons from 6 mice
```