mrot diapause - immunity

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Set-up

```
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.4     v readr     2.1.5
## v forcats   1.0.0     v stringr   1.5.1
## v ggplot2   3.5.1     v tibble    3.2.1
## v lubridate 1.9.3     v tidyr     1.3.1
## v purrr     1.0.2
## -- 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
```

```
library(car)
```

```
## Loading required package: carData
##
## Attaching package: 'car'
##
## The following object is masked from 'package:dplyr':
##
##     recode
##
## The following object is masked from 'package:purrr':
##
##     some
```

```
library(nortest)
library(lme4)
```

```
## Warning: package 'lme4' was built under R version 4.3.3
```

```
## Loading required package: Matrix
##
## Attaching package: 'Matrix'
##
```

```
## The following objects are masked from 'package:tidyr':
##
##     expand, pack, unpack
```

```
library(ggsignif)
```

Data

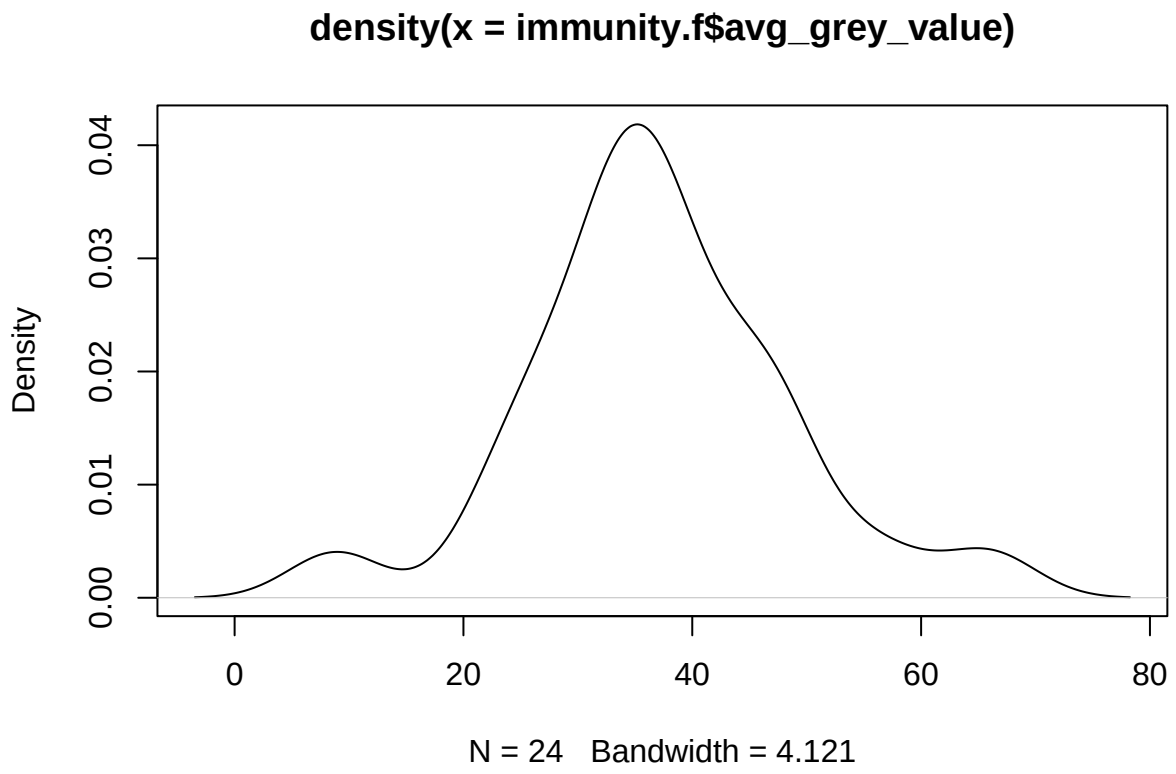
```
immunity <- read_csv("Megachile_D_vs_ND_grey_values.csv",
                     col_select = c(1:5),
                     col_names = TRUE,
                     col_types = cols(
                       beeID = col_character(),
                       avg_grey_value = col_double(),
                       treatment = col_character(),
                       sex = col_character(),
                       thorax = col_double()
                     ))
problems(immunity)
```

```
immunity.f <- immunity %>%
  filter(sex == "F")
```

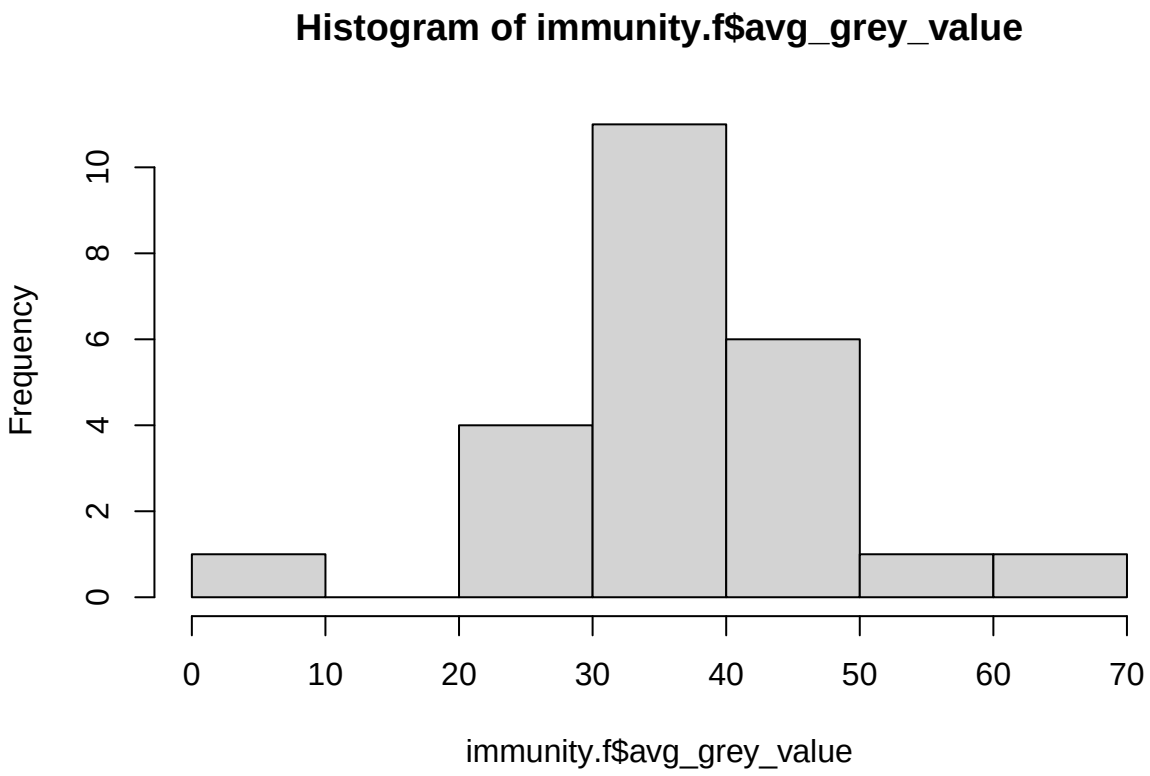
Separate out just the females

Summarize

```
plot(density(immunity.f$avg_grey_value))
```




```r
hist(immunity.f$avg_grey_value)
```

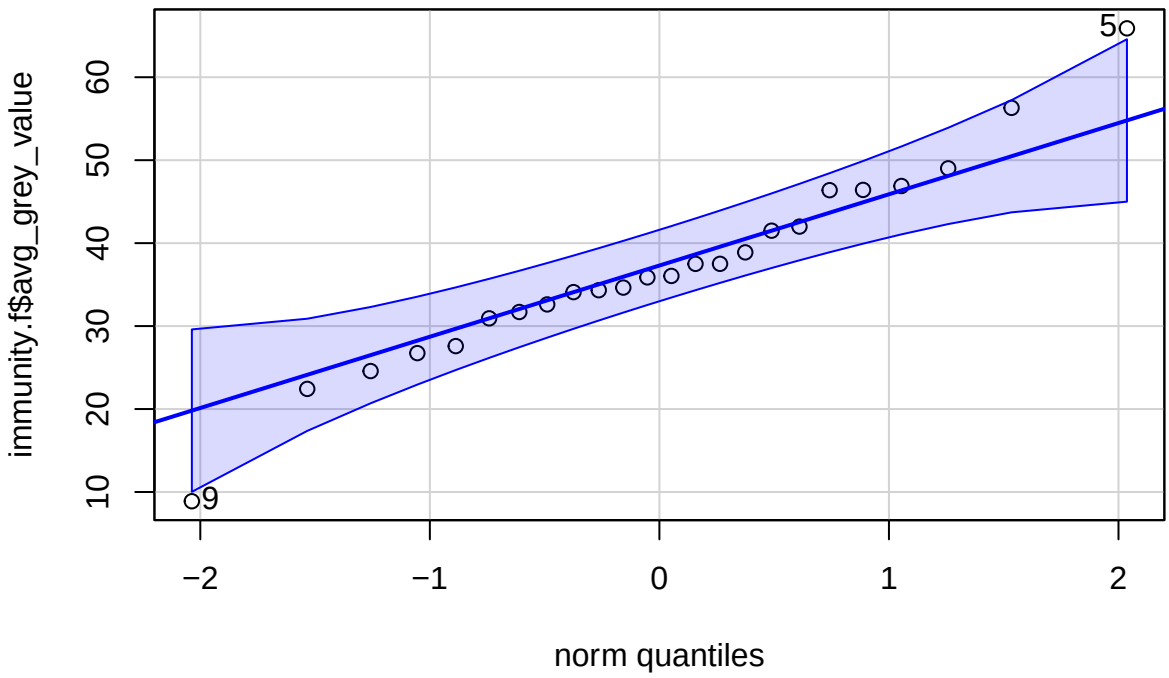



```
immunity.f %>%
  group_by(treatment) %>%
  summarise(median = median(avg_grey_value),
            mean = mean(avg_grey_value),
            se = sd(avg_grey_value)/sqrt(n()),
            n = n())
```

```
## # A tibble: 2 x 5
##   treatment median  mean    se     n
##   <chr>      <dbl> <dbl> <dbl> <int>
## 1 D           36.7  36.6  4.13    12
## 2 ND          35.3  37.5  2.58    12
```

Statistical analysis

```
qqp(immunity.f$avg_grey_value, "norm")
```




```
## [1] 5 9
```

```
shapiro.test(immunity.f$avg_grey_value)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  immunity.f$avg_grey_value
## W = 0.97227, p-value = 0.7231
```

```
ad.test(immunity.f$avg_grey_value)
```

```
##
##  Anderson-Darling normality test
##
## data:  immunity.f$avg_grey_value
## A = 0.33594, p-value = 0.4784
```

```
leveneTest(avg_grey_value ~ treatment, data = immunity.f)
```

```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to
## factor.
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value Pr(>F)
## group  1  1.0698 0.3122
##       22
```

```
m1 <- lm(avg_grey_value ~ treatment + thorax, data = immunity.f)
summary(m1)
```

```
##
## Call:
## lm(formula = avg_grey_value ~ treatment + thorax, data = immunity.f)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -27.617  -5.506  -1.014   6.195  29.473
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  40.0166    55.3616   0.723    0.478
## treatmentND   0.8018     5.2841   0.152    0.881
## thorax       -1.3836    22.2108  -0.062    0.951
##
## Residual standard error: 12.21 on 21 degrees of freedom
## Multiple R-squared:  0.001775,   Adjusted R-squared:  -0.09329
## F-statistic: 0.01867 on 2 and 21 DF,  p-value: 0.9815
```

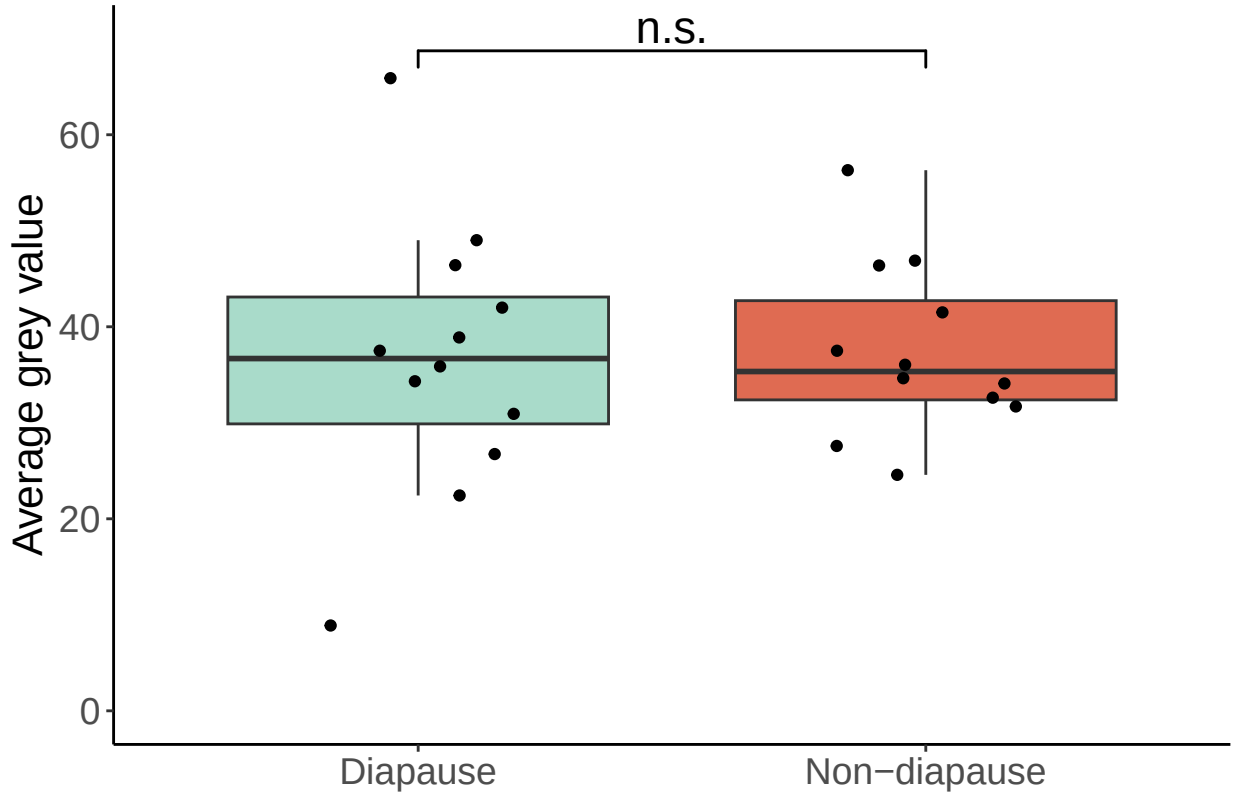
```
Anova(m1)
```

```
## Anova Table (Type II tests)
##
## Response: avg_grey_value
##            Sum Sq Df F value Pr(>F)
## treatment    3.43  1  0.0230 0.8808
## thorax       0.58  1  0.0039 0.9509
## Residuals 3128.55 21
```

plot

```
ggplot(immunity.f, aes(x = treatment, y = avg_grey_value,
                       fill = treatment)) +
  geom_boxplot(alpha = 0.8, outlier.color=NA) +
  geom_jitter(position = position_jitter(width = 0.20)) +
  geom_signif(data = immunity.f, stat = "signif", position = "identity",
              comparisons = list(c("D", "ND")), map_signif_level = TRUE,
              annotations = "n.s.", textsize = 6) +
  coord_cartesian(ylim = c(0, 70)) +
  theme_classic() +
  scale_fill_manual(values = c("#94D2BD","#D84727")) +
  theme(legend.position = "none",
        axis.title=element_text(size=16), axis.text=element_text(size=14)) +
```

```
  xlab("") +
  scale_x_discrete(labels = c("Diapause", "Non-diapause")) +
  ylab("Average grey value")
```




```
ggsave("immunity.png", width = 7, height = 5)
```

bookkeeping

```
sessionInfo()
```

```
## R version 4.3.2 (2023-10-31)
## Platform: aarch64-apple-darwin20 (64-bit)
## Running under: macOS Sonoma 14.2.1
##
## Matrix products: default
## BLAS:   /Library/Frameworks/R.framework/Versions/4.3-arm64/Resources/lib/libRblas.0.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/4.3-arm64/Resources/lib/libRlapack.dylib;  LAPACK v
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## time zone: America/Denver
```

```
## tzcode source: internal
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] ggsignif_0.6.4  lme4_1.1-35.5   Matrix_1.6-5    nortest_1.0-4
##  [5] car_3.1-2       carData_3.0-5   lubridate_1.9.3 forcats_1.0.0
##  [9] stringr_1.5.1   dplyr_1.1.4     purrr_1.0.2     readr_2.1.5
## [13] tidyr_1.3.1     tibble_3.2.1    ggplot2_3.5.1   tidyverse_2.0.0
##
## loaded via a namespace (and not attached):
##  [1] gtable_0.3.5      xfun_0.46         lattice_0.22-6    tzdb_0.4.0
##  [5] vctrs_0.6.5       tools_4.3.2       generics_0.1.3    parallel_4.3.2
##  [9] fansi_1.0.6       highr_0.11        pkgconfig_2.0.3   lifecycle_1.0.4
## [13] compiler_4.3.2    farver_2.1.2      textshaping_0.4.0 munsell_0.5.1
## [17] htmltools_0.5.8.1 yaml_2.3.10       pillar_1.9.0      nloptr_2.1.1
## [21] crayon_1.5.3      MASS_7.3-60.0.1   boot_1.3-30       abind_1.4-5
## [25] nlme_3.1-165      tidyselect_1.2.1  digest_0.6.36     stringi_1.8.4
## [29] labeling_0.4.3    splines_4.3.2     fastmap_1.2.0     grid_4.3.2
## [33] colorspace_2.1-1  cli_3.6.3         magrittr_2.0.3    utf8_1.2.4
## [37] withr_3.0.0       scales_1.3.0      bit64_4.0.5       timechange_0.3.0
## [41] rmarkdown_2.27    bit_4.0.5         ragg_1.3.2        hms_1.1.3
## [45] evaluate_0.24.0   knitr_1.48        rlang_1.1.4       Rcpp_1.0.13
## [49] glue_1.7.0        rstudioapi_0.16.0 vroom_1.6.5       minqa_1.2.7
## [53] R6_2.5.1          systemfonts_1.1.0
```

```
citation("tidyverse")
```

```
## To cite package 'tidyverse' in publications use:
##
##   Wickham H, Averick M, Bryan J, Chang W, McGowan LD, François R,
##   Grolemund G, Hayes A, Henry L, Hester J, Kuhn M, Pedersen TL, Miller
##   E, Bache SM, Müller K, Ooms J, Robinson D, Seidel DP, Spinu V,
##   Takahashi K, Vaughan D, Wilke C, Woo K, Yutani H (2019). "Welcome to
##   the tidyverse." _Journal of Open Source Software_, *4*(43), 1686.
##   doi:10.21105/joss.01686 <https://doi.org/10.21105/joss.01686>.
##
## A BibTeX entry for LaTeX users is
##
##   @Article{,
##     title = {Welcome to the {tidyverse}},
##     author = {Hadley Wickham and Mara Averick and Jennifer Bryan and Winston Chang and Lucy D'Agosti
##     year = {2019},
##     journal = {Journal of Open Source Software},
##     volume = {4},
##     number = {43},
##     pages = {1686},
##     doi = {10.21105/joss.01686},
##   }
```

```
citation("car")
```

```
## To cite the car package in publications use:
```

```
##
##   Fox J, Weisberg S (2019). _An R Companion to Applied Regression_,
##   Third edition. Sage, Thousand Oaks CA.
##   <https://socialsciences.mcmaster.ca/jfox/Books/Companion/>.
##
## A BibTeX entry for LaTeX users is
##
##   @Book{,
##     title = {An {R} Companion to Applied Regression},
##     edition = {Third},
##     author = {John Fox and Sanford Weisberg},
##     year = {2019},
##     publisher = {Sage},
##     address = {Thousand Oaks {CA}},
##     url = {https://socialsciences.mcmaster.ca/jfox/Books/Companion/},
##   }
```

```
citation("nortest")
```

```
## To cite package 'nortest' in publications use:
##
##   Gross J, Ligges U (2015). _nortest: Tests for Normality_. R package
##   version 1.0-4, <https://CRAN.R-project.org/package=nortest>.
##
## A BibTeX entry for LaTeX users is
##
##   @Manual{,
##     title = {nortest: Tests for Normality},
##     author = {Juergen Gross and Uwe Ligges},
##     year = {2015},
##     note = {R package version 1.0-4},
##     url = {https://CRAN.R-project.org/package=nortest},
##   }
```

```
citation("lme4")
```

```
## To cite lme4 in publications use:
##
##   Douglas Bates, Martin Maechler, Ben Bolker, Steve Walker (2015).
##   Fitting Linear Mixed-Effects Models Using lme4. Journal of
##   Statistical Software, 67(1), 1-48. doi:10.18637/jss.v067.i01.
##
## A BibTeX entry for LaTeX users is
##
##   @Article{,
##     title = {Fitting Linear Mixed-Effects Models Using {lme4}},
##     author = {Douglas Bates and Martin M{\"a}chler and Ben Bolker and Steve Walker},
##     journal = {Journal of Statistical Software},
##     year = {2015},
##     volume = {67},
##     number = {1},
##     pages = {1--48},
##     doi = {10.18637/jss.v067.i01},
##   }
```

```r
citation("ggsignif")
```

```
## To cite 'ggsignif' in publications use:
##
##   Ahlmann-Eltze, C., & Patil, I. (2021). ggsignif: R Package for
##   Displaying Significance Brackets for 'ggplot2'. PsyArxiv.
##   doi:10.31234/osf.io/7awm6
##
## A BibTeX entry for LaTeX users is
##
##   @Article{,
##     title = {{ggsignif}: R Package for Displaying Significance Brackets for {'ggplot2'}},
##     author = {Ahlmann-Eltze Constantin and Indrajeet Patil},
##     year = {2021},
##     journal = {PsyArxiv},
##     url = {https://psyarxiv.com/7awm6},
##     doi = {10.31234/osf.io/7awm6},
##   }
```