Baby_BP_pilot

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To help doctors get the most out of working with a biostats hospital hire, here are some template thoughts…

For project XXX and its main objectives, can you provide me with..

1. descriptive figures to summarize data/get-to-know variables. Ok to send before main objective results.

> i.e. distribution on continuous variables and counts for categorical. this should be a baseline. doctors dont always know what to ask for and biostats person, as part of their job, should be providing more than whats requested (otherwise biostats person is no better than AI and can easily be replaced).

2. your interpretation of all results/plots-in simple terms tell me what the plot shows and what you concluded solely based on the figure

> this is especially important for main objective plots. citations related to plot type should be provided with biostats report (i.e. citation for bp plot)

3. your concerns with study design and/or results, and any suggestions for improvements. You are the expert and i would greatly appreciate any feedback!

> not all concerns can be addressed but doctors should at least have an idea of what biostats person thinks-is the study design sufficient to address main objective? are their limitations? if some adjustments can be made to better address project aims, is it going to require an IRB update? is it reasonable within a timeline discussed for project? i.e. not having enough power to make claim like wrist cuffs are correlated with gold standard-a power analysis can tell you if the current study design will be sufficient to address objectives. i.e. a requested plot had different number of data points (26 vs 29 for all other correlation plots)-why? following # 2 point of template will prevent questions like this in future

4. responses to any of my questions within 48 hours. need more time and will get back to you soon is valid response.

> doctors are likely interested in what biostats person makes, so it should be expected that more questions will follow. however, if the biostats person follows template 1-3 points, less questions adn discussion may be required because everything is incldued in report! its a good point for them to invest in doing template points 1-3, if they dont, then template point 4 should absolutely be required. weeks to send any results and being slow to respond to questions from doctors who have looked over results hinders doctors ability to apply their expertise to analysis, get more thorough conclusions from data they have invested time and effort in collecting, and ultimately limits the ability for studies to improve quality of patient care. no excuse.

This markdown is an example of following template points 1-3. it includes basic data summary figures, redundancy of main objective related results (same point made with multiple plot types), and short interpretation following a result (what i thought about table or figure result).

Time spent on this markdown = 1 day.

note - I am not a formally trained biostats person. i would expect the analysis provided by biostats person for hospital to do a MUCH better/more thorough job than this. please consider this a benchmark for minimum effort.

```
## made df for histogram by combining sys and dia into single column. made from Baby_
blood_pressure.csv by copy/paste in excel.
df2 <- read.csv("Baby_blood_pressure_redundant.csv", stringsAsFactors=FALSE)
df2$BabyID <- factor(df2$BabyID)
df2$Session <- factor(df2$Session)
df2[['Device']] <- factor(df2[['Device']], levels = c(
  'Gold',
  'Wristcuff'
))
df2[['Rater']] <- factor(df2[['Rater']], levels = c(
  'RN',
  'Gibbs',
  'Not Gibbs'
))
df2$Device <- df2$Rater
df2[['Device']] <- factor(df2[['Device']],
                          labels = c("Gold standard", "Wrist cuff 1", "Wrist cuff 2")
)
df2[['Type']] <- factor(df2[['Type']], levels = c(
  'Systolic',
```

```
  'Diastolic'
))
df2$Disposition <- df2$Dispo
df2[['Disposition']] <- factor(df2[['Disposition']],
                        levels = c(0,1,2,3),
                        labels = c("sleeping", "calm", "active", "crying")
)

## df for all other plots and stats
df <- read.csv("Baby_blood_pressure.csv", stringsAsFactors=FALSE)
df$BabyID <- factor(df$BabyID)
df$Session <- factor(df$Session)
df[['Device']] <- factor(df[['Device']], levels = c(
  'Gold',
  'Wristcuff'
))
df[['Rater']] <- factor(df[['Rater']], levels = c(
  'RN',
  'Gibbs',
  'Not Gibbs'
))
df$Device <- df$Rater
df[['Device']] <- factor(df[['Device']],
                        labels = c("Gold standard", "Wrist cuff 1", "Wrist cuff 2")
)
df$Disposition <- df$Dispo
df[['Disposition']] <- factor(df[['Disposition']],
                        levels = c(0,1,2,3),
                        labels = c("sleeping", "calm", "active", "crying")
)
drops <- c("Dispo")
df <- df[ , !(names(df) %in% drops)]

# CONSTANTS used in cells below
#rater_colors = c("gold", "#d88c80", "#9c81ff")

wes_palettes <- list(
  BottleRocket1 = c("#A42820", "#5F5647", "#9B110E", "#3F5151", "#4E2A1E", "#550307",
"#0C1707"),
  BottleRocket2 = c("#FAD510", "#CB2314", "#273046", "#354823", "#1E1E1E"),
  Rushmore1 = c("#E1BD6D", "#EABE94", "#0B775E", "#35274A" ,"#F2300F"),
  Rushmore = c("#E1BD6D", "#EABE94", "#0B775E", "#35274A" ,"#F2300F"),
  Royal1 = c("#899DA4", "#C93312", "#FAEFD1", "#DC863B"),
  Royal2 = c("#9A8822", "#F5CDB4", "#F8AFA8", "#FDDDA0", "#74A089"),
  Zissou1 = c("#3B9AB2", "#78B7C5", "#EBCC2A", "#E1AF00", "#F21A00"),
  Darjeeling1 = c("#FF0000", "#00A08A", "#F2AD00", "#F98400", "#5BBCD6"),
  Darjeeling2 = c("#ECCBAE", "#046C9A", "#D69C4E", "#ABDDDE", "#000000"),
  Chevalier1 = c("#446455", "#FDD262", "#D3DDDC", "#C7B19C"),
  FantasticFox1 = c("#DD8D29", "#E2D200", "#46ACC8", "#E58601", "#B40F20"),
```

```
  Moonrise1 = c("#F3DF6C", "#CEAB07", "#D5D5D3", "#24281A"),
  Moonrise2 = c("#798E87", "#C27D38", "#CCC591", "#29211F"),
  Moonrise3 = c("#85D4E3", "#F4B5BD", "#9C964A", "#CDC08C", "#FAD77B"),
  Cavalcanti1 = c("#D8B70A", "#02401B", "#A2A475", "#81A88D", "#972D15"),
  GrandBudapest1 = c("#F1BB7B", "#FD6467", "#5B1A18", "#D67236"),
  GrandBudapest2 = c("#E6A0C4", "#C6CDF7", "#D8A499", "#7294D4"),
  IsleofDogs1 = c("#9986A5", "#79402E", "#CCBA72", "#0F0D0E", "#D9D0D3", "#8D8680"),
  IsleofDogs2 = c("#EAD3BF", "#AA9486", "#B6854D", "#39312F", "#1C1718"),
  FrenchDispatch = c("#90D4CC", "#BD3027", "#B0AFA2", "#7FC0C6", "#9D9C85")
)

rater_colors = c("#DD8D29", "#E2D200", "#46ACC8") #c("#F2AD00","#90D4CC",  "#FD6467")

dispo_colors = c("#7294D4", "#C6CDF7","#FD6467", "#5B1A18")

bp_colors = c("#FF0000", "#08519c")

compare_dispo <- list(c("sleeping", "calm"), c("sleeping", "active"), c("calm", "acti
ve"))
compare_raters <- list(c("RN", "Gibbs"), c("RN", "Not Gibbs"), c("Gibbs", "Not Gibb
s"))
compare_devices <- list(c("Gold standard", "Wrist cuff 1"),
                        c("Gold standard", "Wrist cuff 2"),
                        c("Wrist cuff 1", "Wrist cuff 2"))
```

```
summary(df)
```

```
##      BabyID   Session           Device         Rater         Sys
##  2      : 9   1:39    Gold standard:29   RN       :29   Min.   : 49.00
##  3      : 9   2:30    Wrist cuff 1 :29   Gibbs    :29   1st Qu.: 63.50
##  4      : 9   3:18    Wrist cuff 2 :29   Not Gibbs:29   Median : 71.00
##  8      : 9                                             Mean   : 73.18
##  10     : 9                                             3rd Qu.: 82.00
##  12     : 9                                             Max.   :108.00
##  (Other):33
##       Dia          Disposition
##  Min.   :26.00   sleeping:19
##  1st Qu.:37.00   calm    :51
##  Median :41.00   active  :16
##  Mean   :42.74   crying  : 1
##  3rd Qu.:46.50
##  Max.   :71.00
##
```

- result: babies 2,3,4,8,10,12 have 3 sessions. each rater has 29 data points for systolic and 29 for diastolic, total of 87 measurement points.

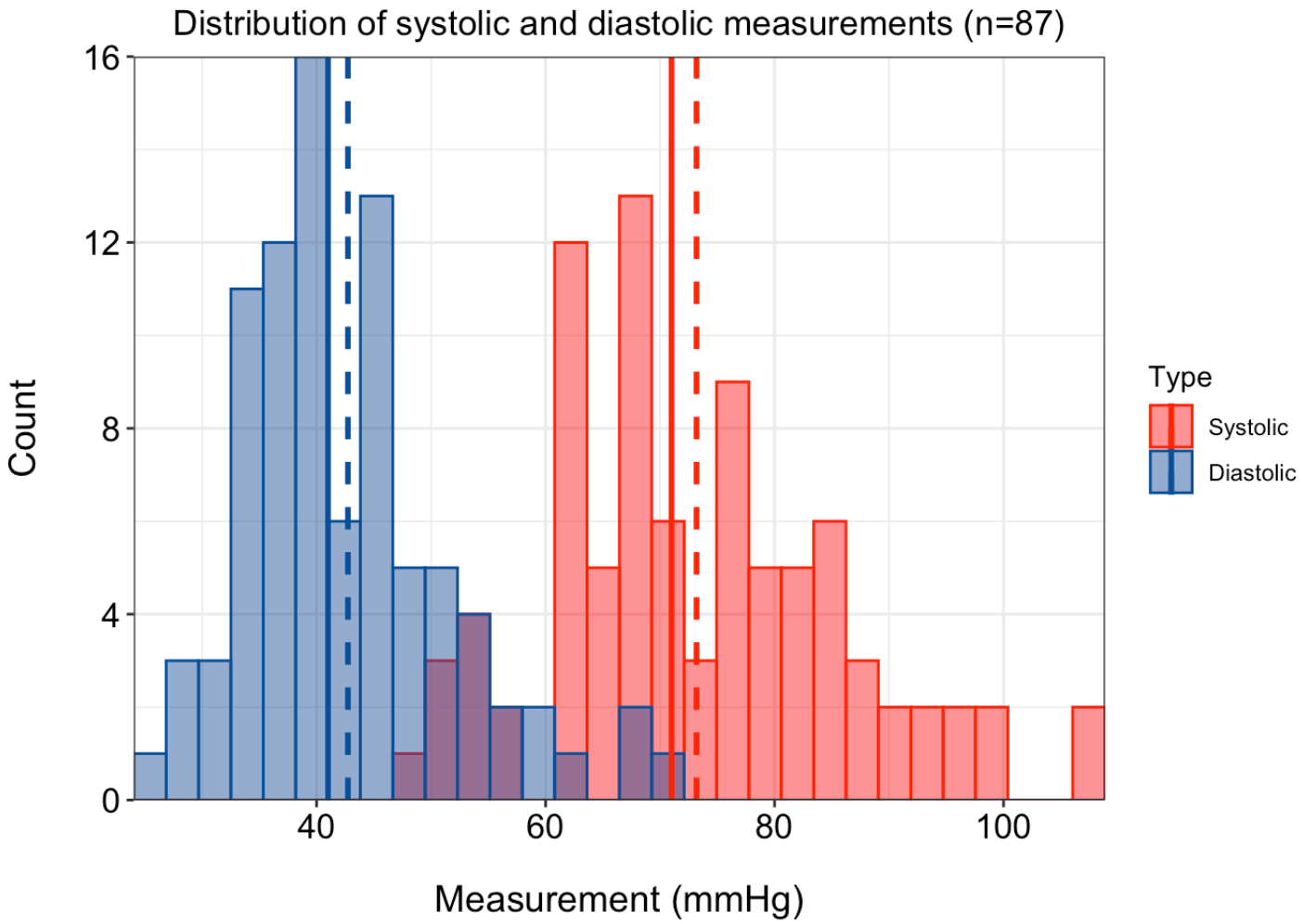
To assess device/rater measurement mean differences, i first used histograms to understand the variable distribution. this matters for picking the best stats test method to use to compare group means.

```
summary_mean_median <- ddply(df2, "Type", summarise,
                         Mean=mean(Measurement),
                         Median=median(Measurement))
summary_mean_median
```

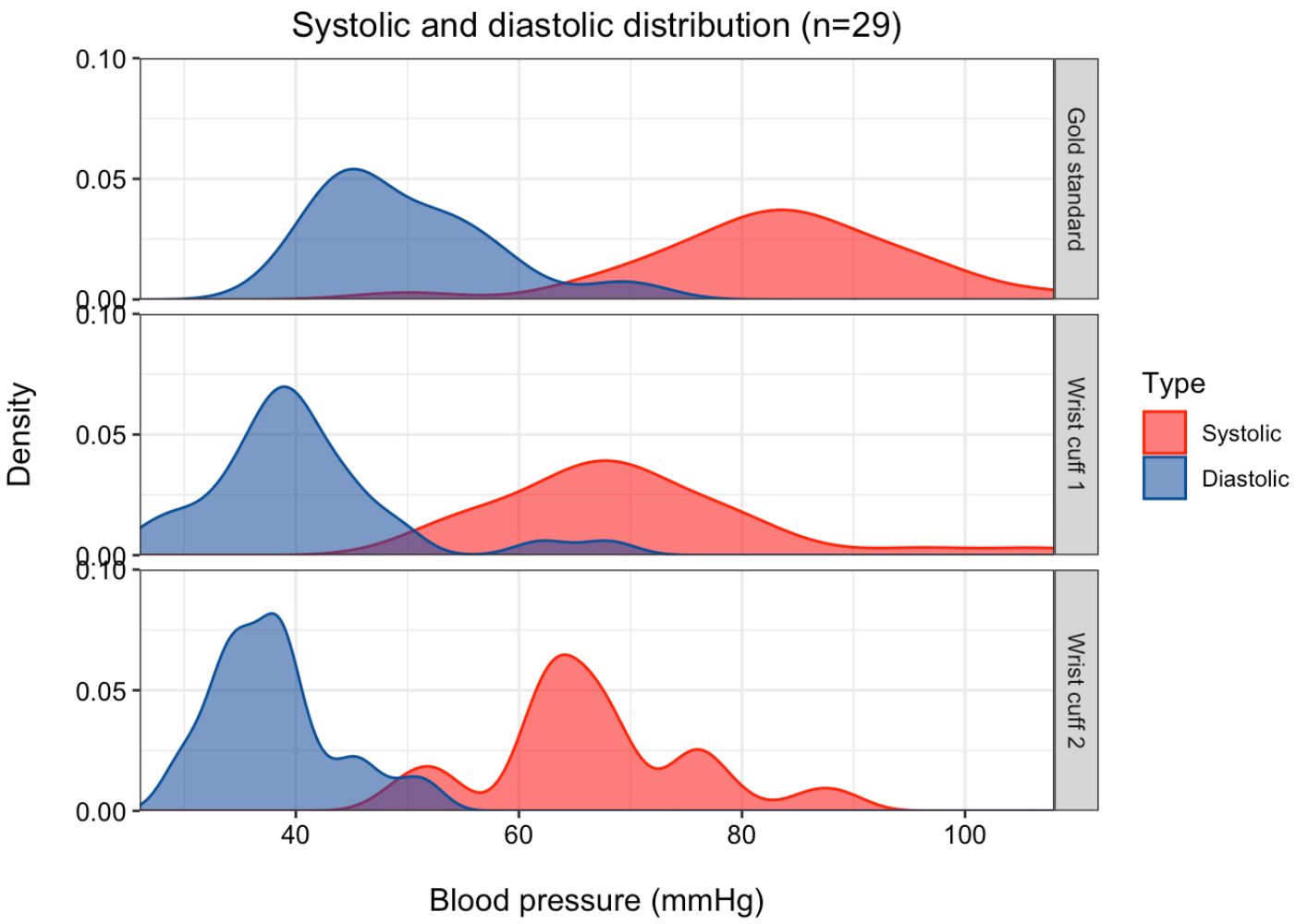
```
##        Type     Mean Median
## 1  Systolic 73.18391     71
## 2 Diastolic 42.73563     41
```

```
normalized_dist_check <- ggplot(df2, aes(x = Measurement, color=Type, fill = Type))

hist_all <- normalized_dist_check +
  geom_histogram(position="identity", alpha=0.5)  + #bins=100, binwidth = 0.02 ,
  geom_vline(data=summary_mean_median, aes(xintercept=Mean, color=Type), size=1,  lin
etype="dashed") +
  geom_vline(data=summary_mean_median, aes(xintercept=Median, color=Type), size=1, li
netype="solid") +
  theme_bw() +
  scale_fill_manual(values=bp_colors) +
  scale_color_manual(values=bp_colors) +
  scale_y_continuous(expand = c(0, 0)) +
  scale_x_continuous(expand = c(0, 0)) +
  ylab("Count") +
  xlab("Measurement (mmHg)") +
  ggtitle("Distribution of systolic and diastolic measurements (n=87)") +
  theme(legend.position="right",
        plot.title = element_text(hjust=0.5),
        axis.title.x = element_text(size=14, color="black",
                                    margin=margin(t=15, b=5)),
        axis.title.y = element_text(size=14, color="black", margin=margin(t=0, r=15,
b=0)),
        axis.text=element_text(size=13,vjust=0.5, color="black", margin=margin(t=20,
b=20)))
hist_all
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```


Distribution of systolic and diastolic measurements (n=87)
Count
16
12
8
4
0
40
60
80
100
Measurement (mmHg)
Type
Systolic
Diastolic

```
hist_wrap <- normalized_dist_check +
  geom_density(alpha=0.6) +
  #geom_histogram(bins=10, binwidth =1 ,position="identity", alpha=0.5)  + #
  #geom_vline(data=summary_mean_median, aes(xintercept=Mean, color=Type), size=1,  li
netype="dashed") +
  #geom_vline(data=summary_mean_median, aes(xintercept=Median, color=Type), size=1, l
inetype="solid") +
  theme_bw() +
  scale_fill_manual(values=bp_colors) +
  scale_color_manual(values=bp_colors) +
  scale_y_continuous(expand = c(0, 0), limits = c(0,0.1), n.breaks = 4) +
  scale_x_continuous(expand = c(0, 0)) +
  ylab("Density") +
  xlab("Blood pressure (mmHg)") +
  ggtitle("Systolic and diastolic distribution (n=29)") +
  theme(legend.position="right",
        plot.title = element_text(hjust=0.5),
        axis.title.x = element_text(size=12, color="black",
                                    margin=margin(t=15, b=5)),
        axis.title.y = element_text(size=12, color="black", margin=margin(t=0, r=15,
b=0)),
        axis.text=element_text(size=10,vjust=0.5, color="black", margin=margin(t=20,
b=20))) + facet_grid(Device ~ .)

hist_wrap
```




```
ggsave("density_systolic_diastolic_facetgrid_device.png", width=8, height=6, dpi=300)
```

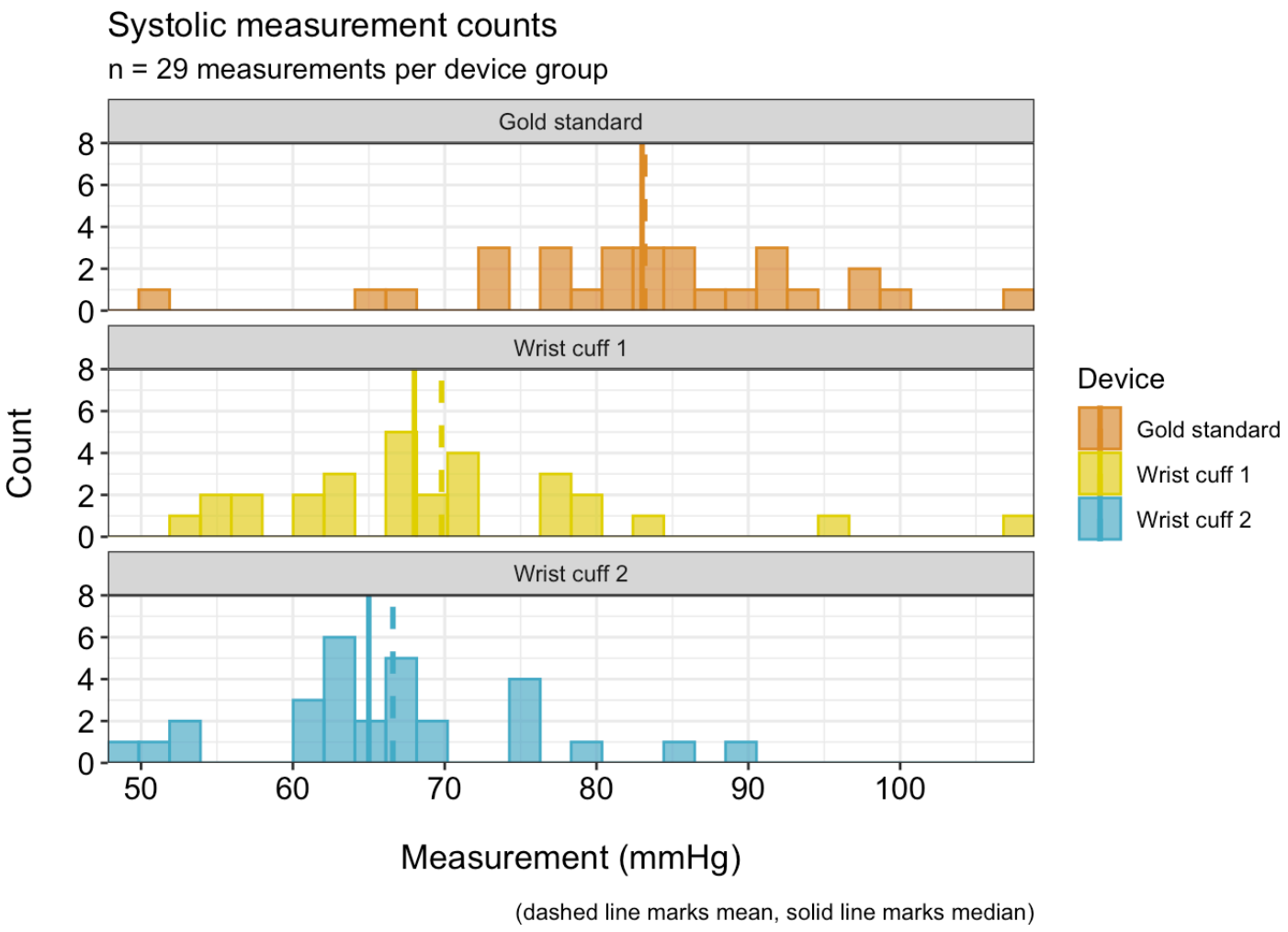
- result: slight right skew in sys and dia distribution. mean (dashed line) slightly higher than median (solid line).
- question of whether to use parametric or nonparametric test- for all data points (n=87)?
- note on central limit theorem- if the sample size is large enough (n > 30), we can ignore the distribution of the data and use parametric tests. The central limit theorem tells us that no matter what distribution things have, the sampling distribution tends to be normal if the sample is large enough (n > 30).
- but since data is skewed, for comparisons of groups with n= <30, is parametric test ok?

```
df2_sys <- df2 %>% filter(Type == "Systolic")

summary_mean_median_sys <- ddply(df2_sys, "Device", summarise,
                         Mean=mean(Measurement),
                         Median=median(Measurement))
summary_mean_median_sys
```

```
##          Device     Mean Median
## 1 Gold standard 83.17241     83
## 2  Wrist cuff 1 69.79310     68
## 3  Wrist cuff 2 66.58621     65
```

```
hist_sys_data <- ggplot(df2_sys, aes(x = Measurement, color=Device, fill = Device))

hist_raters <- hist_sys_data +
  geom_histogram(position="identity", alpha=0.7)  +
  geom_vline(data=summary_mean_median_sys, aes(xintercept=Mean, color=Device), size=
1,  linetype="dashed") +
  geom_vline(data=summary_mean_median_sys, aes(xintercept=Median, color=Device), size
=1, linetype="solid") +
  theme_bw() +
  scale_fill_manual(values=rater_colors) +
  scale_color_manual(values=rater_colors) +
  scale_y_continuous(expand = c(0, 0), limits = c(0,8), n.breaks = 5) +
  scale_x_continuous(expand = c(0, 0), n.breaks = 9) +
  labs(y="Count", x="Measurement (mmHg)",
       title="Systolic measurement counts",
        subtitle = "n = 29 measurements per device group",
              caption = "(dashed line marks mean, solid line marks median)") +
  theme(legend.position="right",
        #plot.title = element_text(hjust=0.5),
        axis.title.x = element_text(size=13, color="black",
                                    margin=margin(t=15, b=5)),
        axis.title.y = element_text(size=13, color="black", margin=margin(t=0, r=15,
b=0)),
        axis.text=element_text(size=12,vjust=0.5, color="black", margin=margin(t=20,
b=20)))
hist_raters = hist_raters + facet_wrap(~ Device, ncol=1)
hist_raters
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```




```
ggsave("histogram_systolic_per_device.png", width =8, height = 6)
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

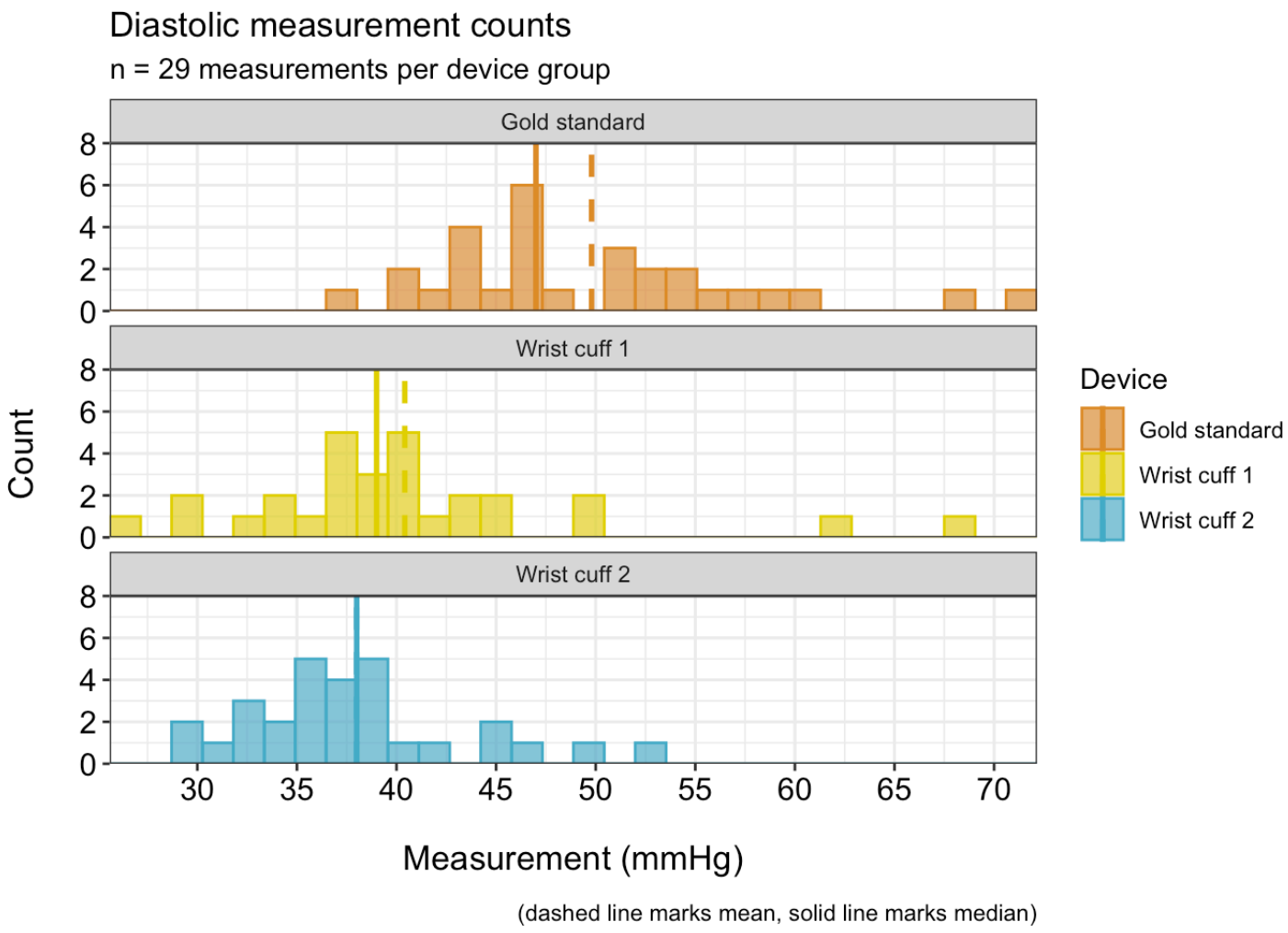
- result = systolic RN/gold standard device is normally distributed (median = mean). systolic wrist cuff measurements skewed.

```
df2_sys <- df2 %>% filter(Type == "Diastolic")

summary_mean_median_sys <- ddply(df2_sys, "Device", summarise,
                         Mean=mean(Measurement),
                         Median=median(Measurement))
summary_mean_median_sys
```

```
##          Device     Mean Median
## 1 Gold standard 49.79310     47
## 2  Wrist cuff 1 40.41379     39
## 3  Wrist cuff 2 38.00000     38
```

```
hist_sys_data <- ggplot(df2_sys, aes(x = Measurement, color=Device, fill = Device))

hist_raters <- hist_sys_data +
  geom_histogram(position="identity", alpha=0.7)  +
  geom_vline(data=summary_mean_median_sys, aes(xintercept=Mean, color=Device), size=
1,  linetype="dashed") +
  geom_vline(data=summary_mean_median_sys, aes(xintercept=Median, color=Device), size
=1, linetype="solid") +
  theme_bw() +
  scale_fill_manual(values=rater_colors) +
  scale_color_manual(values=rater_colors) +
  scale_y_continuous(expand = c(0, 0), limits = c(0,8), n.breaks = 5) +
  scale_x_continuous(expand = c(0, 0), n.breaks = 9) +
  labs(y="Count", x="Measurement (mmHg)",
       title="Diastolic measurement counts",
        subtitle = "n = 29 measurements per device group",
              caption = "(dashed line marks mean, solid line marks median)") +
  theme(legend.position="right",
        #plot.title = element_text(hjust=0.5),
        axis.title.x = element_text(size=13, color="black",
                                    margin=margin(t=15, b=5)),
        axis.title.y = element_text(size=13, color="black", margin=margin(t=0, r=15,
b=0)),
        axis.text=element_text(size=12,vjust=0.5, color="black", margin=margin(t=20,
b=20)))
hist_raters = hist_raters + facet_wrap(~ Device, ncol=1)
hist_raters
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```




```
ggsave("histogram_diastolic_per_device.png", width =8, height = 6)
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

- result: similar to systolic result for RN, the not gibbs diastolic result seems normally distributed (mean=median). largest skew observed for RN gold standard measurements for diastolic.

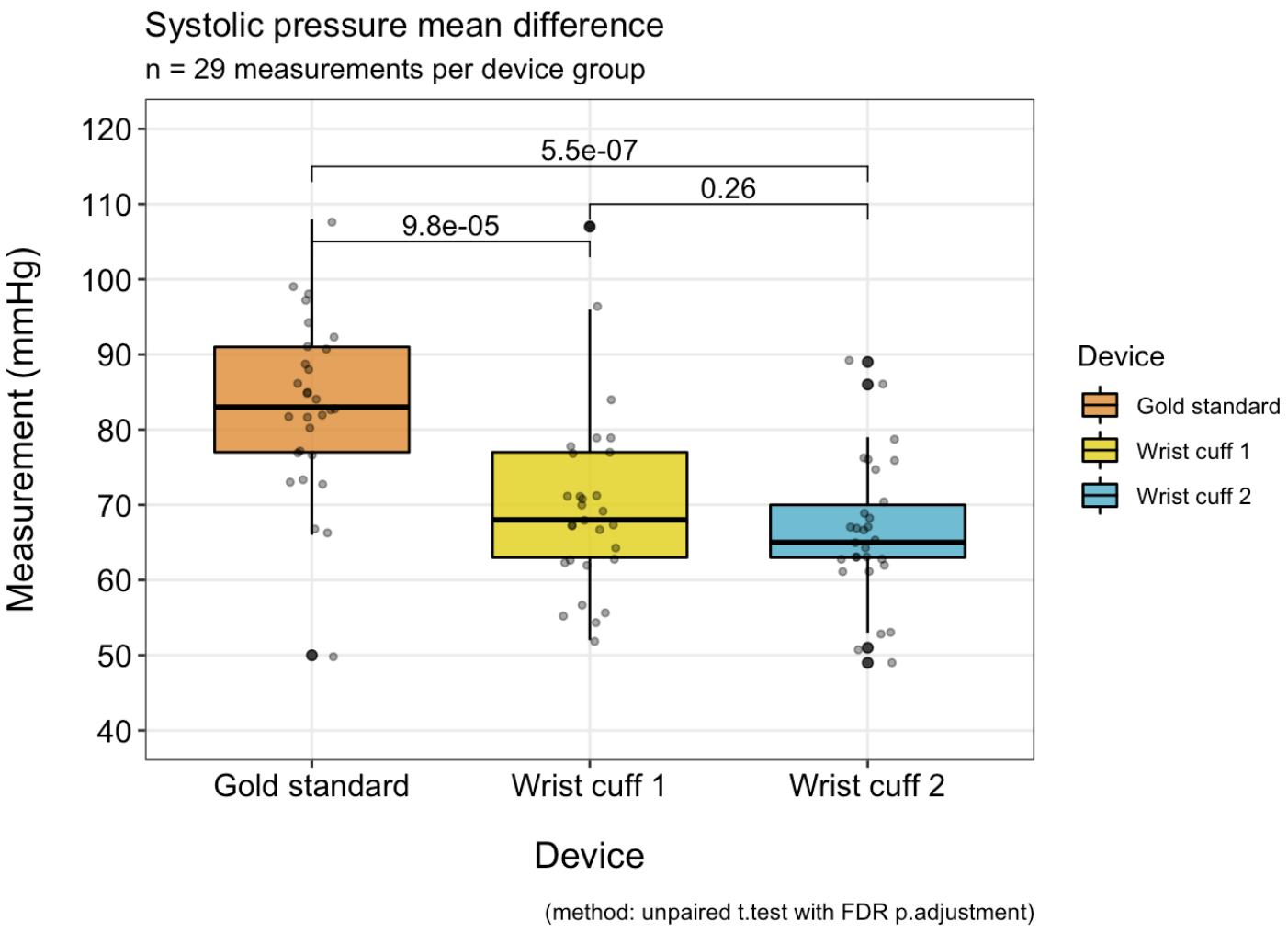
shapiro.test(df[['Sys']])

```
boxplot_3_comparison <- function(df, xname, yname, fillname, ylabel, yrange, titlenam
e, subname, capname, colorname, stat_table, stat_label) {
  bxplot <- ggboxplot(df, x = xname, y = yname, fill = fillname, alpha=0.8, notch=FAL
SE) +
  stat_pvalue_manual(stat_table, label = stat_label) +
  scale_fill_manual(values=colorname) +
  scale_y_continuous(n.breaks = 9, limits=yrange) +
  theme_bw() +
  labs(x=xname,
       y= ylabel,
        title = titlename,
       subtitle = subname,
       caption = capname) +
  theme(panel.grid.minor = element_blank()) +
  theme(legend.position='right') +
  theme(
        axis.title.x = element_text(size=14, color="black", margin=margin(t=15, b=
5)),
        axis.title.y = element_text(size=14, color="black", margin=margin(t=0, r=15,
b=0)),
        axis.text=element_text(size=12, color="black", margin=margin(t=20, b=20)))
  return(bxplot)
}
```

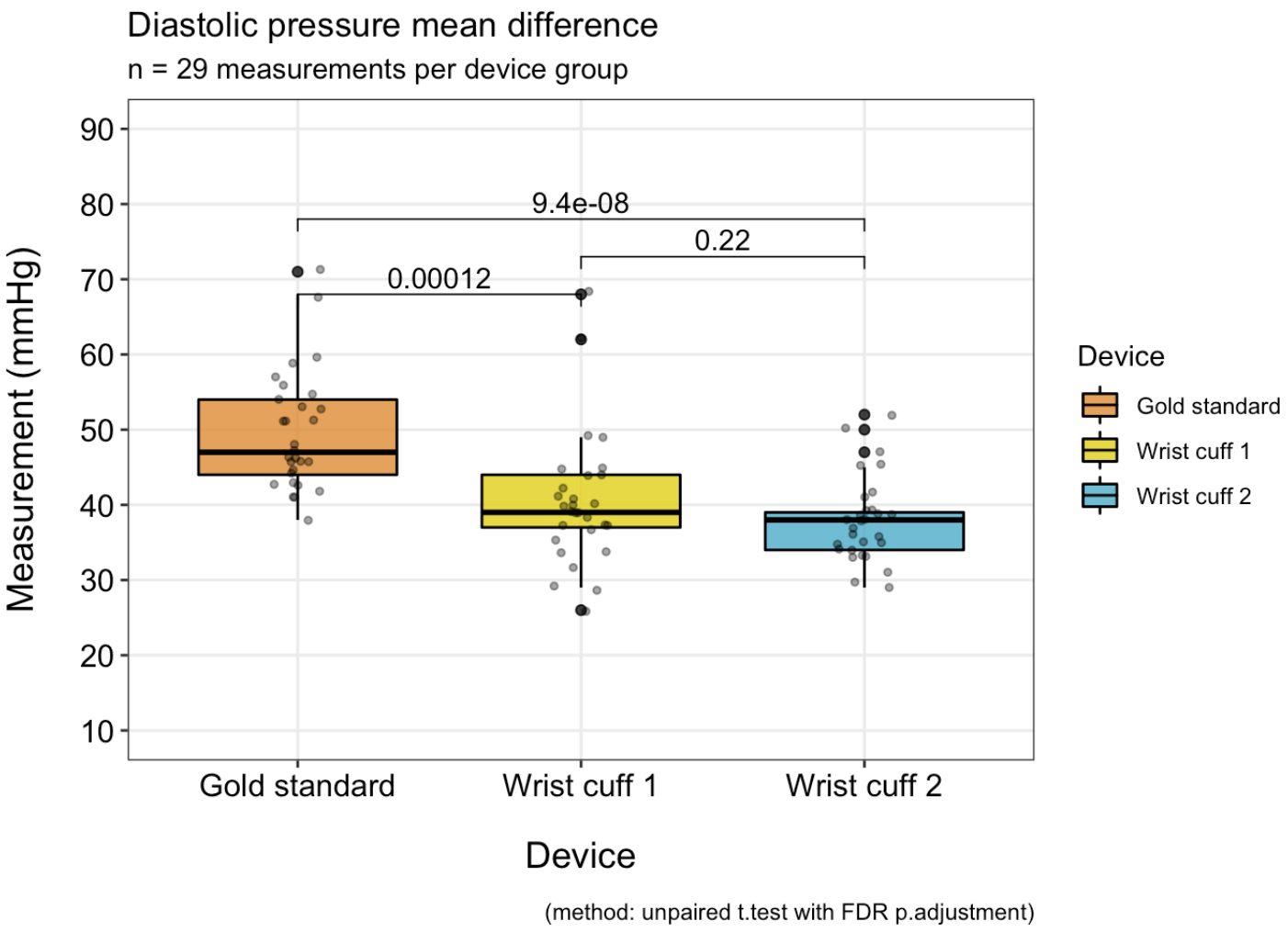
```
sys_test <- compare_means(Sys ~ Device,
                          data=df,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=FALSE,
                          comparisons = compare_devices)
sys_test <- sys_test %>% mutate(y.position = c(105, 115, 110))
dia_test <- compare_means(Dia ~ Device,
                          data=df,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=FALSE,
                          comparisons = compare_devices)
dia_test <- dia_test %>% mutate(y.position = c(68, 78, 73))
bind_rows(sys_test, dia_test)
```

```
## # A tibble: 6 × 9
##   .y.   group1        group2        p  p.adj p.format p.signif method y.position
##   <chr> <chr>         <chr>     <dbl>  <dbl> <chr>    <chr>    <chr>       <dbl>
## 1 Sys   Gold standard Wrist … 6.55e-5 9.8e-5 6.6e-05  ****     T-test        105
## 2 Sys   Gold standard Wrist … 1.83e-7 5.5e-7 1.8e-07  ****     T-test        115
## 3 Sys   Wrist cuff 1  Wrist … 2.63e-1 2.6e-1 0.26     ns       T-test        110
## 4 Dia   Gold standard Wrist … 7.72e-5 1.2e-4 7.7e-05  ****     T-test         68
## 5 Dia   Gold standard Wrist … 3.14e-8 9.4e-8 3.1e-08  ****     T-test         78
## 6 Dia   Wrist cuff 1  Wrist … 2.18e-1 2.2e-1 0.22     ns       T-test         73
```

```
sys_all_box1 <- boxplot_3_comparison(df, "Device", "Sys", "Device",
                                     "Measurement (mmHg)",
                                     c(40,120),
                                     "Systolic pressure mean difference",
                                     "n = 29 measurements per device group",
                                     "(method: unpaired t.test with FDR p.adjustmen
t)",
                                     rater_colors,
                                     sys_test,
                                     "p.adj"
                                     )
sys_all_box1 + geom_jitter(size=1, color="black", width=0.1, alpha=0.4)
```




```
ggsave("boxplot_systolic_device.png", width=8, height=6, dpi=300)

dia_all_box1 <- boxplot_3_comparison(df, "Device", "Dia", "Device",
                                     "Measurement (mmHg)",
                                     c(10,90),
                                      "Diastolic pressure mean difference",
                                     "n = 29 measurements per device group",
                                     "(method: unpaired t.test with FDR p.adjustmen
t)",
                                     rater_colors,
                                     dia_test,
                                     "p.adj"
                                     )
dia_all_box1 + geom_jitter(size=1, color="black", width=0.1, alpha=0.4)
```



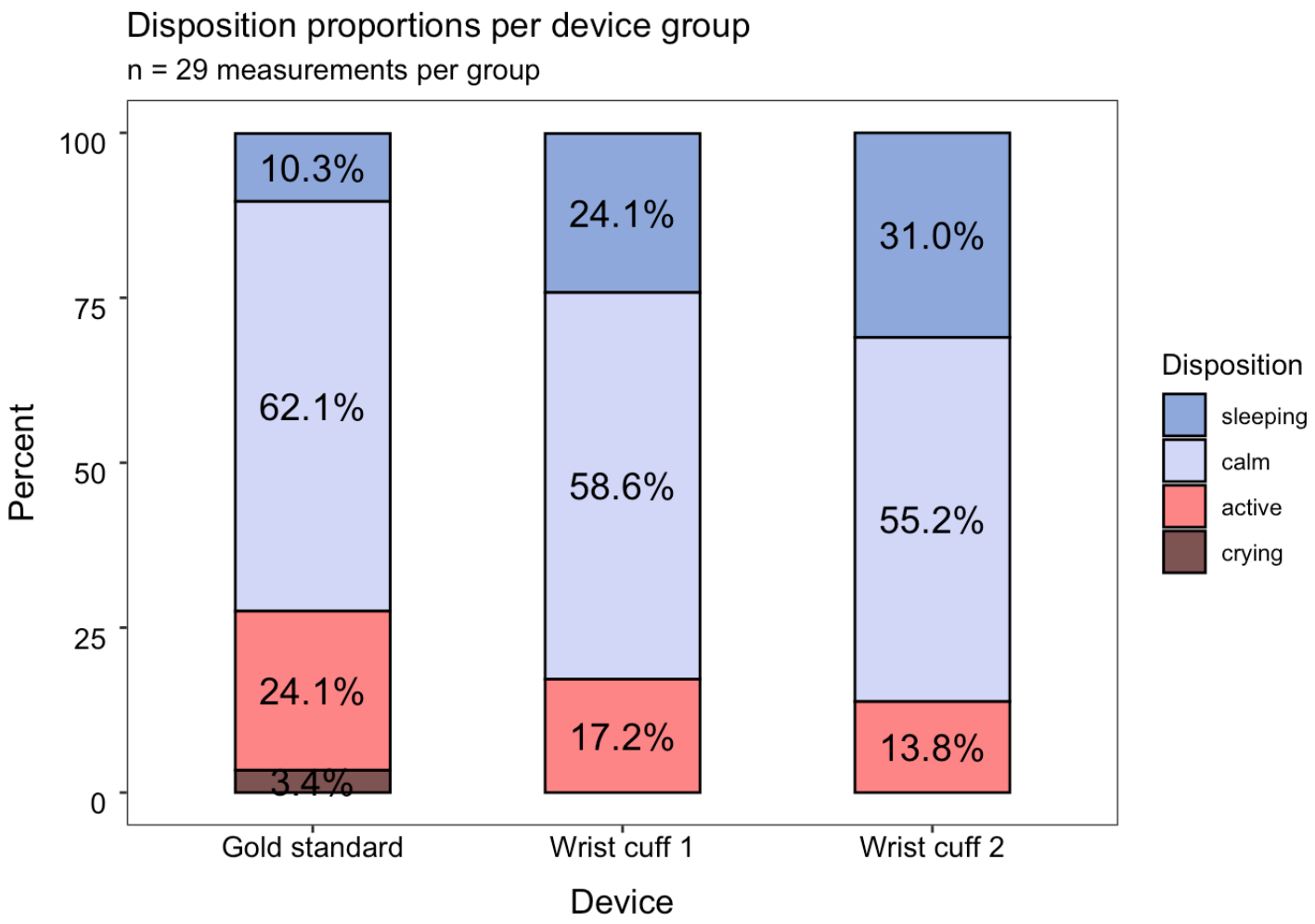

```
ggsave("boxplot_diastolic_device.png", width=8, height=6, dpi=300)
```

- result = when looking at all data points, the mean difference between two wrist cuff groups is insignificant. significant mean difference observed for all wrist cuff to gold standard comparisons, with the gold standard on average having higher measurement values than the wrist cuff.

```
rater_dispo_percent <- df %>%
  dplyr::group_by(Device, Disposition) %>%
  dplyr::tally() %>%
  dplyr::mutate(Percent = round(n/sum(n) * 100, 1))
rater_dispo_percent
```

```
## # A tibble: 10 × 4
## # Groups:   Device [3]
##    Device        Disposition     n Percent
##    <fct>         <fct>       <int>   <dbl>
##  1 Gold standard sleeping        3    10.3
##  2 Gold standard calm           18    62.1
##  3 Gold standard active          7    24.1
##  4 Gold standard crying          1     3.4
##  5 Wrist cuff 1  sleeping        7    24.1
##  6 Wrist cuff 1  calm           17    58.6
##  7 Wrist cuff 1  active          5    17.2
##  8 Wrist cuff 2  sleeping        9    31
##  9 Wrist cuff 2  calm           16    55.2
## 10 Wrist cuff 2  active          4    13.8
```

```
bar_dispo_percennt <- ggplot(rater_dispo_percent, aes(x=Device,
                          y=Percent,
                          fill=Disposition)) +
 geom_bar(stat="identity", width=0.5, colour="black", alpha=0.8) +
 geom_text(aes(label=paste0(sprintf("%1.1f", Percent),"%")),
                     position=position_stack(vjust=0.5),
                    colour="black",
           size = 5,
           check_overlap = TRUE) +
  scale_fill_manual(values = dispo_colors) +
  labs(fill='Disposition') +
  theme_bw() +
  theme(panel.grid.minor = element_blank(),
        panel.grid.major = element_blank(),
        panel.background = element_blank(),
        axis.line = element_blank()) +
                    labs(x="Device",
                         y= "Percent",
                         title="Disposition proportions per device group",
                         subtitle = "n = 29 measurements per group") +
                    theme(legend.position='right') +

                    theme(axis.title.x = element_text(size=13, color="black", margin=
margin(t=10, b=5)),
                          axis.title.y = element_text(vjust = 3, size=13, color="blac
k", margin=margin(t=5, b=5, r=1, l=1)),
                           axis.text.y = element_text(vjust = 1, size=11, color="blac
k", margin = margin(t = 5, r=5, b = 5)),
                           axis.text.x = element_text(size=11, color="black", margin
= margin(t = 1)),
                          axis.text = element_text(size=13, color="black", margin = m
argin(t = 1))
                          )
bar_dispo_percennt
```




```
ggsave("barstack_disposition_proportions_per_device.png", width = 8, height = 6, dpi=
300)
```

- result: larger % of babies are sleeping during measurements taken with wrist cuff (24% and 31%) than with gold standard (10%). this makes me think that the lower measurements seen for wrist cuff vs gold stadard are related to baby disposition, and interpretation of above results is confounded by this variable. Most babies were calm during measurements for all 3 groups. are the differences significant when only looking at calm disposition measurements?

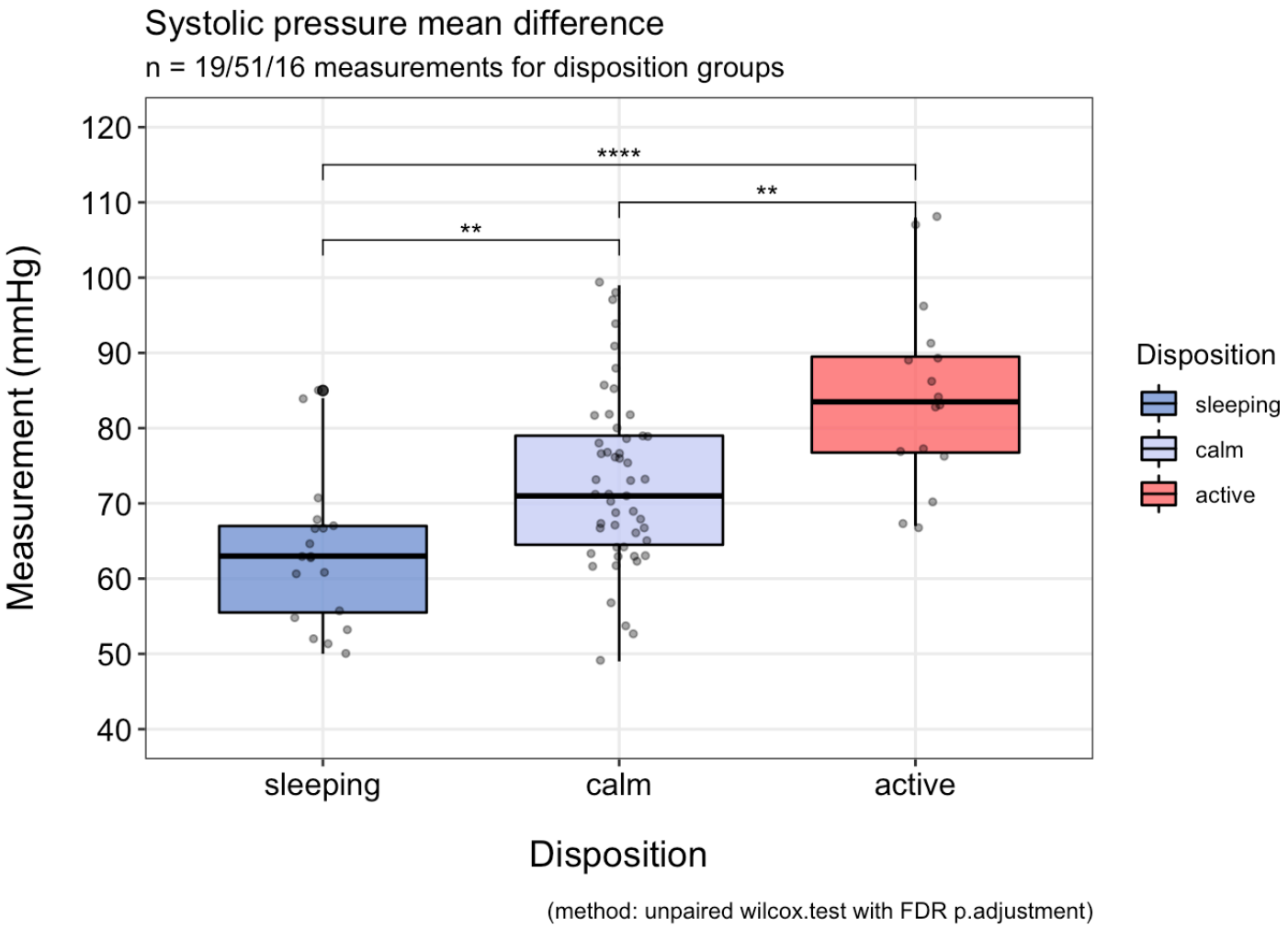
```
dispo_count <- df %>%
  dplyr::group_by(Disposition) %>%
  dplyr::tally() %>%
  dplyr::mutate(Percent.Dispo = round(n/sum(n) * 100, 1))
dispo_count
```

```
## # A tibble: 4 × 3
##   Disposition     n Percent.Dispo
##   <fct>       <int>         <dbl>
## 1 sleeping       19          21.8
## 2 calm           51          58.6
## 3 active         16          18.4
## 4 crying          1           1.1
```

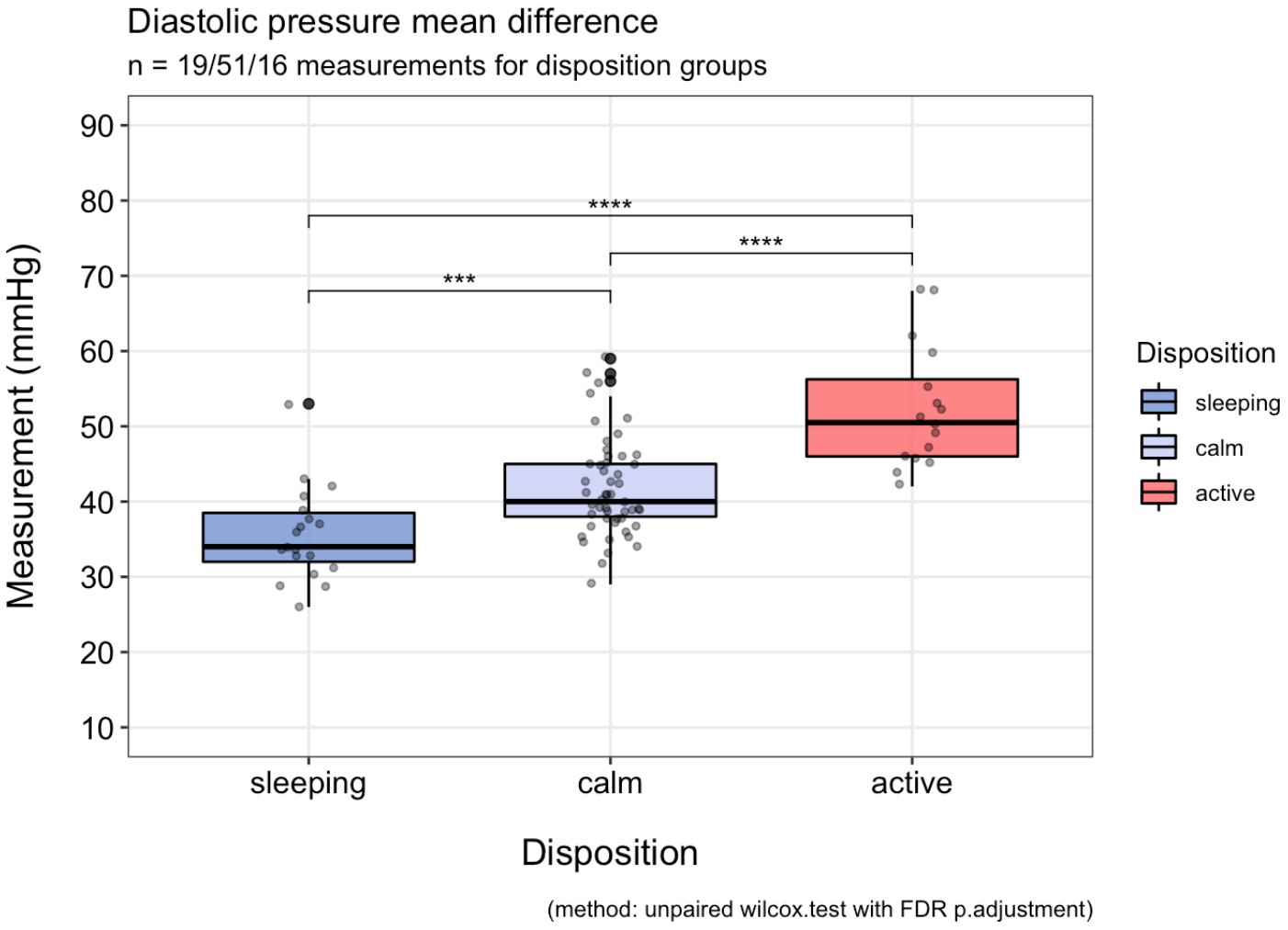
```
nocry <- df %>% filter(Disposition != "crying")

sys_test <- compare_means(Sys ~ Disposition,
                          data=nocry,
                          method="wilcox.test",
                          p.adjust.method ="fdr",
                          paired=FALSE,
                          comparisons = compare_dispo)
sys_test <- sys_test %>% mutate(y.position = c(105, 115, 110))

dia_test <- compare_means(Dia ~ Disposition,
                          data=nocry,
                          method="wilcox.test",
                          p.adjust.method ="fdr",
                          paired=FALSE,
                          comparisons = compare_dispo)
dia_test <- dia_test %>% mutate(y.position = c(68, 78, 73))

bind_rows(sys_test, dia_test)
```

```
## # A tibble: 6 × 9
##   .y.   group1   group2          p    p.adj p.format p.signif method  y.position
##   <chr> <chr>    <chr>       <dbl>    <dbl> <chr>    <chr>    <chr>         <dbl>
## 1 Sys   sleeping calm   0.00128    0.0019   0.0013   **       Wilcox…         105
## 2 Sys   sleeping active 0.0000291  0.000087 2.9e-05  ****     Wilcox…         115
## 3 Sys   calm     active 0.00220    0.0022   0.0022   **       Wilcox…         110
## 4 Dia   sleeping calm   0.000455   0.00046  0.00046  ***      Wilcox…          68
## 5 Dia   sleeping active 0.00000378 0.000011 3.8e-06  ****     Wilcox…          78
## 6 Dia   calm     active 0.0000114  0.000017 1.1e-05  ****     Wilcox…          73
```

```
# plot with p adjust value
sys_all_box1 <- boxplot_3_comparison(nocry, "Disposition", "Sys", "Disposition",
                                     "Measurement (mmHg)",
                                     c(40,120),
                                     "Systolic pressure mean difference",
                                    "n = 19/51/16 measurements for disposition group
s",
                                     "(method: unpaired wilcox.test with FDR p.adjust
ment)",
                                     dispo_colors,
                                     sys_test,
                                     "p.signif"
                                     )
sys_all_box1+ geom_jitter(size=1, color="black", alpha=0.4, width=0.1)
```



```
ggsave("boxplot_systolic_disposition.png", width=8, height=6, dpi=300)

# plot with p adjust value
dia_all_box1 <- boxplot_3_comparison(nocry, "Disposition", "Dia", "Disposition",
                                     "Measurement (mmHg)",
                                     c(10,90),
                                    "Diastolic pressure mean difference",
                                     "n = 19/51/16 measurements for disposition group
s",
                                     "(method: unpaired wilcox.test with FDR p.adjust
ment)",
                                     dispo_colors,
                                     dia_test,
                                     "p.signif"
                                     )
dia_all_box1 + geom_jitter(size=1, color="black", alpha=0.4, width=0.1)
```

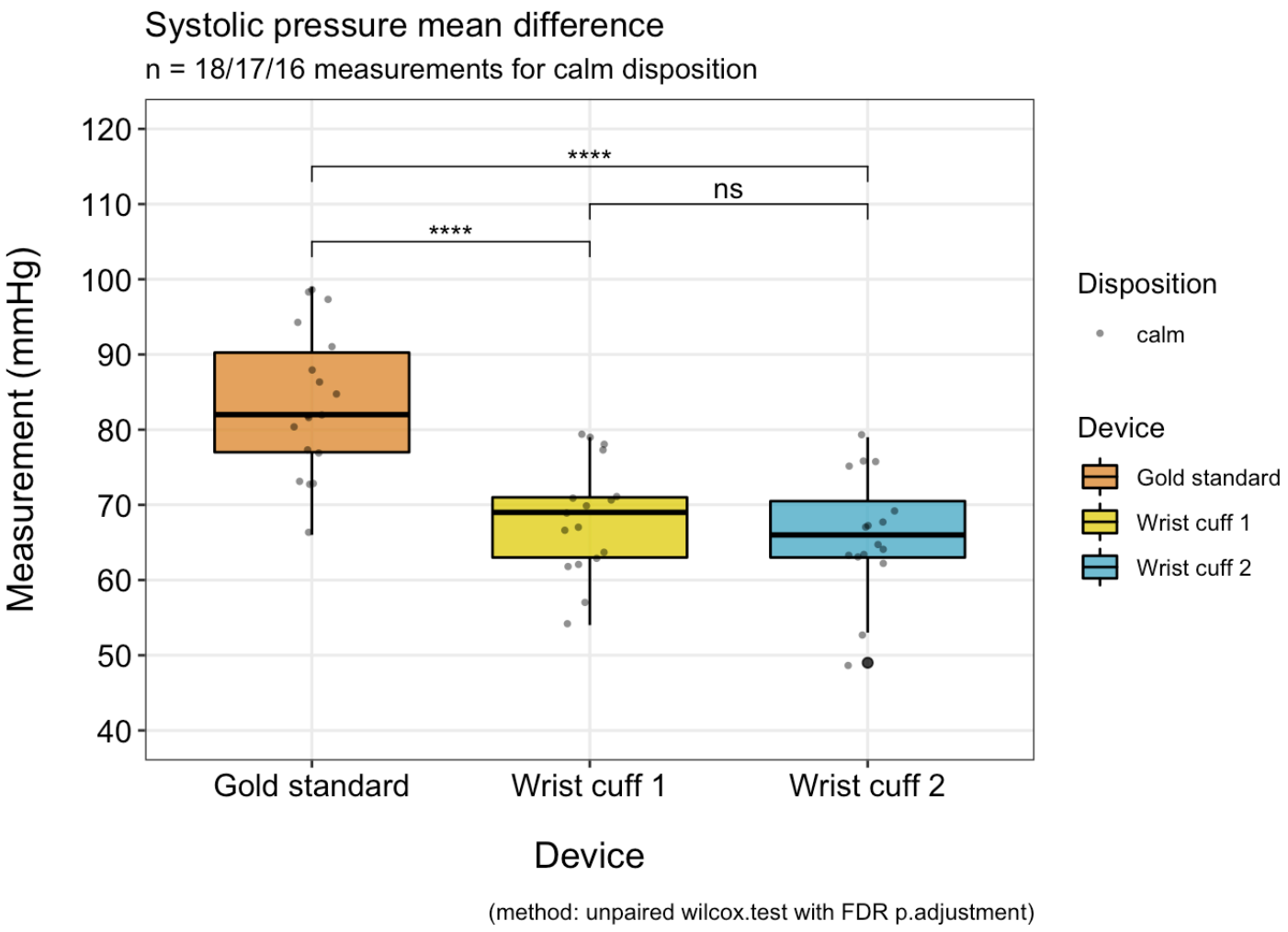



```
ggsave("boxplot_diastolic_disposition.png", width=8, height=6, dpi=300)
```

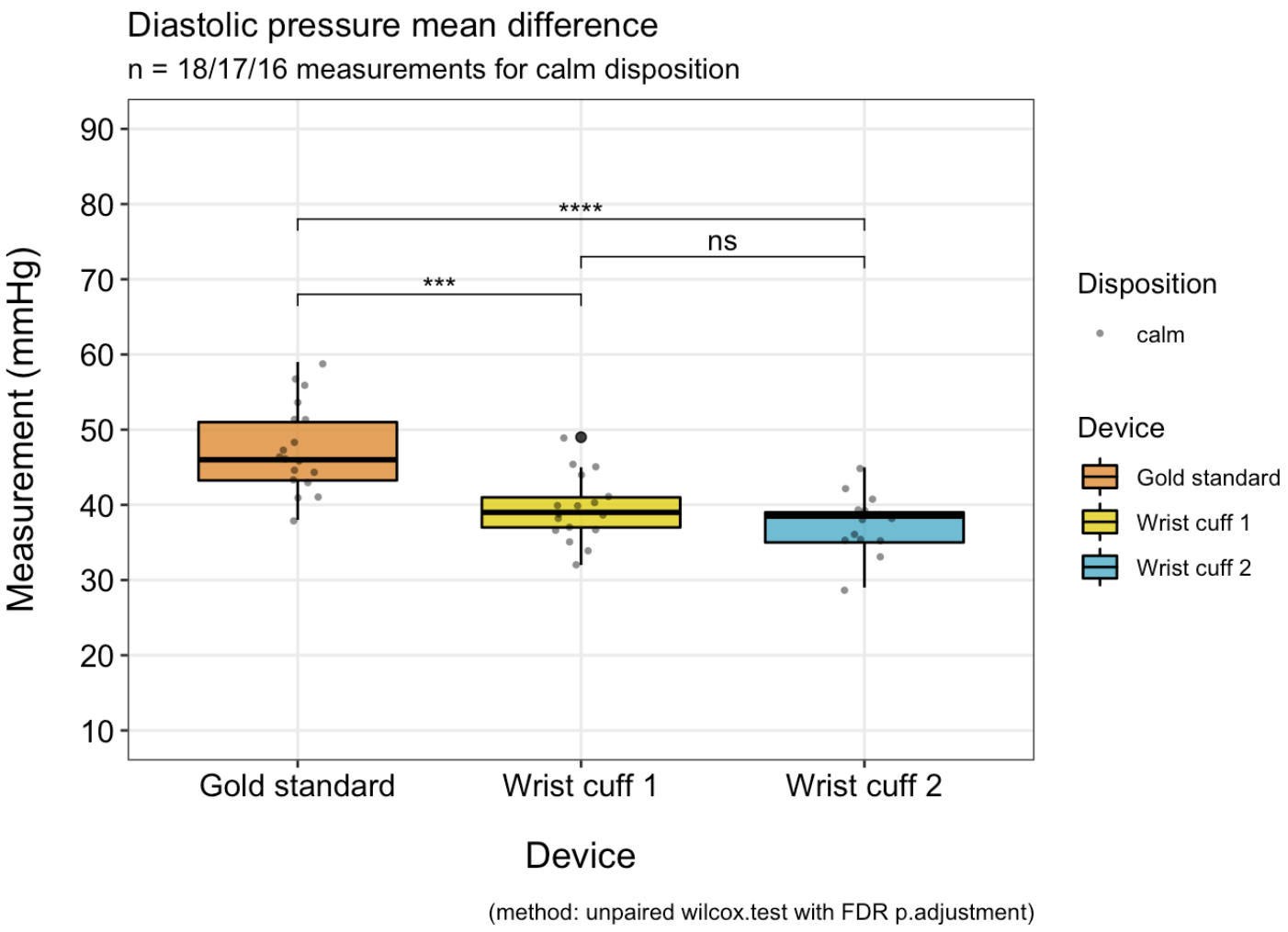
```
calm <- df %>% filter(Disposition == 'calm')

sys_test <- compare_means(Sys ~ Device,
                          data=calm,
                          method="wilcox.test",
                          p.adjust.method ="fdr",
                          paired=FALSE,
                          comparisons = compare_devices)
sys_test <- sys_test %>% mutate(y.position = c(105, 115, 110))

dia_test <- compare_means(Dia ~ Device,
                          data=calm,
                          method="wilcox.test",
                          p.adjust.method ="fdr",
                          paired=FALSE,
                          comparisons = compare_devices)
dia_test <- dia_test %>% mutate(y.position = c(68, 78, 73))

bind_rows(sys_test, dia_test)
```

```
## # A tibble: 6 × 9
##   .y.   group1        group2        p  p.adj p.format p.signif method y.position
##   <chr> <chr>         <chr>     <dbl>  <dbl> <chr>    <chr>    <chr>       <dbl>
## 1 Sys   Gold standard Wrist … 5.15e-5 7.7e-5 5.2e-05  ****     Wilco…        105
## 2 Sys   Gold standard Wrist … 2.71e-5 7.7e-5 2.7e-05  ****     Wilco…        115
## 3 Sys   Wrist cuff 1  Wrist … 4.27e-1 4.3e-1 0.43     ns       Wilco…        110
## 4 Dia   Gold standard Wrist … 1.53e-4 2.3e-4 0.00015  ***      Wilco…         68
## 5 Dia   Gold standard Wrist … 1.30e-5 3.9e-5 1.3e-05  ****     Wilco…         78
## 6 Dia   Wrist cuff 1  Wrist … 2.69e-1 2.7e-1 0.26857  ns       Wilco…         73
```

```
# plot with p adjust value
sys_all_box1 <- boxplot_3_comparison(calm, "Device", "Sys", "Device",
                                     "Measurement (mmHg)",
                                     c(40,120),
                                      "Systolic pressure mean difference",
                                    "n = 18/17/16 measurements for calm disposition",
                                     "(method: unpaired wilcox.test with FDR p.adjust
ment)",
                                     rater_colors,
                                     sys_test,
                                     "p.signif"
                                     )
sys_all_box1 + geom_jitter(aes(shape=Disposition),size=1, color="black", alpha=0.5, w
idth=0.1)
```




```
ggsave("boxplot_systolic_calm_disposition.png", width=8, height=6, dpi=300)

# plot with p adjust value
dia_all_box1 <- boxplot_3_comparison(calm, "Device", "Dia", "Device",
                                     "Measurement (mmHg)",
                                     c(10,90),
                                     "Diastolic pressure mean difference",
                                     "n = 18/17/16 measurements for calm dispositio
n",
                                     "(method: unpaired wilcox.test with FDR p.adjust
ment)",
                                     rater_colors,
                                     dia_test,
                                     "p.signif"
                                     )
dia_all_box1 + geom_jitter(aes(shape=Disposition),size=1, color="black", alpha=0.5, w
idth=0.1)
```



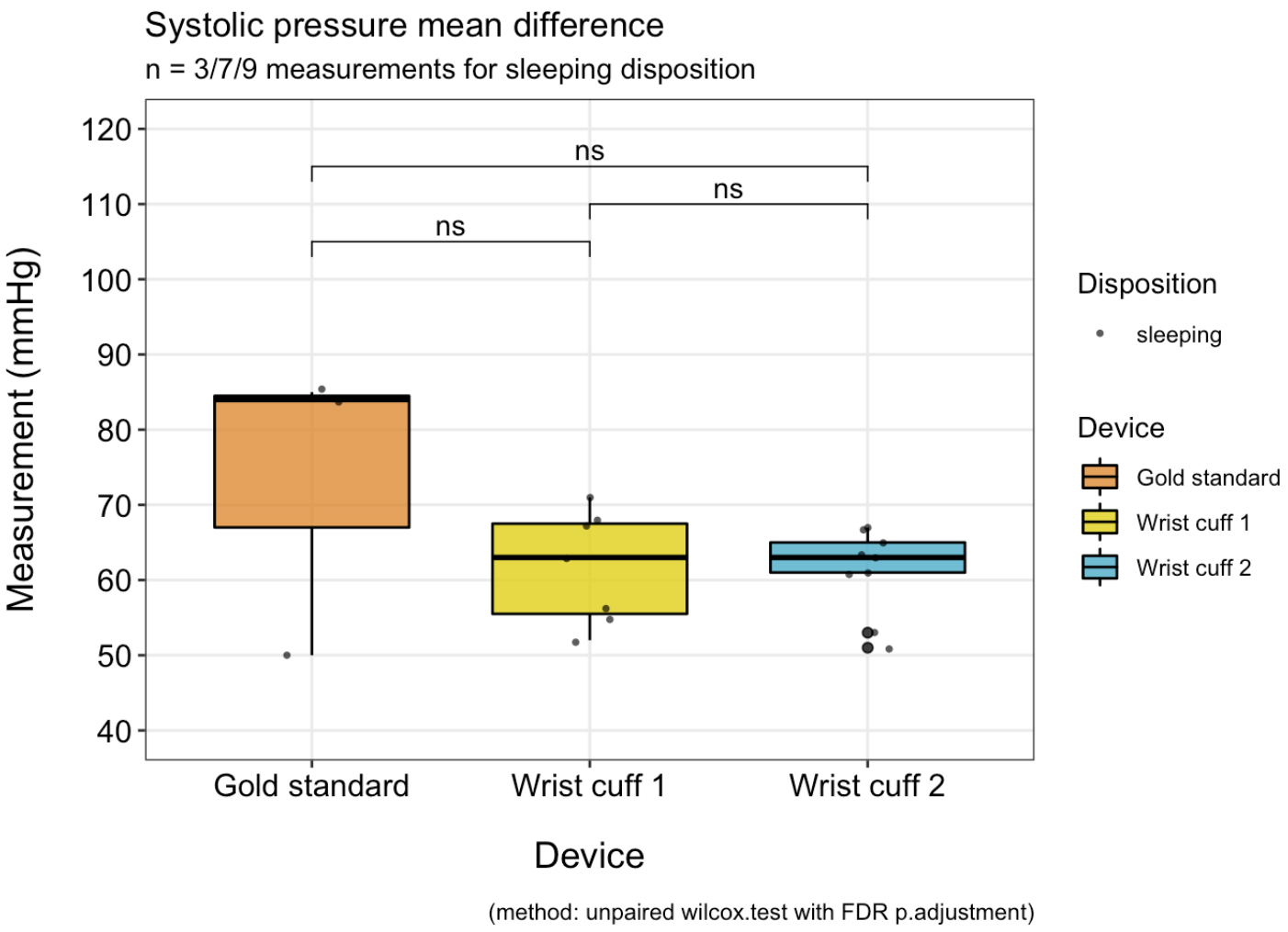

```
ggsave("boxplot_diastolic_calm_disposition.png", width=8, height=6, dpi=300)
```

- result: used wilcox non parametric test because each group has different number of measurements (18 vs 17 vs 16) and paired=false because multiple babies included. calm only results replicate all data point boxplot result.

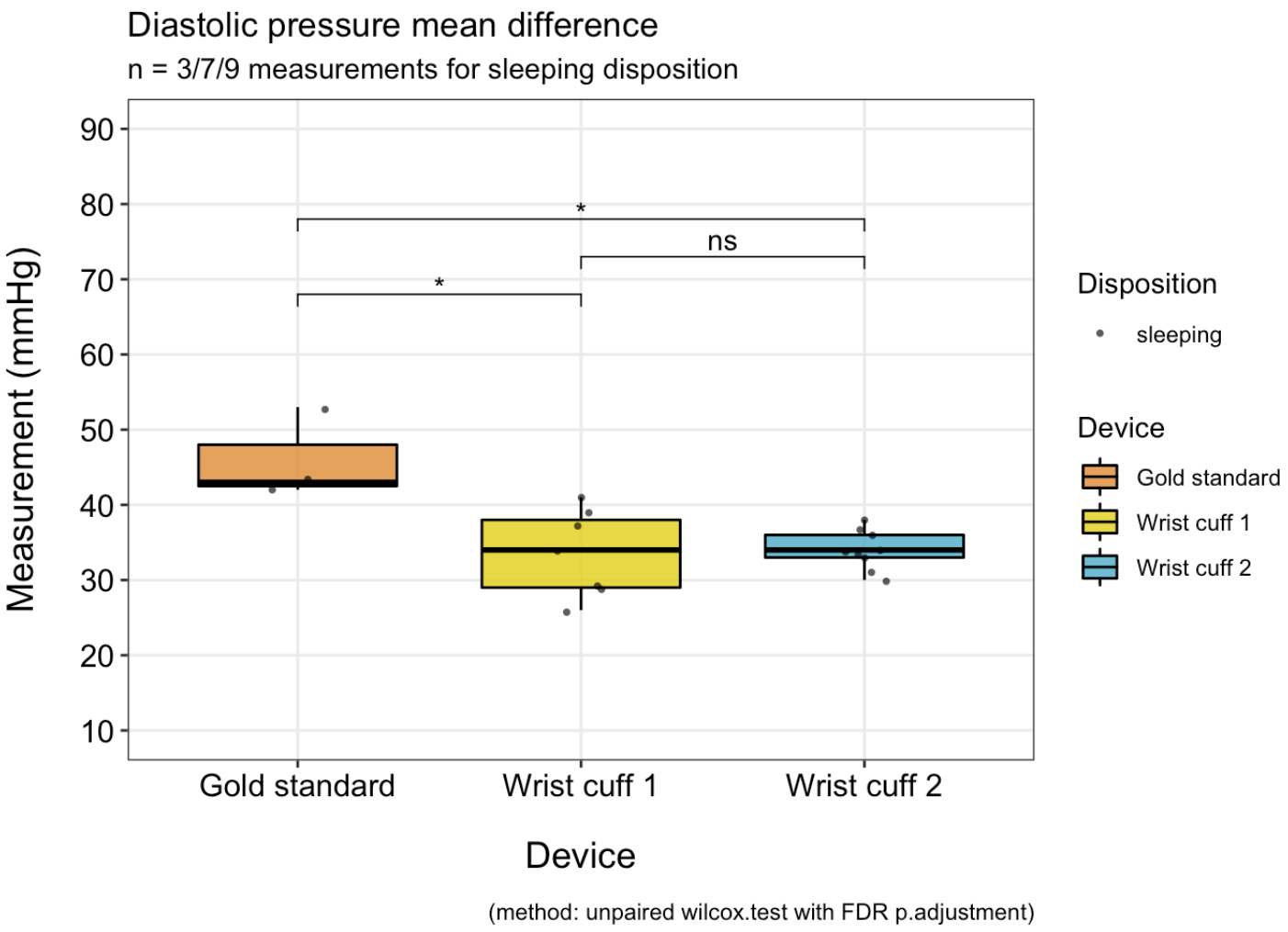
```
sleep <- df %>% filter(Disposition == 'sleeping')

sys_test <- compare_means(Sys ~ Device,
                          data=sleep,
                          method="wilcox.test",
                          p.adjust.method ="fdr",
                          paired=FALSE,
                          comparisons = compare_devices)
sys_test <- sys_test %>% mutate(y.position = c(105, 115, 110))

dia_test <- compare_means(Dia ~ Device,
                          data=sleep,
                          method="wilcox.test",
                          p.adjust.method ="fdr",
                          paired=FALSE,
                          comparisons = compare_devices)
dia_test <- dia_test %>% mutate(y.position = c(68, 78, 73))

bind_rows(sys_test, dia_test)
```

```
## # A tibble: 6 × 9
##   .y.   group1        group2         p p.adj p.format p.signif method y.position
##   <chr> <chr>         <chr>      <dbl> <dbl> <chr>    <chr>    <chr>       <dbl>
## 1 Sys   Gold standard Wrist cu… 0.517  0.67  0.52     ns       Wilco…        105
## 2 Sys   Gold standard Wrist cu… 0.457  0.67  0.46     ns       Wilco…        115
## 3 Sys   Wrist cuff 1  Wrist cu… 0.670  0.67  0.67     ns       Wilco…        110
## 4 Dia   Gold standard Wrist cu… 0.0222 0.033 0.022    *        Wilco…         68
## 5 Dia   Gold standard Wrist cu… 0.0159 0.033 0.016    *        Wilco…         78
## 6 Dia   Wrist cuff 1  Wrist cu… 0.958  0.96  0.958    ns       Wilco…         73
```

```
# plot with p adjust value
sys_all_box1 <- boxplot_3_comparison(sleep, "Device", "Sys", "Device",
                                     "Measurement (mmHg)",
                                     c(40,120),
                                      "Systolic pressure mean difference",
                                     "n = 3/7/9 measurements for sleeping dispositio
n",
                                     "(method: unpaired wilcox.test with FDR p.adjust
ment)",
                                     rater_colors,
                                     sys_test,
                                     "p.signif"
                                     )
sys_all_box1 + geom_jitter(aes(shape=Disposition),size=1, width=0.1, color="black", a
lpha=0.7)
```




```
ggsave("boxplot_systolic_sleeping_disposition.png", width=8, height=6, dpi=300)

# plot with p adjust value
dia_all_box1 <- boxplot_3_comparison(sleep, "Device", "Dia", "Device",
                                     "Measurement (mmHg)",
                                     c(10,90),
                                     "Diastolic pressure mean difference",
                                     "n = 3/7/9 measurements for sleeping dispositio
n",
                                     "(method: unpaired wilcox.test with FDR p.adjust
ment)",
                                     rater_colors,
                                     dia_test,
                                     "p.signif"
                                     )
dia_all_box1 + geom_jitter(aes(shape=Disposition),size=1, width=0.1, color="black", a
lpha=0.7)
```




```
ggsave("boxplot_diastolic_sleeping_disposition.png", width=8, height=6, dpi=300)
```

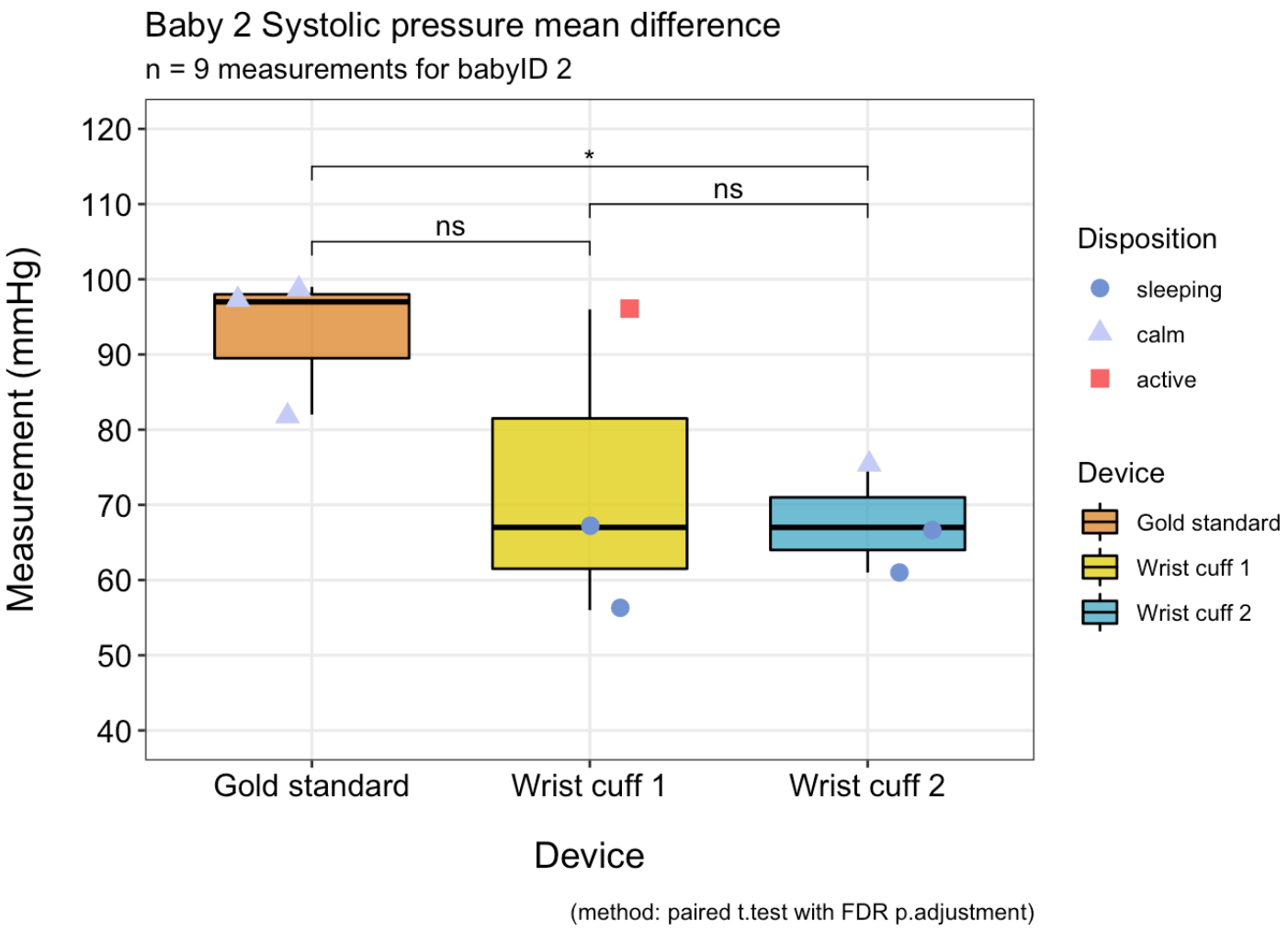
- result: used wilcox non parametric test because each group has different number of measurements (3 vs 7 vs 9) and paired=false. unlike calm result, the sleeping only results did not replicate significance seen for data points boxplot result. either babies are less variable and devices therefore show similar readings (no significant mean diff for sys and slight significant diff for diastolic) when they are sleeping, or the gold standard having the lowest number of data points confounds the differences thats possible to detect between devices.

following these results for all data points and select disposition data points, i wondered if measurement differences were significant when controlling for baby by looking at data points taken of same baby. for stats test i used paired = True, method = t.test, selected babies with 3 sessions because they have more data points available. * question for biostats expert- is t.test best method to use for single baby measurements? wilcox was first used because all data was not normally distributed but none of the values were significantly different which seemed odd given some box plots for gold vs wristcuff are clearly different (non overlapping interquartile ranges)

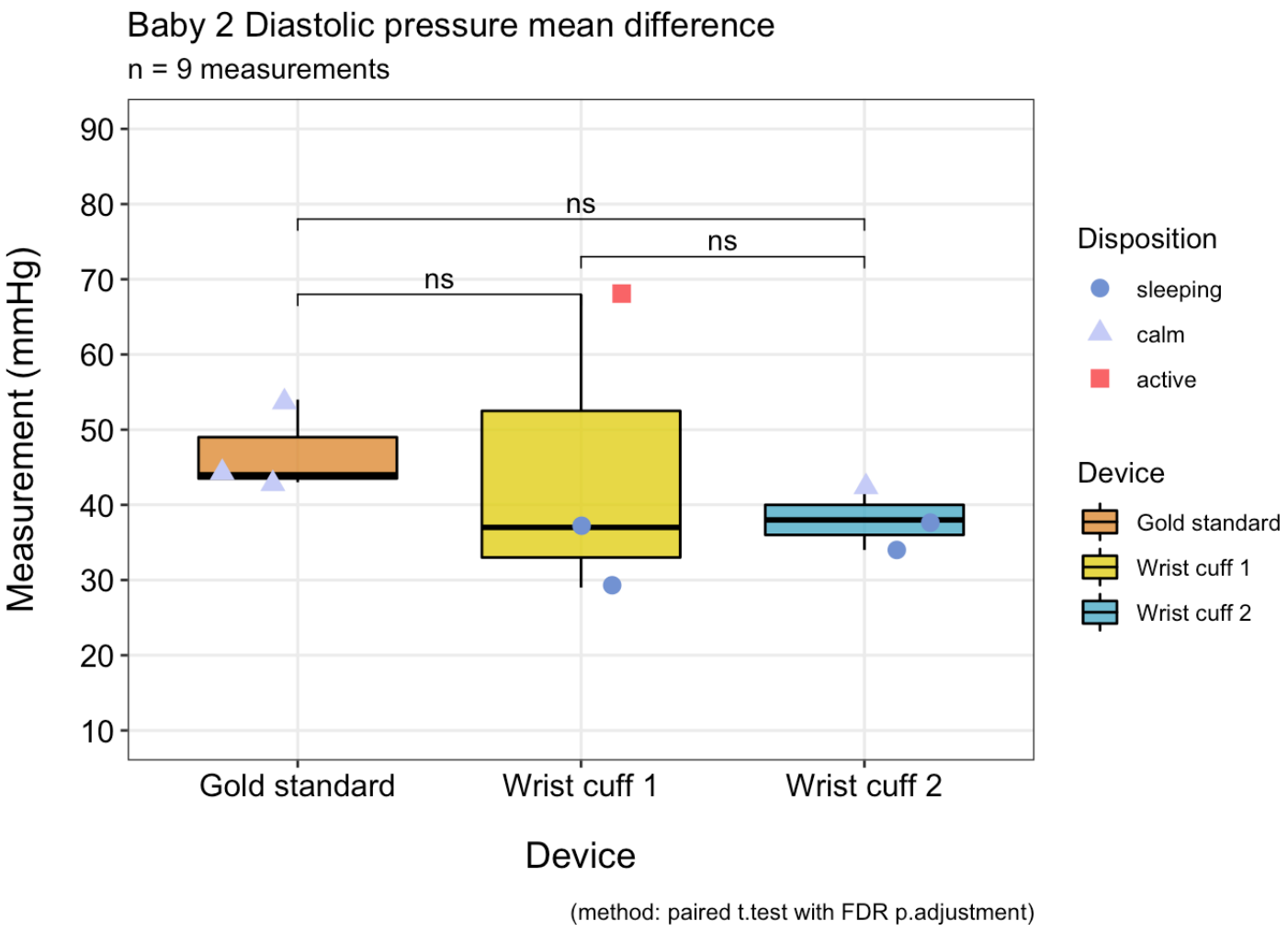
```
baby <- df %>% filter(BabyID == '2')

sys_test <- compare_means(Sys ~ Device,
                          data=baby,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=TRUE,
                          comparisons = compare_devices)
sys_test <- sys_test %>% mutate(y.position = c(105, 115, 110))
dia_test <- compare_means(Dia ~ Device,
                          data=baby,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=TRUE,
                          comparisons = compare_devices)
dia_test <- dia_test %>% mutate(y.position = c(68, 78, 73))
bind_rows(sys_test, dia_test)
```

```
## # A tibble: 6 × 9
##   .y.   group1        group2         p p.adj p.format p.signif method y.position
##   <chr> <chr>         <chr>      <dbl> <dbl> <chr>    <chr>    <chr>       <dbl>
## 1 Sys   Gold standard Wrist cu… 0.174  0.26  0.174    ns       T-test        105
## 2 Sys   Gold standard Wrist cu… 0.0192 0.058 0.019    *        T-test        115
## 3 Sys   Wrist cuff 1  Wrist cu… 0.572  0.57  0.572    ns       T-test        110
## 4 Dia   Gold standard Wrist cu… 0.876  0.88  0.88     ns       T-test         68
## 5 Dia   Gold standard Wrist cu… 0.156  0.47  0.16     ns       T-test         78
## 6 Dia   Wrist cuff 1  Wrist cu… 0.564  0.85  0.56     ns       T-test         73
```

```
# plot sys
sys_baby_box2 <- boxplot_3_comparison(baby, "Device", "Sys", "Device",
                                      "Measurement (mmHg)",
                                       c(40,120),
                                     "Baby 2 Systolic pressure mean difference",
                                      "n = 9 measurements for babyID 2",
                                      "(method: paired t.test with FDR p.adjustment)",
                                      rater_colors,
                                      sys_test,
                                      "p.signif"
                                      )
sys_baby_box2 + geom_jitter(aes(shape=Disposition, colour=Disposition),size=3, alpha=
1) + scale_colour_manual(values = dispo_colors)
```




```
ggsave("baby2_systolic.png", width=8, height=6, dpi=300)

dia_baby_box2 <- boxplot_3_comparison(baby, "Device", "Dia", "Device",
                                      "Measurement (mmHg)",
                                       c(10,90),
                                       "Baby 2 Diastolic pressure mean difference",
                                       "n = 9 measurements",
                                      "(method: paired t.test with FDR p.adjustment)",
                                      rater_colors,
                                      dia_test,
                                      "p.signif"
                                      )
dia_baby_box2 + geom_jitter(aes(shape=Disposition, colour=Disposition),size=3, alpha=
1) + scale_colour_manual(values = dispo_colors)
```

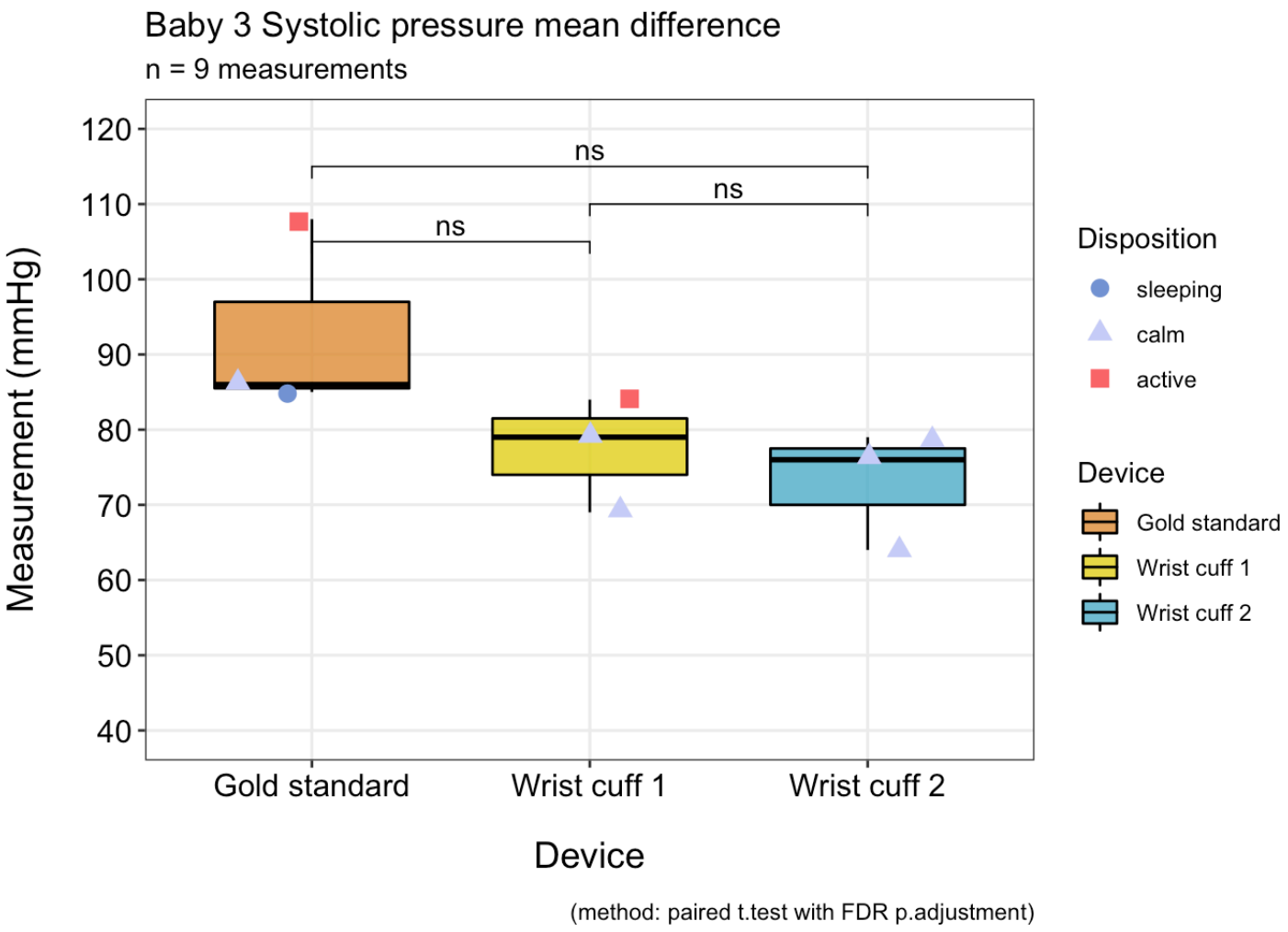



```
ggsave("baby2_diastolic.png", width=8, height=6, dpi=300)
```

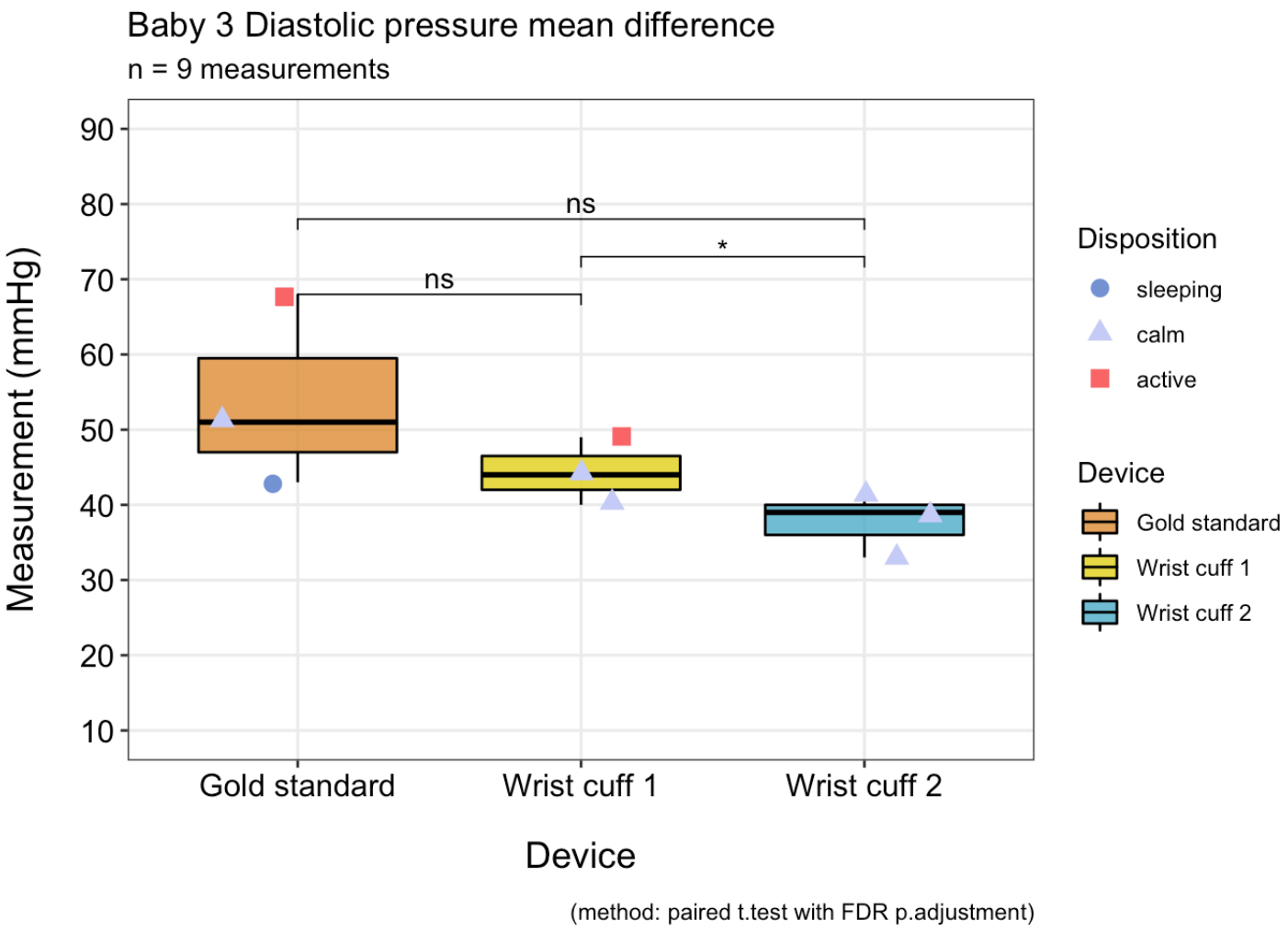
```
baby <- df %>% filter(BabyID == '3')


sys_test <- compare_means(Sys ~ Device,
                          data=baby,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=TRUE,
                          comparisons = compare_devices)
sys_test <- sys_test %>% mutate(y.position = c(105, 115, 110))
dia_test <- compare_means(Dia ~ Device,
                          data=baby,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=TRUE,
                          comparisons = compare_devices)
dia_test <- dia_test %>% mutate(y.position = c(68, 78, 73))
bind_rows(sys_test, dia_test)
```

```
## # A tibble: 6 × 9
##   .y.   group1        group2          p p.adj p.format p.signif method y.position
##   <chr> <chr>         <chr>       <dbl> <dbl> <chr>    <chr>    <chr>       <dbl>
## 1 Sys   Gold standard Wrist cu… 0.182  0.2   0.182    ns       T-test        105
## 2 Sys   Gold standard Wrist cu… 0.0682 0.2   0.068    ns       T-test        115
## 3 Sys   Wrist cuff 1  Wrist cu… 0.204  0.2   0.204    ns       T-test        110
## 4 Dia   Gold standard Wrist cu… 0.310  0.31  0.310    ns       T-test         68
## 5 Dia   Gold standard Wrist cu… 0.123  0.18  0.123    ns       T-test         78
## 6 Dia   Wrist cuff 1  Wrist cu… 0.0171 0.051 0.017    *        T-test         73
```

```
# plot sys
sys_baby_box2 <- boxplot_3_comparison(baby, "Device", "Sys", "Device",
                                      "Measurement (mmHg)",
                                       c(40,120),
                                       "Baby 3 Systolic pressure mean difference",
                                       "n = 9 measurements",
                                      "(method: paired t.test with FDR p.adjustment)",
                                      rater_colors,
                                      sys_test,
                                      "p.signif"
                                      )
sys_baby_box2 + geom_jitter(aes(shape=Disposition, colour=Disposition),size=3, alpha=
1) + scale_colour_manual(values = dispo_colors)
```




```
ggsave("baby3_systolic.png", width=8, height=6, dpi=300)

# plot dia
dia_baby_box2 <- boxplot_3_comparison(baby, "Device", "Dia", "Device",
                                      "Measurement (mmHg)",
                                        c(10,90),
                                     "Baby 3 Diastolic pressure mean difference",
                                      "n = 9 measurements",
                                      "(method: paired t.test with FDR p.adjustment)",
                                      rater_colors,
                                      dia_test,
                                      "p.signif"
                                      )
dia_baby_box2 + geom_jitter(aes(shape=Disposition, colour=Disposition),size=3, alpha=
1) + scale_colour_manual(values = dispo_colors)
```

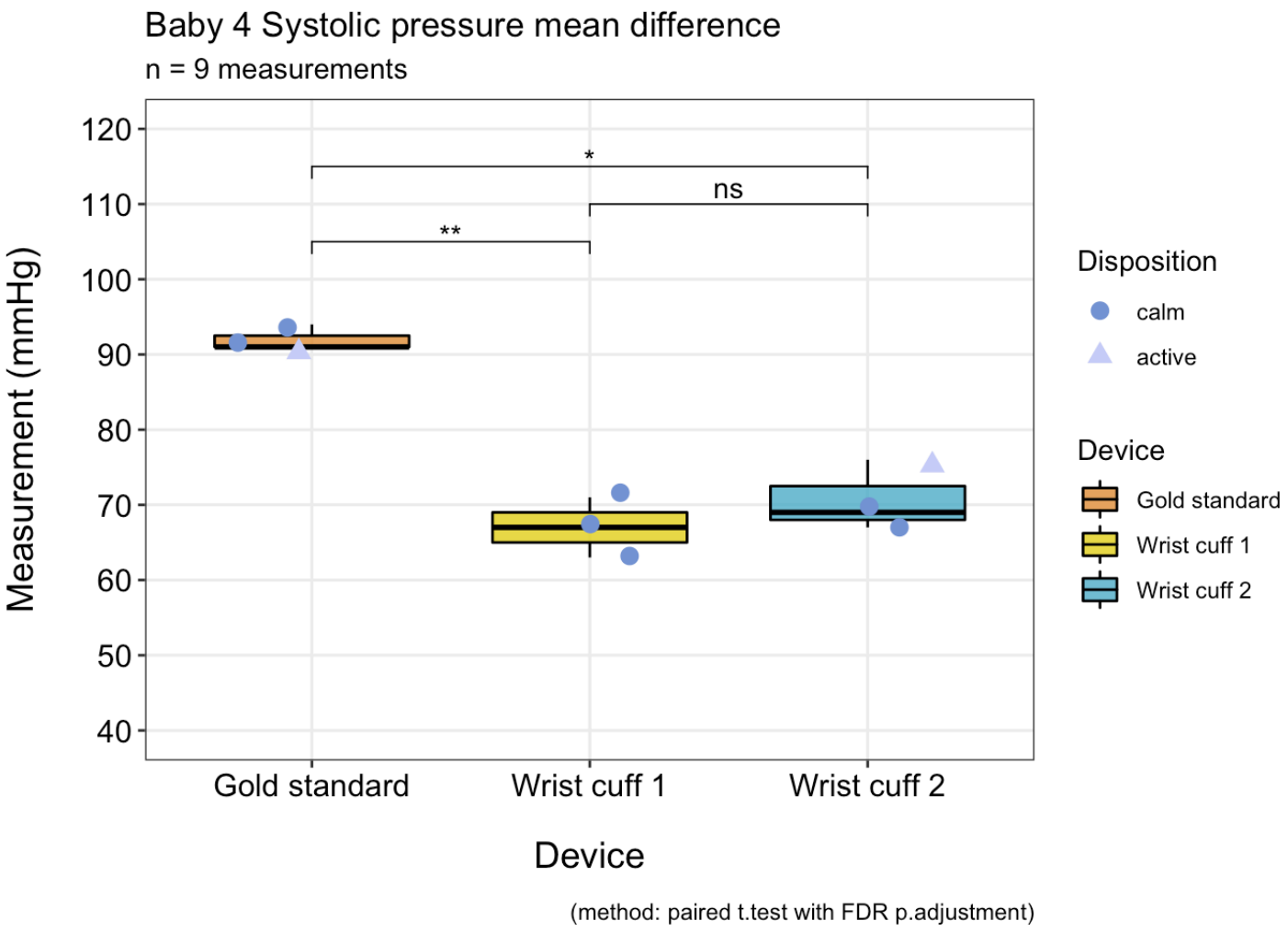



```
ggsave("baby3_diastolic.png", width=8, height=6, dpi=300)
```

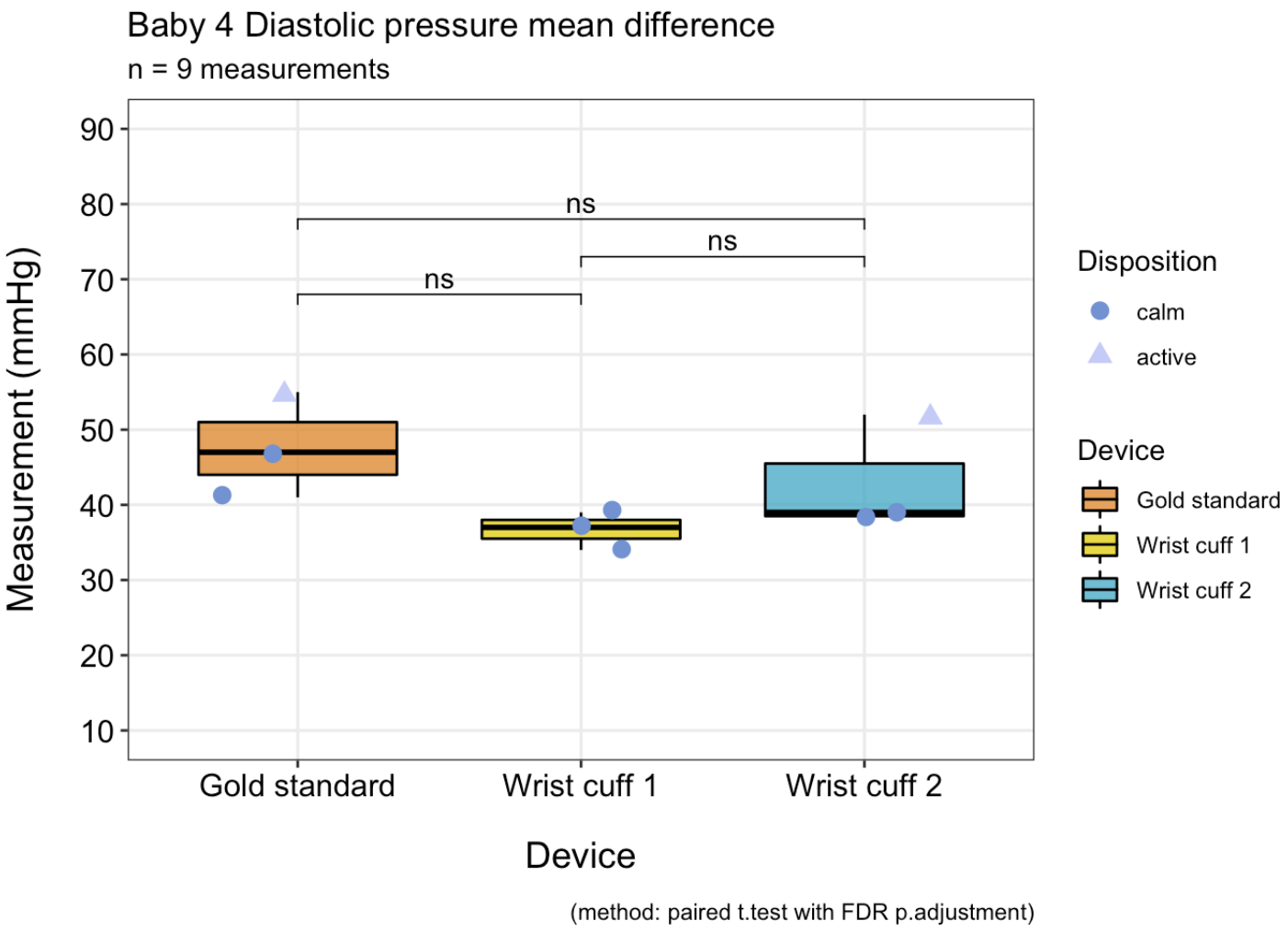
```
baby <- df %>% filter(BabyID == '4')


sys_test <- compare_means(Sys ~ Device,
                          data=baby,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=TRUE,
                          comparisons = compare_devices)
sys_test <- sys_test %>% mutate(y.position = c(105, 115, 110))
dia_test <- compare_means(Dia ~ Device,
                          data=baby,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=TRUE,
                          comparisons = compare_devices)
dia_test <- dia_test %>% mutate(y.position = c(68, 78, 73))
bind_rows(sys_test, dia_test)
```

```
## # A tibble: 6 × 9
##   .y.   group1        group2         p p.adj p.format p.signif method y.position
##   <chr> <chr>         <chr>      <dbl> <dbl> <chr>    <chr>    <chr>       <dbl>
## 1 Sys   Gold standard Wrist c… 0.00371 0.011 0.0037   **       T-test        105
## 2 Sys   Gold standard Wrist c… 0.0256  0.038 0.0256   *        T-test        115
## 3 Sys   Wrist cuff 1  Wrist c… 0.449   0.45  0.4493   ns       T-test        110
## 4 Dia   Gold standard Wrist c… 0.0886  0.16  0.089    ns       T-test         68
## 5 Dia   Gold standard Wrist c… 0.107   0.16  0.107    ns       T-test         78
## 6 Dia   Wrist cuff 1  Wrist c… 0.293   0.29  0.293    ns       T-test         73
```

```
# plot sys
sys_baby_box2 <- boxplot_3_comparison(baby, "Device", "Sys", "Device",
                                      "Measurement (mmHg)",
                                       c(40,120),
                                     "Baby 4 Systolic pressure mean difference",
                                       "n = 9 measurements",
                                      "(method: paired t.test with FDR p.adjustment)",
                                      rater_colors,
                                      sys_test,
                                      "p.signif"
                                      )
sys_baby_box2 + geom_jitter(aes(shape=Disposition, colour=Disposition),size=3, alpha=
1) + scale_colour_manual(values = dispo_colors)
```




```
ggsave("baby4_systolic.png", width=8, height=6, dpi=300)


# plot dia
dia_baby_box2 <- boxplot_3_comparison(baby, "Device", "Dia", "Device",
                                      "Measurement (mmHg)",
                                        c(10,90),
                                    "Baby 4 Diastolic pressure mean difference",
                                       "n = 9 measurements",
                                      "(method: paired t.test with FDR p.adjustment)",
                                      rater_colors,
                                      dia_test,
                                      "p.signif"
                                      )
dia_baby_box2 + geom_jitter(aes(shape=Disposition, colour=Disposition),size=3, alpha=
1) + scale_colour_manual(values = dispo_colors)
```

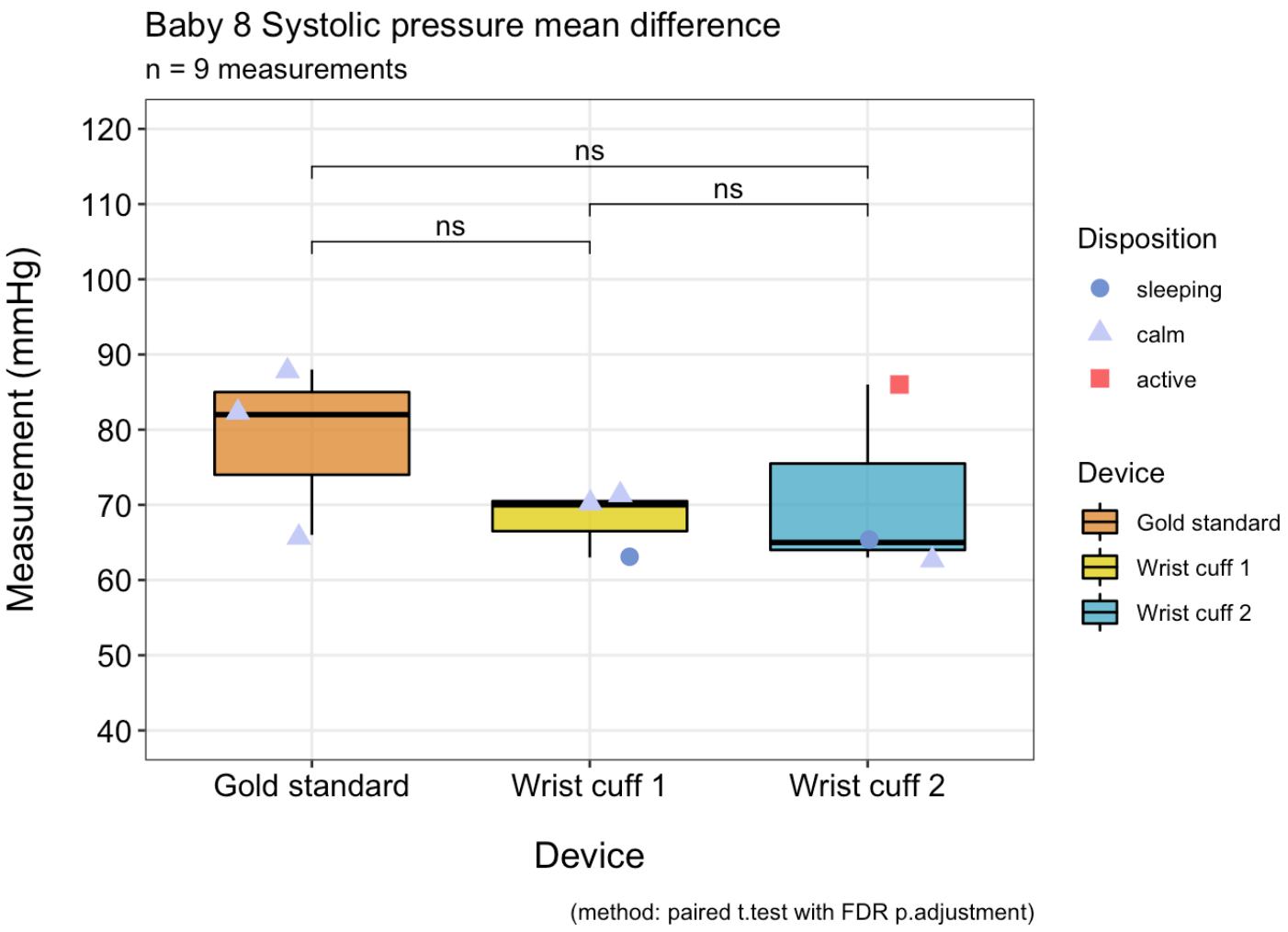



```
ggsave("baby4_diastolic.png", width=8, height=6, dpi=300)
```

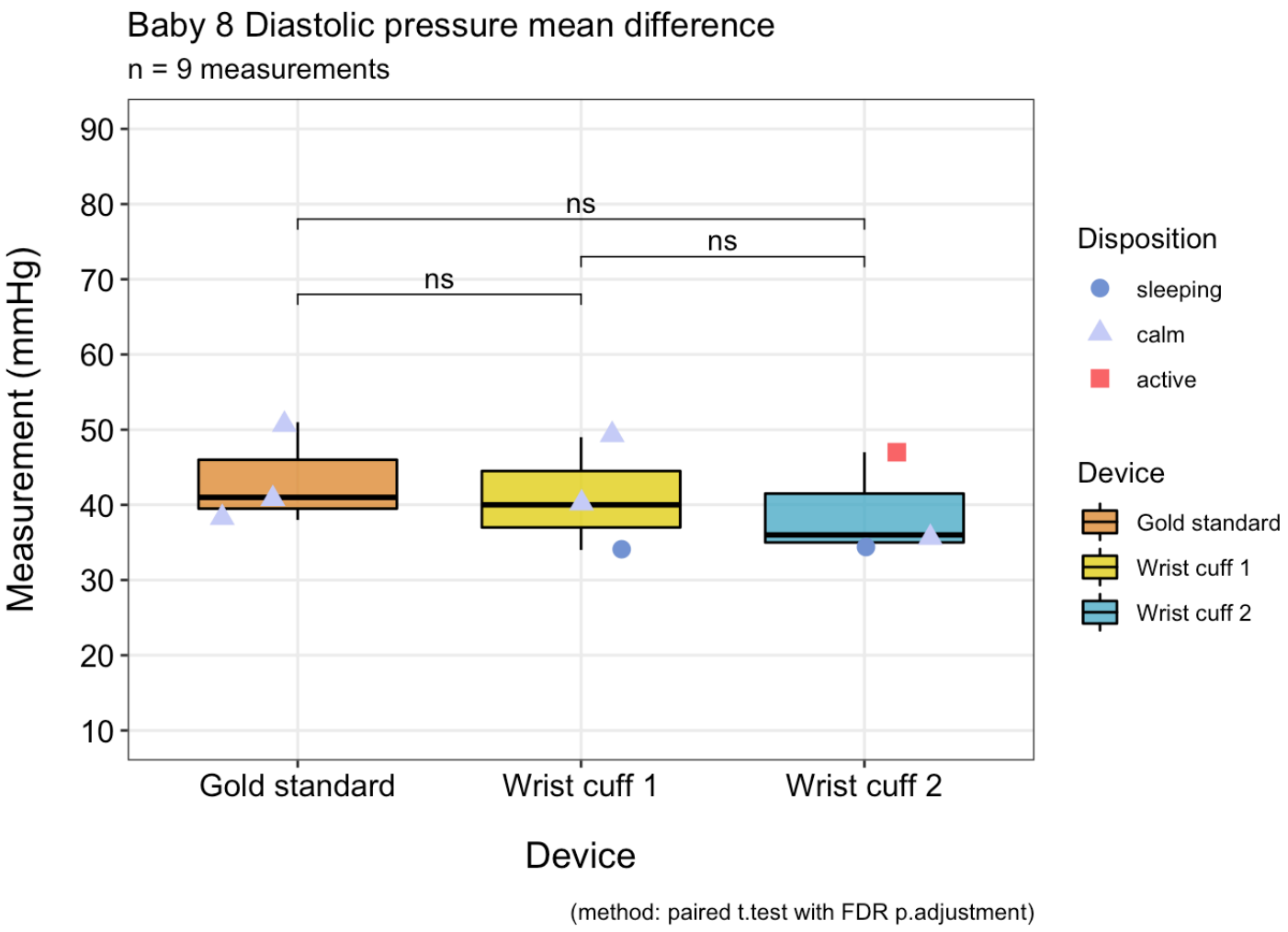
```
baby <- df %>% filter(BabyID == '8')


sys_test <- compare_means(Sys ~ Device,
                          data=baby,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=TRUE,
                          comparisons = compare_devices)
sys_test <- sys_test %>% mutate(y.position = c(105, 115, 110))
dia_test <- compare_means(Dia ~ Device,
                          data=baby,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=TRUE,
                          comparisons = compare_devices)
dia_test <- dia_test %>% mutate(y.position = c(68, 78, 73))
bind_rows(sys_test, dia_test)
```

```
## # A tibble: 6 × 9
##   .y.   group1        group2          p p.adj p.format p.signif method y.position
##   <chr> <chr>         <chr>       <dbl> <dbl> <chr>    <chr>    <chr>       <dbl>
## 1 Sys   Gold standard Wrist cuf… 0.284  0.43 0.28     ns       T-test        105
## 2 Sys   Gold standard Wrist cuf… 0.269  0.43 0.27     ns       T-test        115
## 3 Sys   Wrist cuff 1  Wrist cuf… 0.654  0.65 0.65     ns       T-test        110
## 4 Dia   Gold standard Wrist cuf… 0.715  0.71 0.71     ns       T-test         68
## 5 Dia   Gold standard Wrist cuf… 0.549  0.71 0.55     ns       T-test         78
## 6 Dia   Wrist cuff 1  Wrist cuf… 0.225  0.68 0.23     ns       T-test         73
```

```
# plot sys
sys_baby_box2 <- boxplot_3_comparison(baby, "Device", "Sys", "Device",
                                      "Measurement (mmHg)",
                                       c(40,120),
                                     "Baby 8 Systolic pressure mean difference",
                                       "n = 9 measurements",
                                      "(method: paired t.test with FDR p.adjustment)",
                                      rater_colors,
                                      sys_test,
                                      "p.signif"
                                      )
sys_baby_box2+ geom_jitter(aes(shape=Disposition, colour=Disposition),size=3, alpha=
1) + scale_colour_manual(values = dispo_colors)
```




```
ggsave("baby8_systolic.png", width=8, height=6, dpi=300)

# plot dia
dia_baby_box2 <- boxplot_3_comparison(baby, "Device", "Dia", "Device",
                                      "Measurement (mmHg)",
                                        c(10,90),
                                    "Baby 8 Diastolic pressure mean difference",
                                       "n = 9 measurements",
                                      "(method: paired t.test with FDR p.adjustment)",
                                      rater_colors,
                                      dia_test,
                                      "p.signif"
                                      )
dia_baby_box2+ geom_jitter(aes(shape=Disposition, colour=Disposition),size=3, alpha=
1) + scale_colour_manual(values = dispo_colors)
```

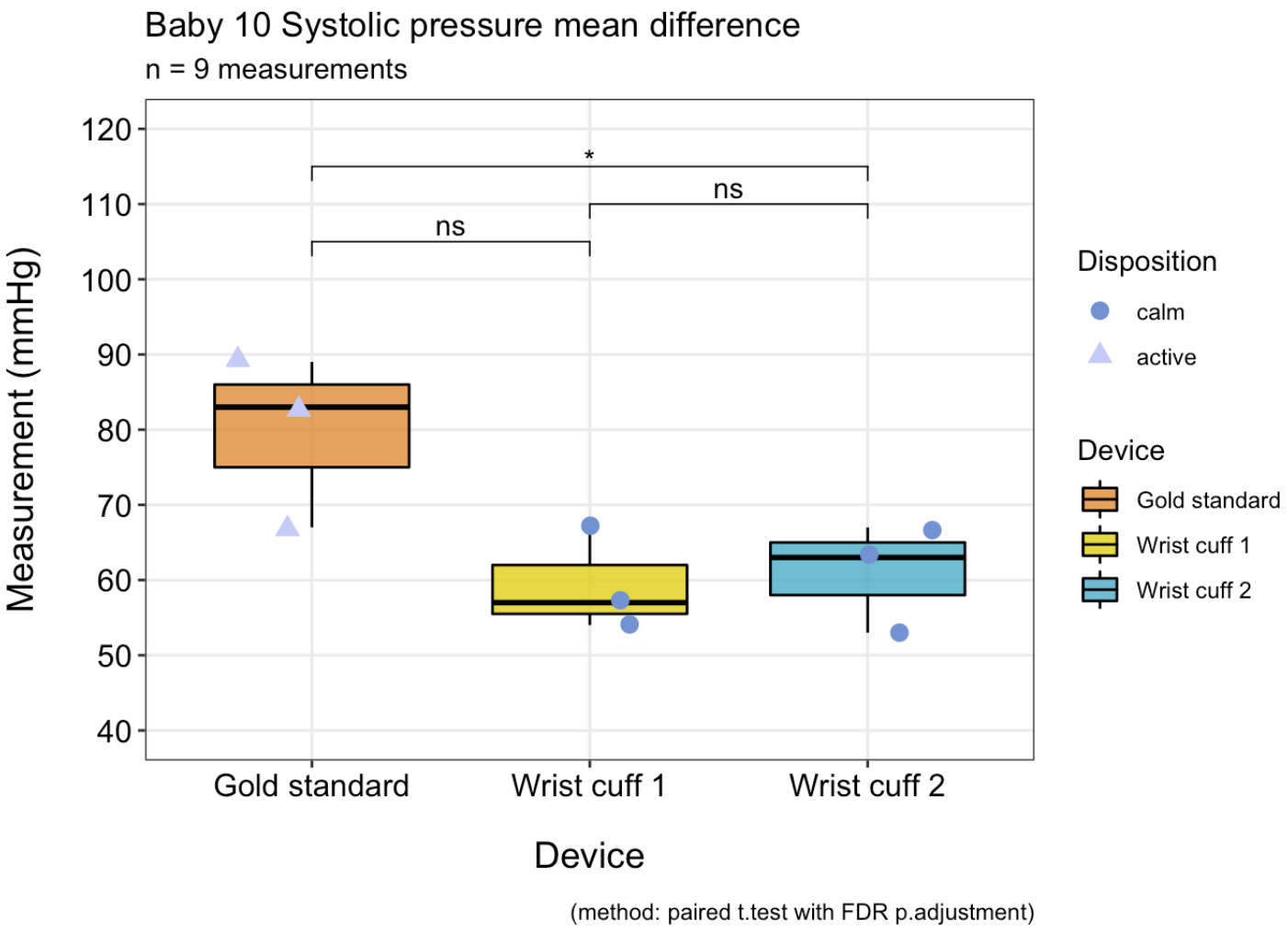



```
ggsave("baby8_diastolic.png", width=8, height=6, dpi=300)
```

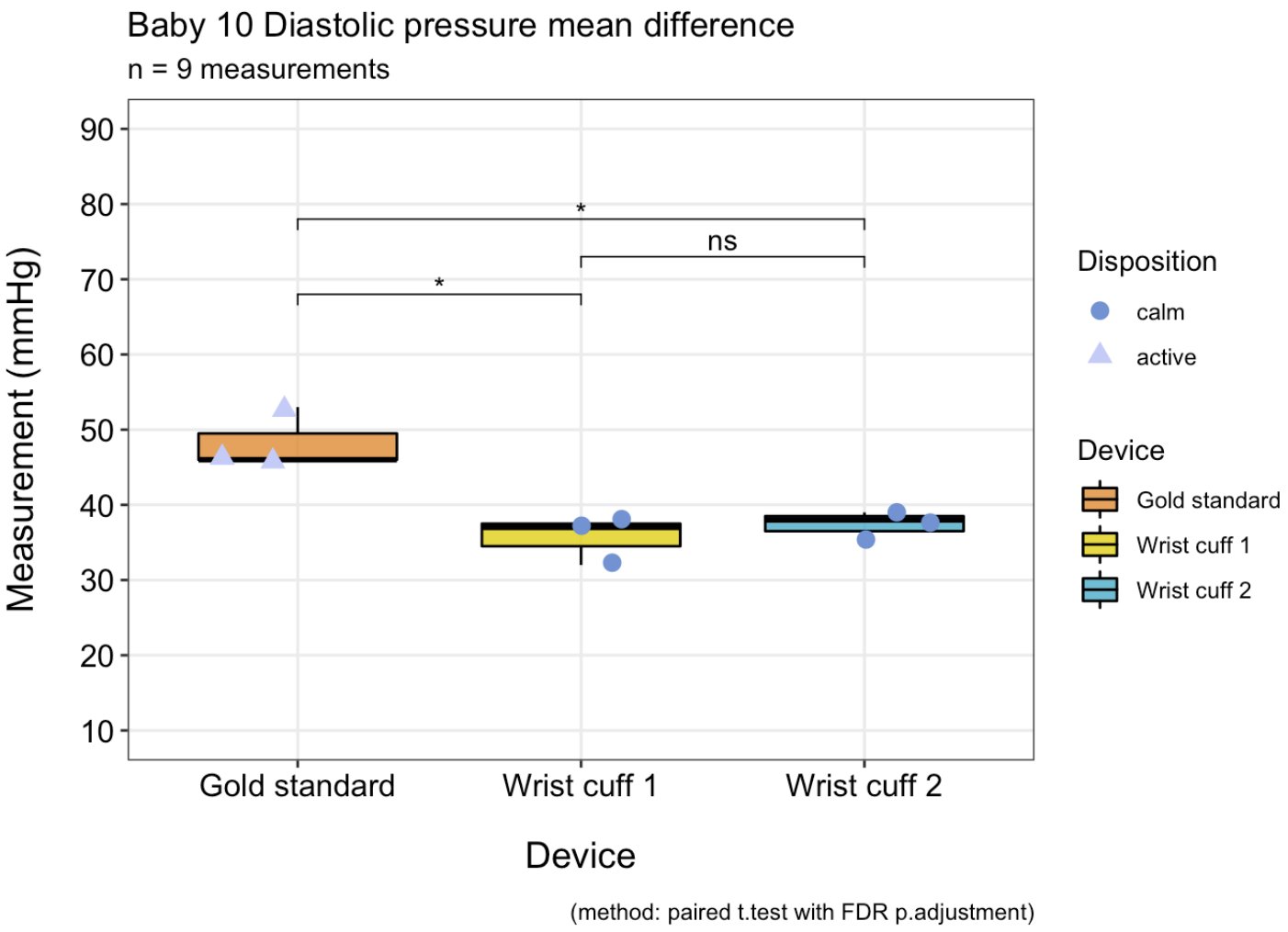
```
baby <- df %>% filter(BabyID == '10')


sys_test <- compare_means(Sys ~ Device,
                          data=baby,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=TRUE,
                          comparisons = compare_devices)
sys_test <- sys_test %>% mutate(y.position = c(105, 115, 110))
dia_test <- compare_means(Dia ~ Device,
                          data=baby,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=TRUE,
                          comparisons = compare_devices)
dia_test <- dia_test %>% mutate(y.position = c(68, 78, 73))
bind_rows(sys_test, dia_test)
```

```
## # A tibble: 6 × 9
##   .y.   group1        group2          p p.adj p.format p.signif method y.position
##   <chr> <chr>         <chr>       <dbl> <dbl> <chr>    <chr>    <chr>       <dbl>
## 1 Sys   Gold standard Wrist cu… 0.114  0.17  0.114    ns       T-test        105
## 2 Sys   Gold standard Wrist cu… 0.0373 0.11  0.037    *        T-test        115
## 3 Sys   Wrist cuff 1  Wrist cu… 0.707  0.71  0.707    ns       T-test        110
## 4 Dia   Gold standard Wrist cu… 0.0342 0.062 0.034    *        T-test         68
## 5 Dia   Gold standard Wrist cu… 0.0414 0.062 0.041    *        T-test         78
## 6 Dia   Wrist cuff 1  Wrist cu… 0.624  0.62  0.624    ns       T-test         73
```

```
# plot sys
sys_baby_box2 <- boxplot_3_comparison(baby, "Device", "Sys", "Device",
                                      "Measurement (mmHg)",
                                       c(40,120),
                                      "Baby 10 Systolic pressure mean difference",
                                       "n = 9 measurements",
                                      "(method: paired t.test with FDR p.adjustment)",
                                      rater_colors,
                                      sys_test,
                                      "p.signif"
                                      )
sys_baby_box2 + geom_jitter(aes(shape=Disposition, colour=Disposition),size=3, alpha=
1) + scale_colour_manual(values = dispo_colors)
```




```
ggsave("baby10_systolic.png", width=8, height=6, dpi=300)

# plot dia
dia_baby_box2 <- boxplot_3_comparison(baby, "Device", "Dia", "Device",
                                      "Measurement (mmHg)",
                                        c(10,90),
                                    "Baby 10 Diastolic pressure mean difference",
                                       "n = 9 measurements",
                                      "(method: paired t.test with FDR p.adjustment)",
                                      rater_colors,
                                      dia_test,
                                      "p.signif"
                                      )
dia_baby_box2+ geom_jitter(aes(shape=Disposition, colour=Disposition),size=3, alpha=
1) + scale_colour_manual(values = dispo_colors)
```

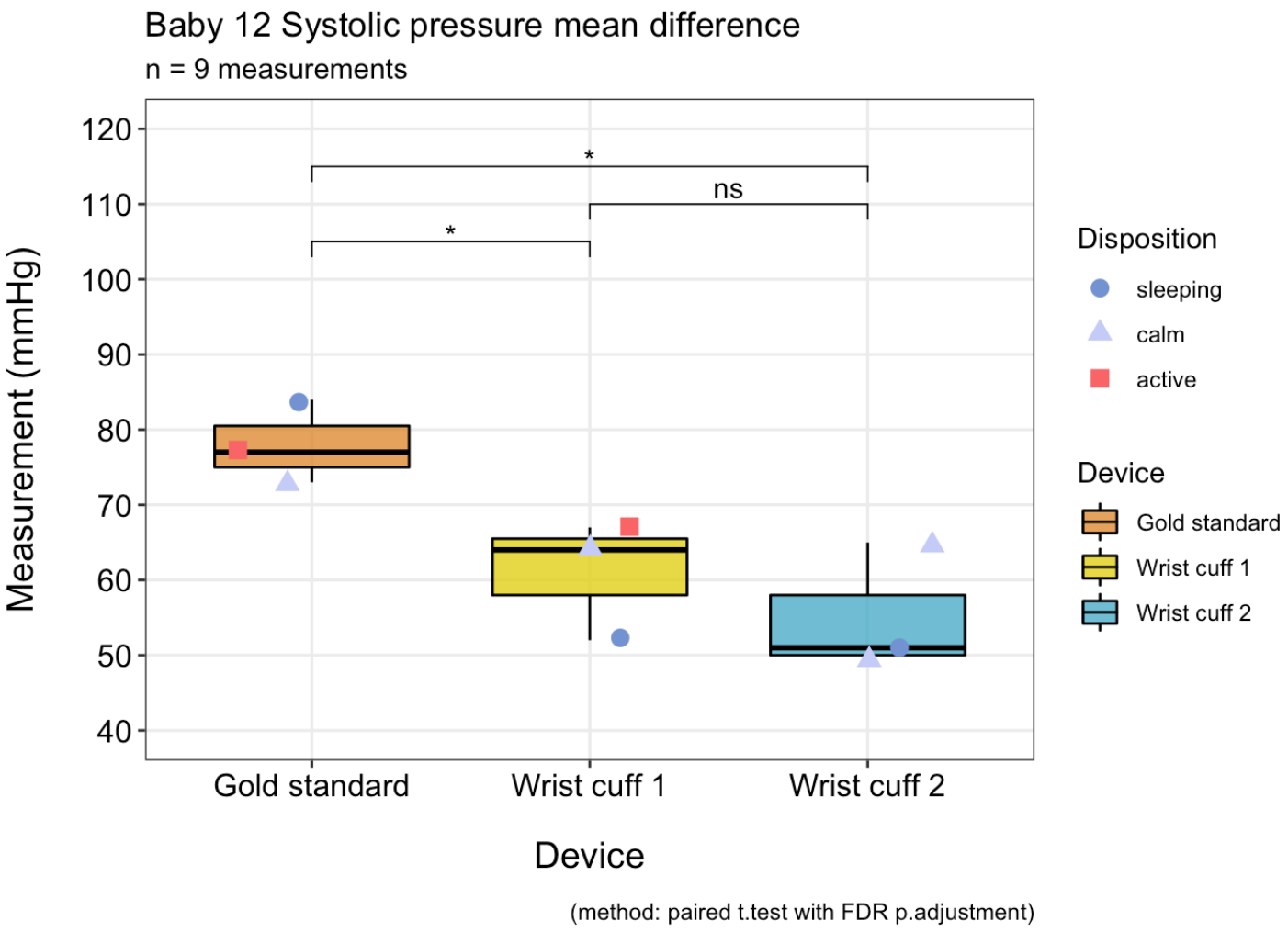



```
ggsave("baby10_diastolic.png", width=8, height=6, dpi=300)
```

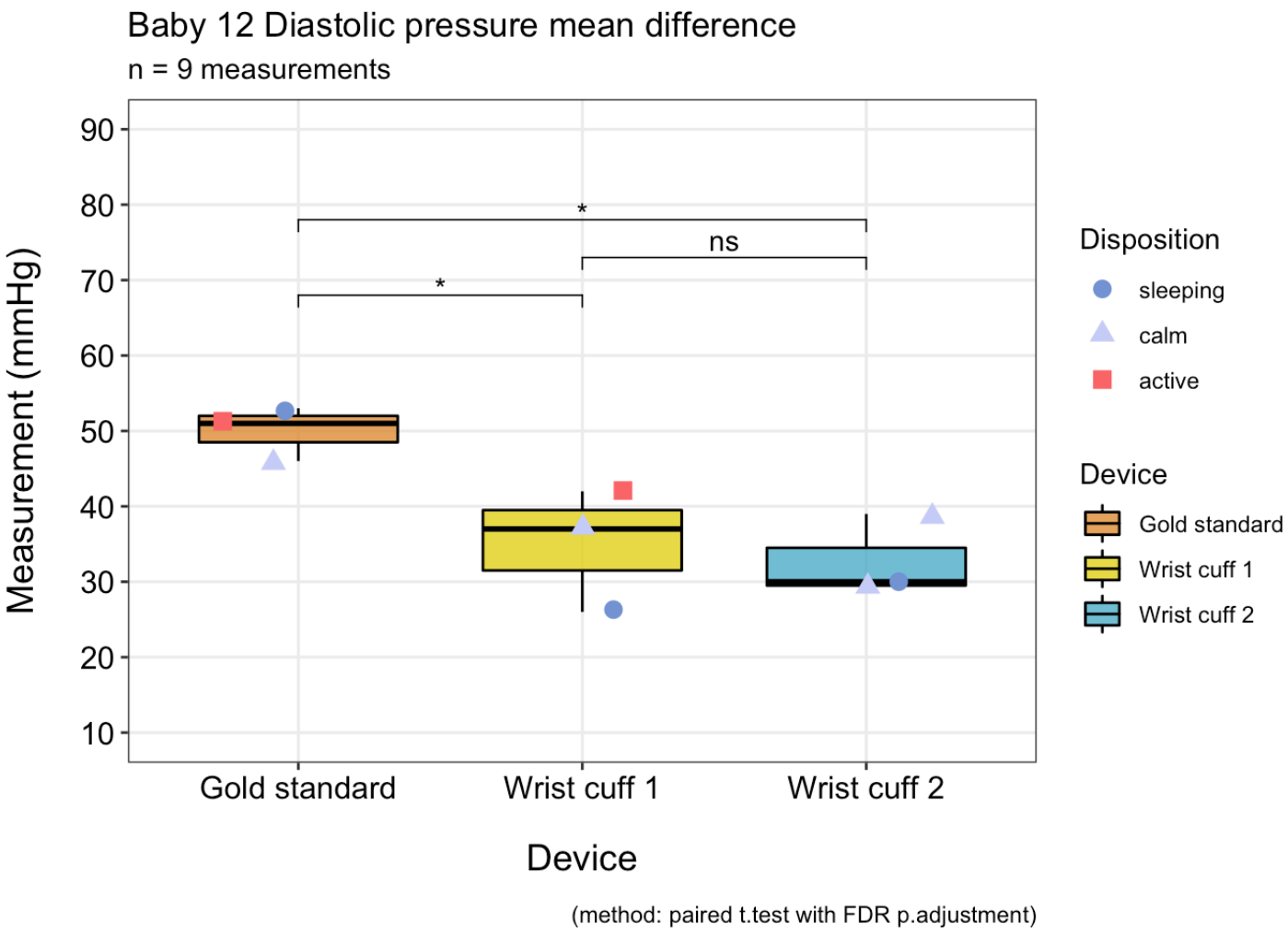
```
baby <- df %>% filter(BabyID == '12')


sys_test <- compare_means(Sys ~ Device,
                          data=baby,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=TRUE,
                          comparisons = compare_devices)
sys_test <- sys_test %>% mutate(y.position = c(105, 115, 110))
dia_test <- compare_means(Dia ~ Device,
                          data=baby,
                          method="t.test",
                          p.adjust.method ="fdr",
                          paired=TRUE,
                          comparisons = compare_devices)
dia_test <- dia_test %>% mutate(y.position = c(68, 78, 73))
bind_rows(sys_test, dia_test)
```

```
## # A tibble: 6 × 9
##   .y.   group1        group2          p p.adj p.format p.signif method y.position
##   <chr> <chr>         <chr>       <dbl> <dbl> <chr>    <chr>    <chr>       <dbl>
## 1 Sys   Gold standard Wrist cu… 0.0401 0.06  0.040    *        T-test        105
## 2 Sys   Gold standard Wrist cu… 0.0130 0.039 0.013    *        T-test        115
## 3 Sys   Wrist cuff 1  Wrist cu… 0.424  0.42  0.424    ns       T-test        110
## 4 Dia   Gold standard Wrist cu… 0.0430 0.064 0.043    *        T-test         68
## 5 Dia   Gold standard Wrist cu… 0.0187 0.056 0.019    *        T-test         78
## 6 Dia   Wrist cuff 1  Wrist cu… 0.706  0.71  0.706    ns       T-test         73
```

```
# plot sys
sys_baby_box2 <- boxplot_3_comparison(baby, "Device", "Sys", "Device",
                                      "Measurement (mmHg)",
                                       c(40,120),
                                      "Baby 12 Systolic pressure mean difference",
                                       "n = 9 measurements",
                                      "(method: paired t.test with FDR p.adjustment)",
                                      rater_colors,
                                      sys_test,
                                      "p.signif"
                                      )
sys_baby_box2 + geom_jitter(aes(shape=Disposition, colour=Disposition),size=3, alpha=
1) + scale_colour_manual(values = dispo_colors)
```



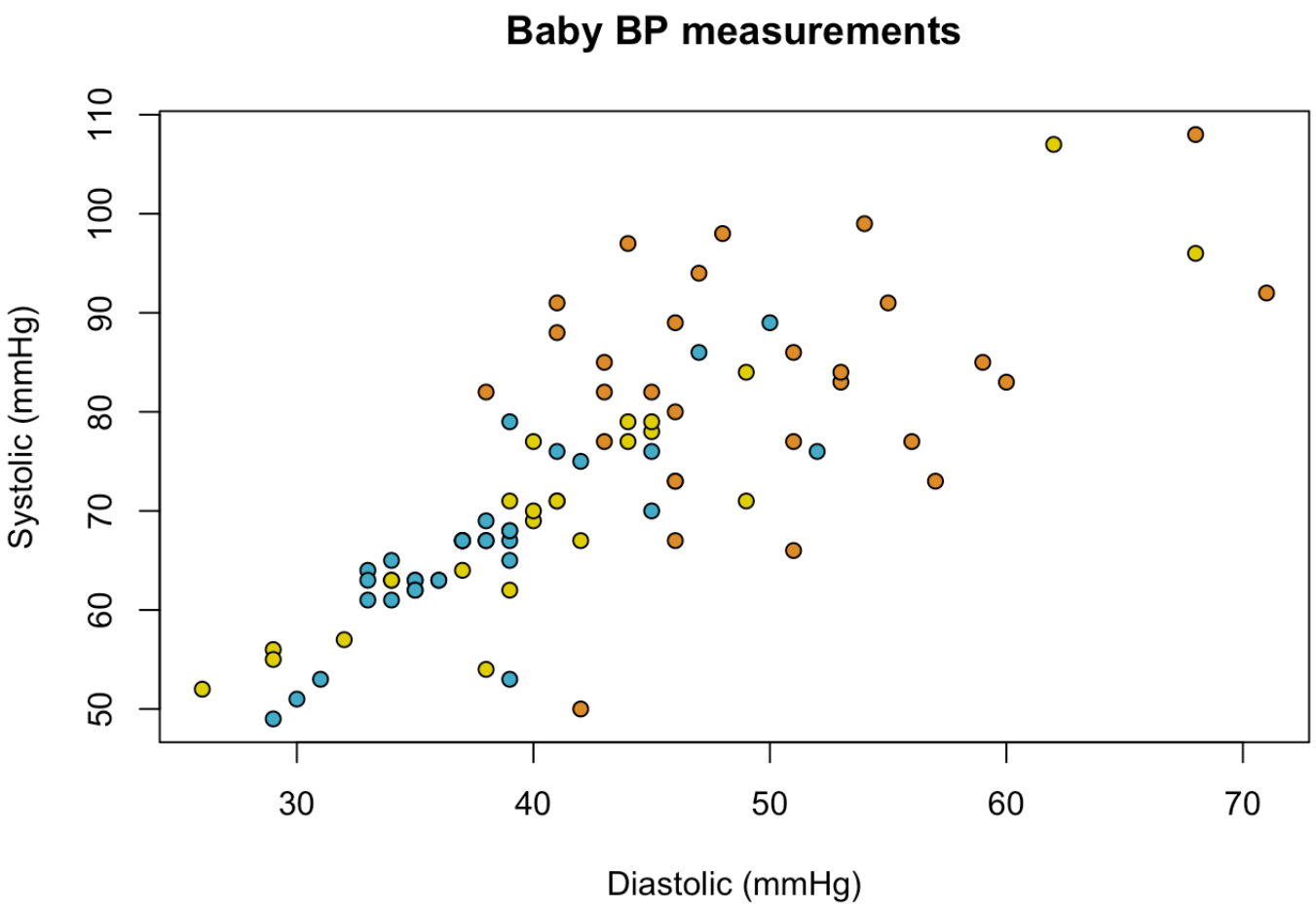

```
ggsave("baby12_systolic.png", width=8, height=6, dpi=300)

# plot dia
dia_baby_box2 <- boxplot_3_comparison(baby, "Device", "Dia", "Device",
                                      "Measurement (mmHg)",
                                        c(10,90),
                                    "Baby 12 Diastolic pressure mean difference",
                                       "n = 9 measurements",
                                      "(method: paired t.test with FDR p.adjustment)",
                                      rater_colors,
                                      dia_test,
                                      "p.signif"
                                      )
dia_baby_box2 + geom_jitter(aes(shape=Disposition, colour=Disposition),size=3, alpha=
1) + scale_colour_manual(values = dispo_colors)
```




```
ggsave("baby12_diastolic.png", width=8, height=6, dpi=300)
```

regression analysis can be used to infer causal relationships between the independent and dependent variables.

```
plot(df$Dia, df$Sys, pch=21, bg=rater_colors[unclass(df$Device)],
     main="Baby BP measurements", xlab="Diastolic (mmHg)", ylab="Systolic (mmHg)")
```




```
# some dependency between axis variables
# gap in between gold points means data will not be normal
```

[Testing correlations] - captures relationship between two random variables

- pearson is magnitude based
- spearmen is rank based - spearman test, cant get exact p value, math behind it based on if rank of A bigger than rank of B, p value of spearman assumes you have n coin flips, non parametric because it can convert everything to coin flip. BUT if two values are the same, it can not calculate exact pvalue. But p value is close enough…

```
# r_p=cor(df$Sys, df$Dia, method = c("pearson"))
# r_p
# r_s=cor(df$Sys, df$Dia, method = c("spearman"))
# r_s
cor.test(df$Sys,df$Dia,method="pearson")
```

```
##
##  Pearson's product-moment correlation
##
## data:  df$Sys and df$Dia
## t = 11.46, df = 85, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.6801394 0.8502551
## sample estimates:
##       cor
## 0.7791576
```

```
cor.test(df$Sys,df$Dia,method="spearman")
```

```
## Warning in cor.test.default(df$Sys, df$Dia, method = "spearman"): Cannot compute
## exact p-value with ties
```

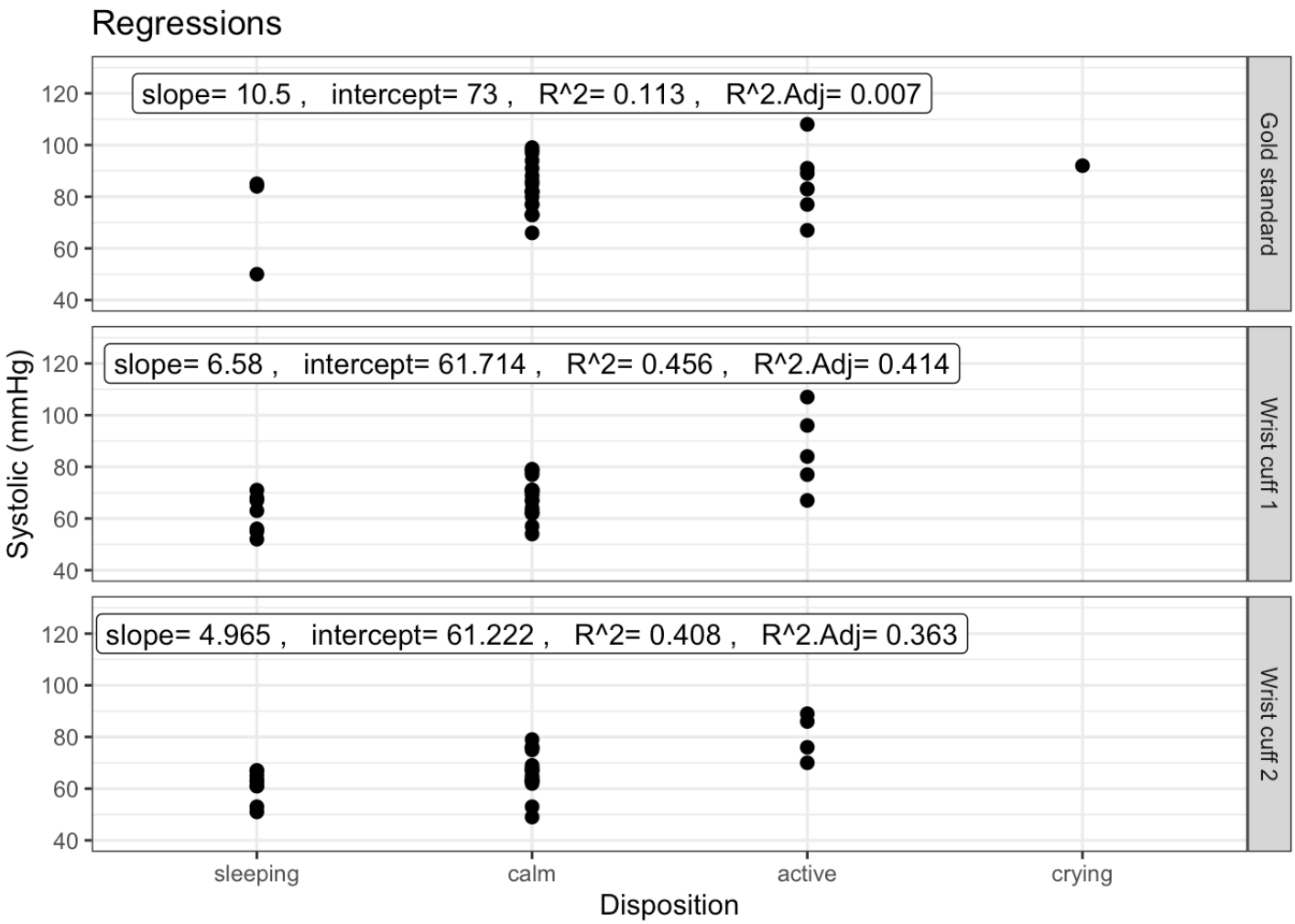
```
##
##  Spearman's rank correlation rho
##
## data:  df$Sys and df$Dia
## S = 19907, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## 0.8185903
```

```
# function from file:///Users/mariapalafox/Desktop/TOOLBOXR/19_04_22_RregressionStats
_facetWrap.html

regression=function(df){
        reg_fun<-lm(formula = df$Sys ~ df$Disposition)
        #getting the slope, intercept, R square and adjusted R squared of
        #the regression function (with 3 decimals).
        slope<-round(coef(reg_fun)[2],3)
        intercept<-round(coef(reg_fun)[1],3)
        R2<-round(as.numeric(summary(reg_fun)[8]),3)
        R2.Adj<-round(as.numeric(summary(reg_fun)[9]),3)
        c(slope,intercept,R2,R2.Adj)
}
# funx call
regressions_data <- ddply(df,"Device", regression)
colnames(regressions_data) <-c("Device","slope","intercept","R2","R2.Adj")

regressions_data
```

```
##          Device  slope intercept    R2 R2.Adj
## 1 Gold standard 10.500    73.000 0.113  0.007
## 2  Wrist cuff 1  6.580    61.714 0.456  0.414
## 3  Wrist cuff 2  4.965    61.222 0.408  0.363
```

```
qplot(Disposition, Sys, data = df, size = I(2)) +
  geom_smooth(method="lm") +
  facet_grid(Device ~ .) +
  scale_y_continuous(limits = c(40, 130)) +
 # scale_x_continuous(limits = c(20, 80)) +
  labs(x="Disposition", y="Systolic (mmHg)") +
  ggtitle("Regressions") +
  theme_bw() +
  geom_label(data=regressions_data,
             inherit.aes=FALSE,
             aes(x = 2, y = 120,
                 label=paste("slope=",slope,",","," ","intercept=",
                             intercept,",","," ","R^2=",R2,",","," ","R^2.Adj=",R2.Adj)))
```

```
## `geom_smooth()` using formula 'y ~ x'
```

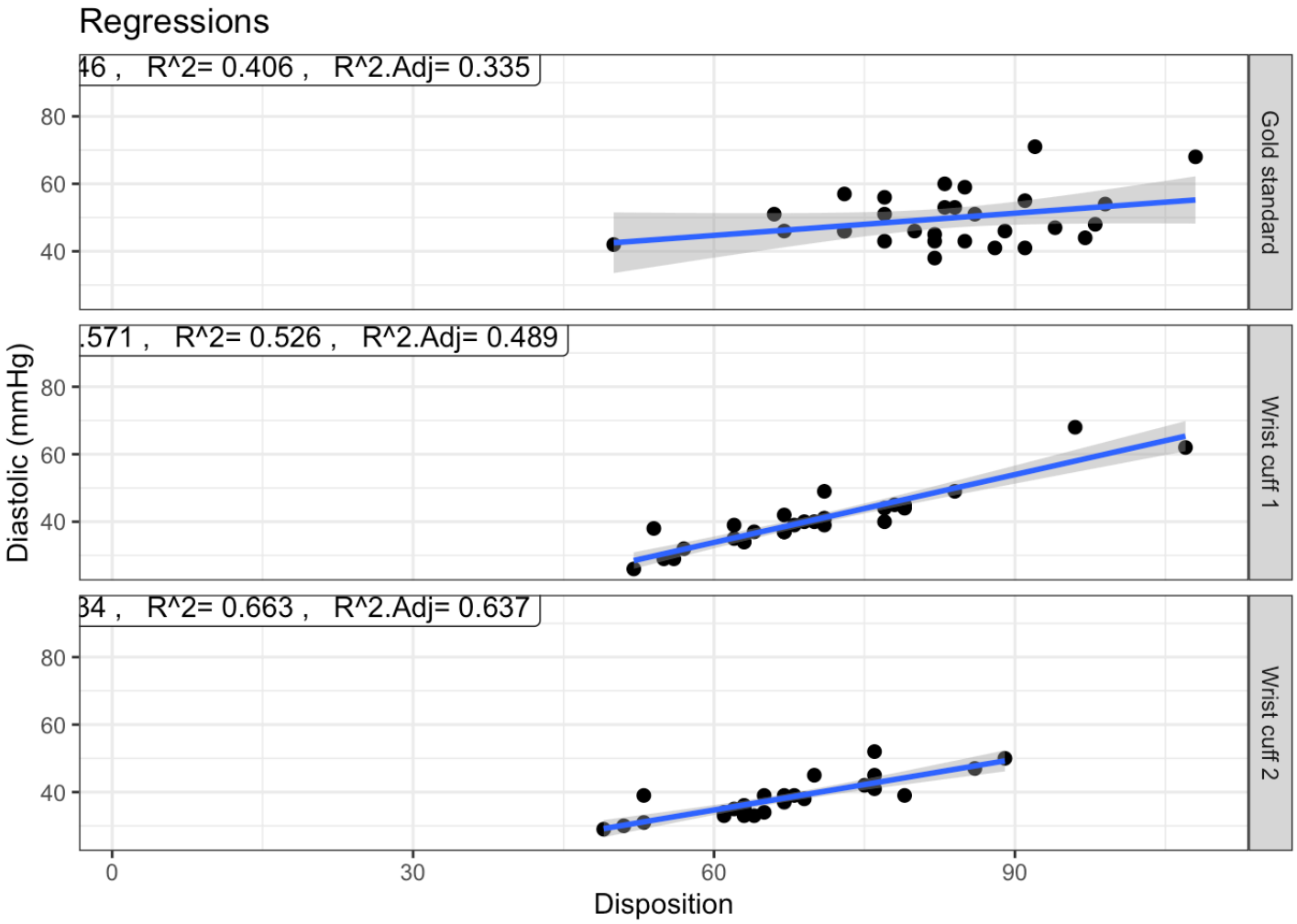



```
regression=function(df){
        reg_fun<-lm(formula = df$Dia ~ df$Disposition) # CHANGE
        slope<-round(coef(reg_fun)[2],3)
        intercept<-round(coef(reg_fun)[1],3)
        R2<-round(as.numeric(summary(reg_fun)[8]),3)
        R2.Adj<-round(as.numeric(summary(reg_fun)[9]),3)
        c(slope,intercept,R2,R2.Adj)
}

regressions_data <- ddply(df,"Device", regression) # CHANGE
colnames(regressions_data) <-c("Device","slope","intercept","R2","R2.Adj")

regressions_data
```

```
##          Device slope intercept    R2 R2.Adj
## 1 Gold standard 1.556    46.000 0.406  0.335
## 2  Wrist cuff 1 5.958    33.571 0.526  0.489
## 3  Wrist cuff 2 3.625    34.000 0.663  0.637
```

```
qplot(Sys, Dia, data = df, size = I(2)) + # CHANGE
  geom_smooth(method="lm") +
  facet_grid(Device ~ .) +
  #scale_y_continuous(limits = c(20, 100)) +
 # scale_x_continuous(limits = c(20, 80)) +
  labs(x="Disposition", y="Diastolic (mmHg)") +
  theme_bw() +
  ggtitle("Regressions") +
  geom_label(data=regressions_data,
             inherit.aes=FALSE,
             aes(x = 2, y = 95,
                 label=paste("slope=",slope,"," " ","intercept=",
                             intercept,"," " ","R^2=",R2,"," " ","R^2.Adj=",R2.Adj)))
```

```
## `geom_smooth()` using formula 'y ~ x'
```



```
# -1 says remove intercept term, you need to do this because you have 3 different spe
cies. now every species gets its own off set
gs <- df %>% filter(Device == 'Gold standard')
wc1 <- df %>% filter(Device == 'Wrist cuff 1')
wc2 <- df %>% filter(Device == 'Wrist cuff 2')

lm_gs = lm(Sys ~ Disposition, data=gs) #
summary(lm_gs)
```

```
##
## Call:
## lm(formula = Sys ~ Disposition, data = gs)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -23.00  -6.50  -1.50   7.50  22.57
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)         73.000      6.672  10.942 5.06e-11 ***
## Dispositioncalm     10.500      7.206   1.457    0.158
## Dispositionactive   12.429      7.974   1.559    0.132
## Dispositioncrying   19.000     13.343   1.424    0.167
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 11.56 on 25 degrees of freedom
## Multiple R-squared:  0.1132, Adjusted R-squared:  0.006731
## F-statistic: 1.063 on 3 and 25 DF,  p-value: 0.3824
```

```
# average all wrist col rows together
library(data.table)
```

```
##
## Attaching package: 'data.table'
```

```
## The following objects are masked from 'package:dplyr':
##
##     between, first, last
```

```
## The following object is masked from 'package:purrr':
##
##     transpose
```

```
dat <- df2 %>% select(BabyID, Session, Device, Measurement, Type, Disposition)
keys <- colnames(dat)[!grepl('Measurement', colnames(dat))]
X <- as.data.table(dat)
X[,list(mean_measurement = mean(Measurement)),keys]
```

```
##      BabyID Session        Device      Type Disposition mean_measurement
##   1:      1       1 Gold standard  Systolic        calm               98
##   2:      1       1  Wrist cuff 1  Systolic      active              107
##   3:      1       1  Wrist cuff 2  Systolic      active               70
##   4:      2       1 Gold standard  Systolic        calm               99
##   5:      2       1  Wrist cuff 1  Systolic    sleeping               67
##  ---
## 170:     13       1  Wrist cuff 1 Diastolic    sleeping               41
## 171:     13       1  Wrist cuff 2 Diastolic    sleeping               37
## 172:     13       2 Gold standard Diastolic        calm               56
## 173:     13       2  Wrist cuff 1 Diastolic      active               44
## 174:     13       2  Wrist cuff 2 Diastolic        calm               39
```

```
# doesnt work because i cant average dispo
```

```
# make unique identifier
reg <- unite(df2, col='ID', c('BabyID', 'Session'), sep='-')
reg <- reg %>% select(ID, Device, Measurement, Type, Disposition)

gs <- reg %>% filter(Device == 'Gold standard')
wc1 <- reg %>% filter(Device == 'Wrist cuff 1')
wc2 <- reg %>% filter(Device == 'Wrist cuff 2')

gs
```

```
##      ID        Device Measurement      Type Disposition
## 1   1-1 Gold standard          98  Systolic        calm
## 2   2-1 Gold standard          99  Systolic        calm
## 3   2-2 Gold standard          97  Systolic        calm
## 4   2-3 Gold standard          82  Systolic        calm
## 5   3-1 Gold standard         108  Systolic      active
## 6   3-2 Gold standard          86  Systolic        calm
## 7   3-3 Gold standard          85  Systolic    sleeping
## 8   4-1 Gold standard          91  Systolic      active
## 9   4-2 Gold standard          91  Systolic        calm
## 10  4-3 Gold standard          94  Systolic        calm
## 11  5-1 Gold standard          77  Systolic        calm
## 12  6-1 Gold standard          73  Systolic        calm
## 13  7-1 Gold standard          80  Systolic        calm
## 14  7-2 Gold standard          85  Systolic        calm
```

```
## 15  8-1 Gold standard          66  Systolic        calm
## 16  8-2 Gold standard          82  Systolic        calm
## 17  8-3 Gold standard          88  Systolic        calm
## 18  9-1 Gold standard          50  Systolic    sleeping
## 19  9-2 Gold standard          73  Systolic        calm
## 20 10-1 Gold standard          83  Systolic      active
## 21 10-2 Gold standard          89  Systolic      active
## 22 10-3 Gold standard          67  Systolic      active
## 23 11-1 Gold standard          83  Systolic      active
## 24 11-2 Gold standard          92  Systolic      crying
## 25 12-1 Gold standard          84  Systolic    sleeping
## 26 12-2 Gold standard          77  Systolic      active
## 27 12-3 Gold standard          73  Systolic        calm
## 28 13-1 Gold standard          82  Systolic        calm
## 29 13-2 Gold standard          77  Systolic        calm
## 30  1-1 Gold standard          48 Diastolic        calm
## 31  2-1 Gold standard          54 Diastolic        calm
## 32  2-2 Gold standard          44 Diastolic        calm
## 33  2-3 Gold standard          43 Diastolic        calm
## 34  3-1 Gold standard          68 Diastolic      active
## 35  3-2 Gold standard          51 Diastolic        calm
## 36  3-3 Gold standard          43 Diastolic    sleeping
## 37  4-1 Gold standard          55 Diastolic      active
## 38  4-2 Gold standard          41 Diastolic        calm
## 39  4-3 Gold standard          47 Diastolic        calm
## 40  5-1 Gold standard          43 Diastolic        calm
## 41  6-1 Gold standard          57 Diastolic        calm
## 42  7-1 Gold standard          46 Diastolic        calm
## 43  7-2 Gold standard          59 Diastolic        calm
## 44  8-1 Gold standard          51 Diastolic        calm
## 45  8-2 Gold standard          38 Diastolic        calm
## 46  8-3 Gold standard          41 Diastolic        calm
## 47  9-1 Gold standard          42 Diastolic    sleeping
## 48  9-2 Gold standard          46 Diastolic        calm
## 49 10-1 Gold standard          53 Diastolic      active
## 50 10-2 Gold standard          46 Diastolic      active
## 51 10-3 Gold standard          46 Diastolic      active
## 52 11-1 Gold standard          60 Diastolic      active
## 53 11-2 Gold standard          71 Diastolic      crying
## 54 12-1 Gold standard          53 Diastolic    sleeping
## 55 12-2 Gold standard          51 Diastolic      active
## 56 12-3 Gold standard          46 Diastolic        calm
## 57 13-1 Gold standard          45 Diastolic        calm
## 58 13-2 Gold standard          56 Diastolic        calm
```

```
wc1
```

```
##      ID       Device Measurement      Type Disposition
```

```
## 1   1-1 Wrist cuff 1         107  Systolic      active
## 2   2-1 Wrist cuff 1          67  Systolic    sleeping
## 3   2-2 Wrist cuff 1          96  Systolic      active
## 4   2-3 Wrist cuff 1          56  Systolic    sleeping
## 5   3-1 Wrist cuff 1          79  Systolic        calm
## 6   3-2 Wrist cuff 1          84  Systolic      active
## 7   3-3 Wrist cuff 1          69  Systolic        calm
## 8   4-1 Wrist cuff 1          67  Systolic        calm
## 9   4-2 Wrist cuff 1          63  Systolic        calm
## 10  4-3 Wrist cuff 1          71  Systolic        calm
## 11  5-1 Wrist cuff 1          77  Systolic        calm
## 12  6-1 Wrist cuff 1          78  Systolic        calm
## 13  7-1 Wrist cuff 1          71  Systolic        calm
## 14  7-2 Wrist cuff 1          68  Systolic    sleeping
## 15  8-1 Wrist cuff 1          70  Systolic        calm
## 16  8-2 Wrist cuff 1          63  Systolic    sleeping
## 17  8-3 Wrist cuff 1          71  Systolic        calm
## 18  9-1 Wrist cuff 1          55  Systolic    sleeping
## 19  9-2 Wrist cuff 1          62  Systolic        calm
## 20 10-1 Wrist cuff 1          67  Systolic        calm
## 21 10-2 Wrist cuff 1          54  Systolic        calm
## 22 10-3 Wrist cuff 1          57  Systolic        calm
## 23 11-1 Wrist cuff 1          62  Systolic        calm
## 24 11-2 Wrist cuff 1          79  Systolic        calm
## 25 12-1 Wrist cuff 1          64  Systolic        calm
## 26 12-2 Wrist cuff 1          67  Systolic      active
## 27 12-3 Wrist cuff 1          52  Systolic    sleeping
## 28 13-1 Wrist cuff 1          71  Systolic    sleeping
## 29 13-2 Wrist cuff 1          77  Systolic      active
## 30  1-1 Wrist cuff 1          62 Diastolic      active
## 31  2-1 Wrist cuff 1          37 Diastolic    sleeping
## 32  2-2 Wrist cuff 1          68 Diastolic      active
## 33  2-3 Wrist cuff 1          29 Diastolic    sleeping
## 34  3-1 Wrist cuff 1          44 Diastolic        calm
## 35  3-2 Wrist cuff 1          49 Diastolic      active
## 36  3-3 Wrist cuff 1          40 Diastolic        calm
## 37  4-1 Wrist cuff 1          37 Diastolic        calm
## 38  4-2 Wrist cuff 1          34 Diastolic        calm
## 39  4-3 Wrist cuff 1          39 Diastolic        calm
## 40  5-1 Wrist cuff 1          40 Diastolic        calm
## 41  6-1 Wrist cuff 1          45 Diastolic        calm
## 42  7-1 Wrist cuff 1          41 Diastolic        calm
## 43  7-2 Wrist cuff 1          39 Diastolic    sleeping
## 44  8-1 Wrist cuff 1          40 Diastolic        calm
## 45  8-2 Wrist cuff 1          34 Diastolic    sleeping
## 46  8-3 Wrist cuff 1          49 Diastolic        calm
## 47  9-1 Wrist cuff 1          29 Diastolic    sleeping
## 48  9-2 Wrist cuff 1          39 Diastolic        calm
## 49 10-1 Wrist cuff 1          37 Diastolic        calm
```

```
## 50 10-2 Wrist cuff 1          38 Diastolic        calm
## 51 10-3 Wrist cuff 1          32 Diastolic        calm
## 52 11-1 Wrist cuff 1          35 Diastolic        calm
## 53 11-2 Wrist cuff 1          45 Diastolic        calm
## 54 12-1 Wrist cuff 1          37 Diastolic        calm
## 55 12-2 Wrist cuff 1          42 Diastolic      active
## 56 12-3 Wrist cuff 1          26 Diastolic    sleeping
## 57 13-1 Wrist cuff 1          41 Diastolic    sleeping
## 58 13-2 Wrist cuff 1          44 Diastolic      active
```

```
#reg <- bind_rows
# colnames(gs)[colnames(gs) == "Measurement"] ="Gold standard"
# colnames(wc1)[colnames(wc1) == "Measurement"] = "Wrist cuff 1"
# colnames(wc2)[colnames(wc2) == "Measurement"] = "Wrist cuff 2"
# reg <- list(gs,wc1,wc2) %>% reduce(inner_join, by='ID')
# reg
```

```
regression=function(df){
        #setting the regression function.
        reg_fun<-lm(formula= df$Sys ~ df$Dia)
        #getting the slope, intercept, R square and adjusted R squared of
        #the regression function (with 3 decimals).
        slope<-round(coef(reg_fun)[2],3)
        intercept<-round(coef(reg_fun)[1],3)
        R2<-round(as.numeric(summary(reg_fun)[8]),3)
        R2.Adj<-round(as.numeric(summary(reg_fun)[9]),3)
        c(slope,intercept,R2,R2.Adj)
}

regressions_data <- ddply(df,"Device", regression)

colnames(regressions_data) <-c("Device","slope","intercept","R2","R2.Adj")

qplot(Dia, Sys, data = df, size = I(2)) +
  geom_smooth(method="lm") +
  facet_grid(Device ~ .) +
  scale_y_continuous(limits = c(40, 130)) +
  scale_x_continuous(limits = c(20, 80)) +
  labs(x="Diastolic (mmHg)", y="Systolic (mmHg)") +
  ggtitle("Regressions") +
  geom_label(data=regressions_data,
             inherit.aes=FALSE,
             aes(x = 50, y = 120,
                 label=paste("slope=",slope,",","," ","intercept=",
                             intercept,",","," ","R^2=",R2,",","," ","R^2.Adj=",R2.Adj)))
```

```
## `geom_smooth()` using formula 'y ~ x'
```