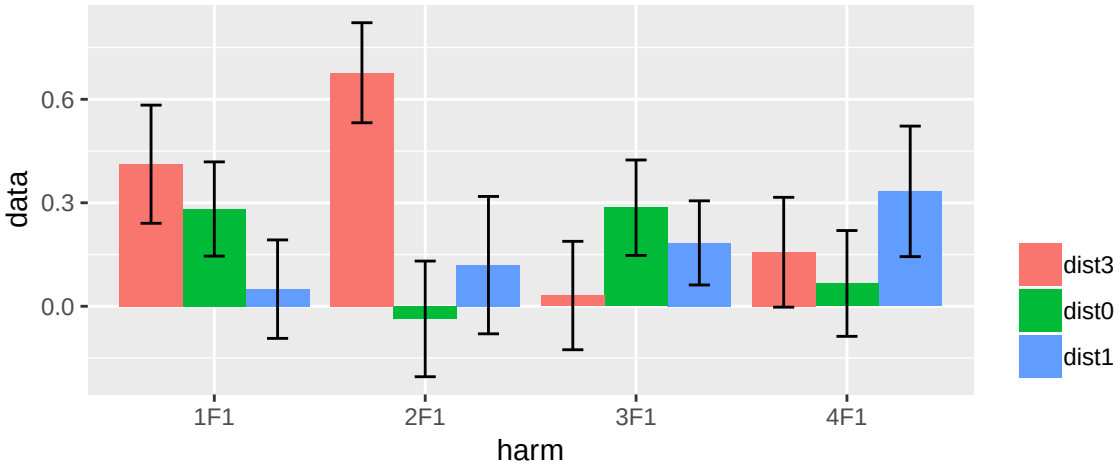
NUMEROSITY ANALYSIS RESULTS

```
top_folder = '/Users/kohler/Dropbox/WRITING/Articles/2019_KohlerNumerositySSVEP/figures/results/experiment2'
counter = 0
for (c in c(6,8)) {
  for (q in c(1,2,3,4)) {
    cur_file = switch(q, "RLS_oddball_rc1_carr", "RLS_carrier_rc1_carr", "RLS_oddball_rc2_carr", "RLS_carrier_rc
    cur_csv <- sprintf('%s/%s%d_full_projected_all_trials.csv', top_folder, cur_file, c)
    cur_data <-data.frame( read.csv(file = cur_csv ) )
    cur_data$cond <- factor(cur_data$condition, levels(cur_data$condition)[c(3,1,2)])
    cur_data$harm <- cur_data$harmonic
    cur_data$harm_alt <- factor(cur_data$harmonic, levels(cur_data$harmonic)[c(2,1,3,4)])
    g <- ggplot(cur_data, aes(harm, data, fill = cond)) +
      stat_summary(geom = "bar", fun.y = mean, position=position_dodge()) +
      stat_summary(geom = "errorbar", fun.data = mean_se, width=.3, position=position_dodge(.9))
    g <- g + theme(legend.title=element_blank(),
      legend.justification=c(1,0),
      legend.background = element_blank()) +
      ggtitle(toupper(sprintf('%s%d\n',cur_file, c)))
    if (q == 1 && c == 6) {
      cat("RESULTS BELOW\n  ")
      cat("\n  ")
    }
    print(g)
    m1 <- lmer(data ~ cond * harm + (1|subject), cur_data)
    emm = emmeans(m1, ~ cond * harm, lmer.df = "satterthwaite")
    m2 <- lmer(data ~ cond + harm + (1|subject), cur_data)
    if (isSingular(m1)) {
      if (isSingular(m2)) {
        cat("WARNING: BOTH MODELS ARE SINGULAR!\n\n")
      } else {
        cat("WARNING: MODEL1 IS SINGULAR, BUT MODEL2 IS NOT!\n\n")
      }
    } else {
      cat("LOVELY: NONE OF THE MODELS ARE SINGULAR!\n\n")
    }
    cat("ANOVA TEST FOR MAIN EFFECTS AND INTERACTIONS\n")
    print(anova(m1), type='pdf')
    cat("\nESTIMATED MARGINAL MEANS, SIMPLE MAIN EFFECTS OF CONDITION WITHOUT CORRECTION\n")
    print(prettify(summary(pairs(emm, simple = "cond", adjust = "none"))))
    cat("\nTEST OF WHETHER OR NOT THE INTERACTION PROVIDES A BETTER FIT\n")
    print(anova(m1, m2))
  }
}
```

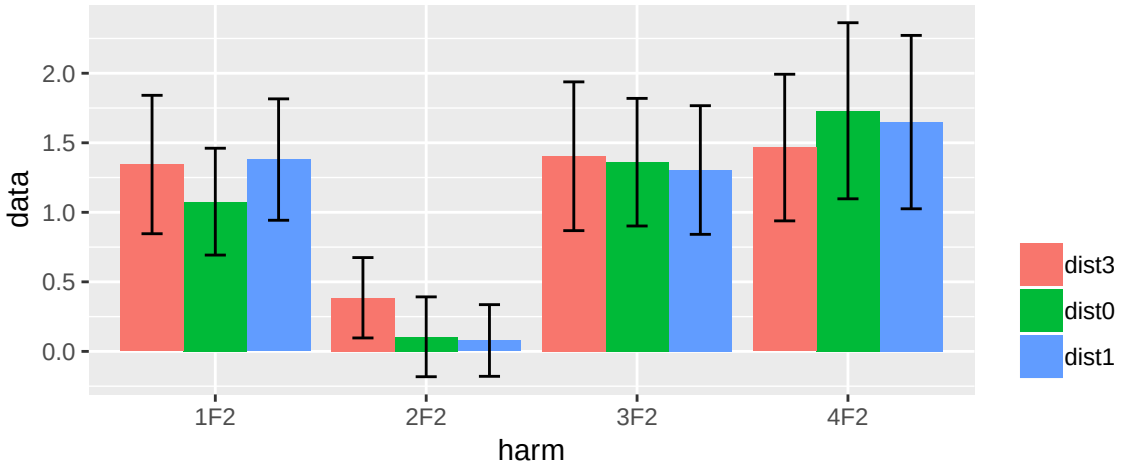
```
## RESULTS BELOW
##
##
```

RLS_ODDBALL_RC1_CARR6



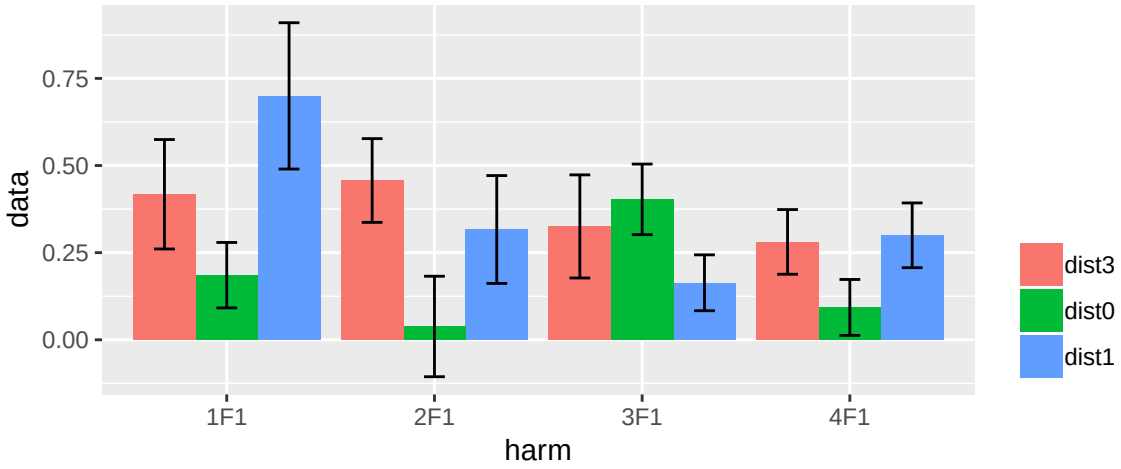

```
## WARNING: BOTH MODELS ARE SINGULAR!
##
## ANOVA TEST FOR MAIN EFFECTS AND INTERACTIONS
## Type III Analysis of Variance Table with Satterthwaite's method
##           Sum Sq Mean Sq NumDF DenDF F value  Pr(>F)
## cond      1.0229 0.51147     2   168  1.3620 0.25897
## harm      0.2578 0.08593     3   168  0.2288 0.87624
## cond:harm 5.2550 0.87584     6   168  2.3322 0.03445 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## ESTIMATED MARGINAL MEANS, SIMPLE MAIN EFFECTS OF CONDITION WITHOUT CORRECTION
##            contrast harm    estimate        SE  df    t.ratio     p.value
## 1    1 dist3 - dist0  1F1  0.12977409 0.2237685 168  0.5799480 0.562726674
## 2    2 dist3 - dist1  1F1  0.36218199 0.2237685 168  1.6185566 0.107418560
## 3    3 dist0 - dist1  1F1  0.23240789 0.2237685 168  1.0386086 0.300479312
## 4    4 dist3 - dist0  2F1  0.71356893 0.2237685 168  3.1888711 0.001704027
## 5    5 dist3 - dist1  2F1  0.55770251 0.2237685 168  2.4923190 0.013660459
## 6    6 dist0 - dist1  2F1 -0.15586642 0.2237685 168 -0.6965521 0.487045793
## 7    7 dist3 - dist0  3F1 -0.25458827 0.2237685 168 -1.1377306 0.256853001
## 8    8 dist3 - dist1  3F1 -0.15254606 0.2237685 168 -0.6817137 0.496358700
## 9    9 dist0 - dist1  3F1  0.10204221 0.2237685 168  0.4560168 0.648966800
## 10 10 dist3 - dist0  4F1  0.09048833 0.2237685 168  0.4043837 0.686444946
## 11 11 dist3 - dist1  4F1 -0.17642404 0.2237685 168 -0.7884221 0.431560961
## 12 12 dist0 - dist1  4F1 -0.26691237 0.2237685 168 -1.1928058 0.234627366
##
## TEST OF WHETHER OR NOT THE INTERACTION PROVIDES A BETTER FIT
## Data: cur_data
## Models:
## m2: data ~ cond + harm + (1 | subject)
## m1: data ~ cond * harm + (1 | subject)
##    Df    AIC    BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## m2  8 352.51 378.05 -168.26   336.51
## m1 14 350.11 394.81 -161.06   322.11 14.401      6    0.02546 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

RLS_CARRIER_RC1_CARR6



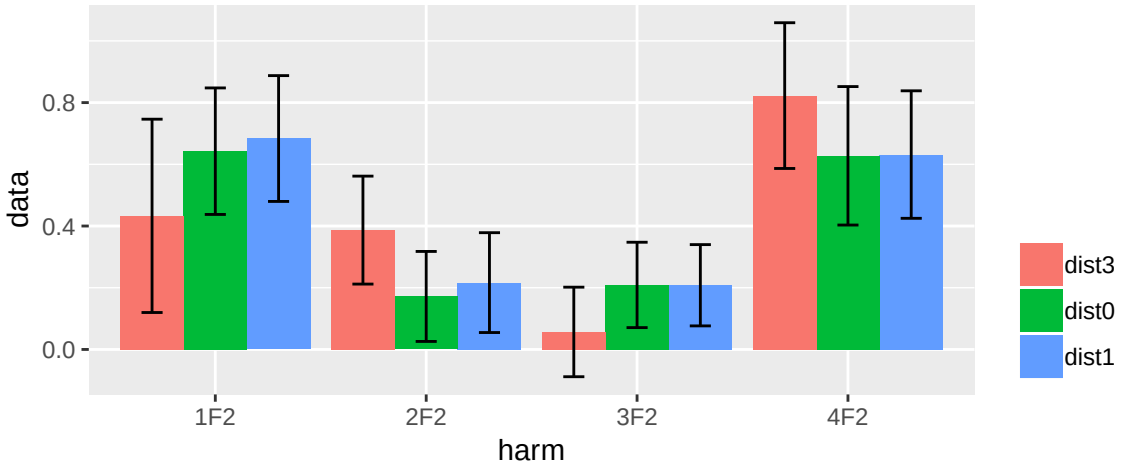

```
## LOVELY: NONE OF THE MODELS ARE SINGULAR!
##
## ANOVA TEST FOR MAIN EFFECTS AND INTERACTIONS
## Type III Analysis of Variance Table with Satterthwaite's method
##           Sum Sq Mean Sq NumDF DenDF F value    Pr(>F)
## cond       0.200  0.1002     2   154  0.0344 0.9661911
## harm      53.410 17.8035     3   154  6.1107 0.0005914 ***
## cond:harm  2.114  0.3523     6   154  0.1209 0.9937484
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## ESTIMATED MARGINAL MEANS, SIMPLE MAIN EFFECTS OF CONDITION WITHOUT CORRECTION
##            contrast harm    estimate        SE  df     t.ratio   p.value
## 1   1 dist3 - dist0  1F2  0.26688923 0.6232708 154  0.42820747 0.6690984
## 2   2 dist3 - dist1  1F2 -0.03569123 0.6232708 154 -0.05726440 0.9544088
## 3   3 dist0 - dist1  1F2 -0.30258046 0.6232708 154 -0.48547186 0.6280316
## 4   4 dist3 - dist0  2F2  0.28076425 0.6232708 154  0.45046909 0.6530058
## 5   5 dist3 - dist1  2F2  0.30718738 0.6232708 154  0.49286340 0.6228111
## 6   6 dist0 - dist1  2F2  0.02642313 0.6232708 154  0.04239431 0.9662393
## 7   7 dist3 - dist0  3F2  0.04263527 0.6232708 154  0.06840568 0.9455514
## 8   8 dist3 - dist1  3F2  0.09881422 0.6232708 154  0.15854139 0.8742379
## 9   9 dist0 - dist1  3F2  0.05617896 0.6232708 154  0.09013571 0.9282965
## 10 10 dist3 - dist0  4F2 -0.26452747 0.6232708 154 -0.42441818 0.6718532
## 11 11 dist3 - dist1  4F2 -0.18309495 0.6232708 154 -0.29376466 0.7693333
## 12 12 dist0 - dist1  4F2  0.08143253 0.6232708 154  0.13065352 0.8962199
##
## TEST OF WHETHER OR NOT THE INTERACTION PROVIDES A BETTER FIT
## Data: cur_data
## Models:
## m2: data ~ cond + harm + (1 | subject)
## m1: data ~ cond * harm + (1 | subject)
##    Df    AIC    BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## m2  8 720.57 746.11 -352.28   704.57
## m1 14 731.79 776.49 -351.90   703.79 0.7755      6     0.9927
```

RLS_ODDBALL_RC2_CARR6

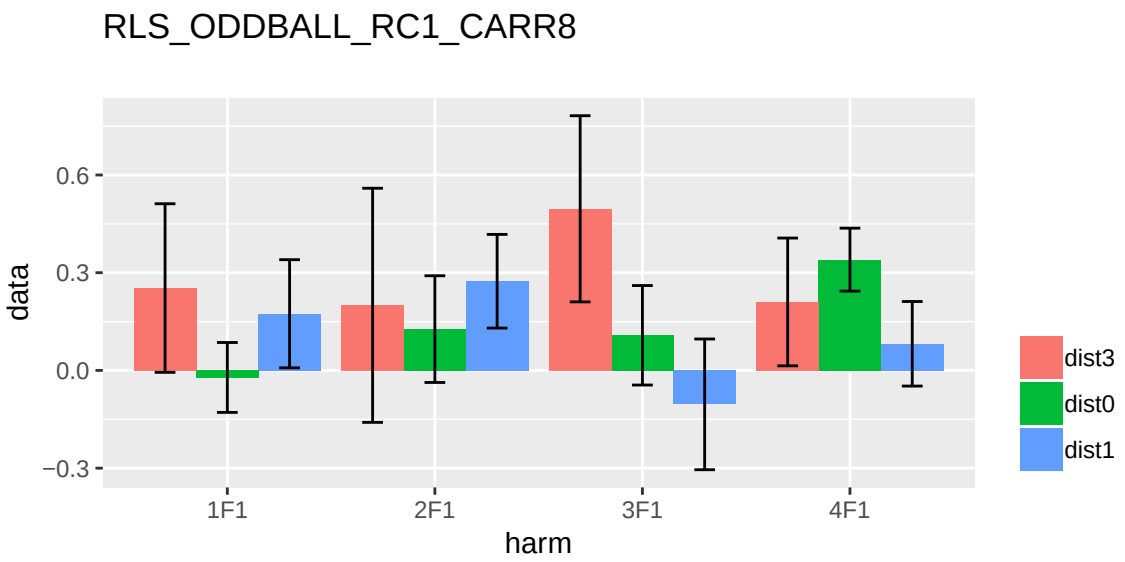



```
## WARNING: BOTH MODELS ARE SINGULAR!
##
## ANOVA TEST FOR MAIN EFFECTS AND INTERACTIONS
## Type III Analysis of Variance Table with Satterthwaite's method
##           Sum Sq Mean Sq NumDF DenDF F value  Pr(>F)
## cond      1.4477 0.72384     2   168  2.9104 0.05721 .
## harm      1.0996 0.36653     3   168  1.4737 0.22353
## cond:harm 2.7486 0.45811     6   168  1.8419 0.09379 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## ESTIMATED MARGINAL MEANS, SIMPLE MAIN EFFECTS OF CONDITION WITHOUT CORRECTION
##            contrast harm    estimate        SE  df    t.ratio     p.value
## 1   1 dist3 - dist0  1F1  0.23222357 0.1821025 168  1.2752353 0.203986644
## 2   2 dist3 - dist1  1F1 -0.28232772 0.1821025 168 -1.5503777 0.122932639
## 3   3 dist0 - dist1  1F1 -0.51455129 0.1821025 168 -2.8256130 0.005291315
## 4   4 dist3 - dist0  2F1  0.41892334 0.1821025 168  2.3004805 0.022650380
## 5   5 dist3 - dist1  2F1  0.14057973 0.1821025 168  0.7719812 0.441210144
## 6   6 dist0 - dist1  2F1 -0.27834361 0.1821025 168 -1.5284994 0.128269233
## 7   7 dist3 - dist0  3F1 -0.07771770 0.1821025 168 -0.4267799 0.670086080
## 8   8 dist3 - dist1  3F1  0.16174574 0.1821025 168  0.8882125 0.375696383
## 9   9 dist0 - dist1  3F1  0.23946344 0.1821025 168  1.3149923 0.190304583
## 10 10 dist3 - dist0  4F1  0.18803598 0.1821025 168  1.0325830 0.303283278
## 11 11 dist3 - dist1  4F1 -0.01900536 0.1821025 168 -0.1043662 0.917003211
## 12 12 dist0 - dist1  4F1 -0.20704133 0.1821025 168 -1.1369492 0.257178586
##
## TEST OF WHETHER OR NOT THE INTERACTION PROVIDES A BETTER FIT
## Data: cur_data
## Models:
## m2: data ~ cond + harm + (1 | subject)
## m1: data ~ cond * harm + (1 | subject)
##    Df    AIC    BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## m2  8 275.40 300.95 -129.70   259.40
## m1 14 275.94 320.64 -123.97   247.94 11.468      6    0.07495 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

RLS_CARRIER_RC2_CARR6

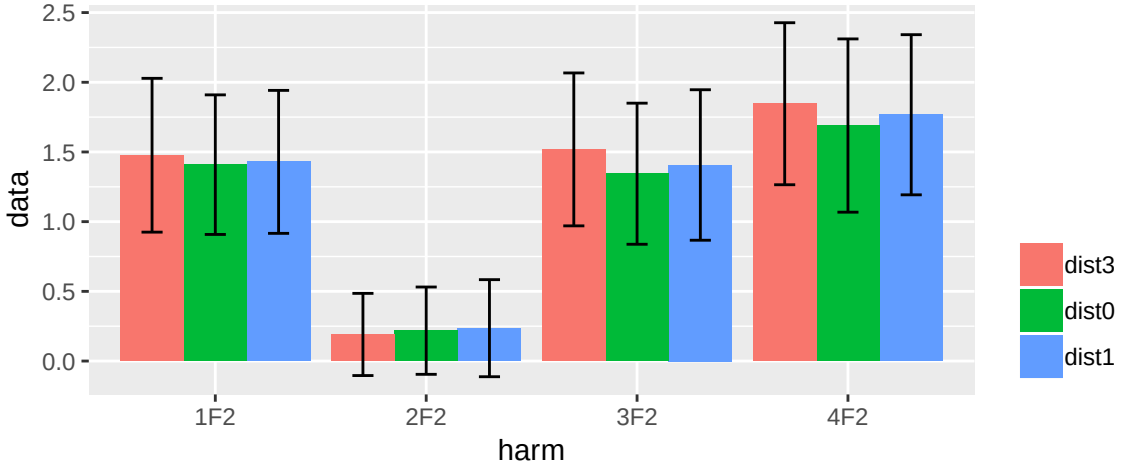



```
## LOVELY: NONE OF THE MODELS ARE SINGULAR!
##
## ANOVA TEST FOR MAIN EFFECTS AND INTERACTIONS
## Type III Analysis of Variance Table with Satterthwaite's method
##           Sum Sq Mean Sq NumDF DenDF F value   Pr(>F)
## cond      0.0149 0.00744     2   154  0.0140 0.986077
## harm      8.8855 2.96182     3   154  5.5854 0.001157 **
## cond:harm 1.5171 0.25285     6   154  0.4768 0.824817
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## ESTIMATED MARGINAL MEANS, SIMPLE MAIN EFFECTS OF CONDITION WITHOUT CORRECTION
##            contrast harm     estimate        SE  df      t.ratio   p.value
## 1    1 dist3 - dist0  1F2 -0.209587411 0.2659023 154 -0.788212126 0.4317842
## 2    2 dist3 - dist1  1F2 -0.250639097 0.2659023 154 -0.942598482 0.3473627
## 3    3 dist0 - dist1  1F2 -0.041051686 0.2659023 154 -0.154386355 0.8775073
## 4    4 dist3 - dist0  2F2  0.215022420 0.2659023 154  0.808652000 0.4199628
## 5    5 dist3 - dist1  2F2  0.170172295 0.2659023 154  0.639980550 0.5231362
## 6    6 dist0 - dist1  2F2 -0.044850125 0.2659023 154 -0.168671450 0.8662764
## 7    7 dist3 - dist0  3F2 -0.152396282 0.2659023 154 -0.573128878 0.5673934
## 8    8 dist3 - dist1  3F2 -0.151368679 0.2659023 154 -0.569264289 0.5700062
## 9    9 dist0 - dist1  3F2  0.001027603 0.2659023 154  0.003864588 0.9969215
## 10 10 dist3 - dist0  4F2  0.195166609 0.2659023 154  0.733978664 0.4640777
## 11 11 dist3 - dist1  4F2  0.191086910 0.2659023 154  0.718635816 0.4734543
## 12 12 dist0 - dist1  4F2 -0.004079699 0.2659023 154 -0.015342848 0.9877785
##
## TEST OF WHETHER OR NOT THE INTERACTION PROVIDES A BETTER FIT
## Data: cur_data
## Models:
## m2: data ~ cond + harm + (1 | subject)
## m1: data ~ cond * harm + (1 | subject)
##    Df    AIC    BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## m2  8 414.98 440.53 -199.49   398.98
## m1 14 423.95 468.65 -197.97   395.95 3.0372      6     0.8042
```

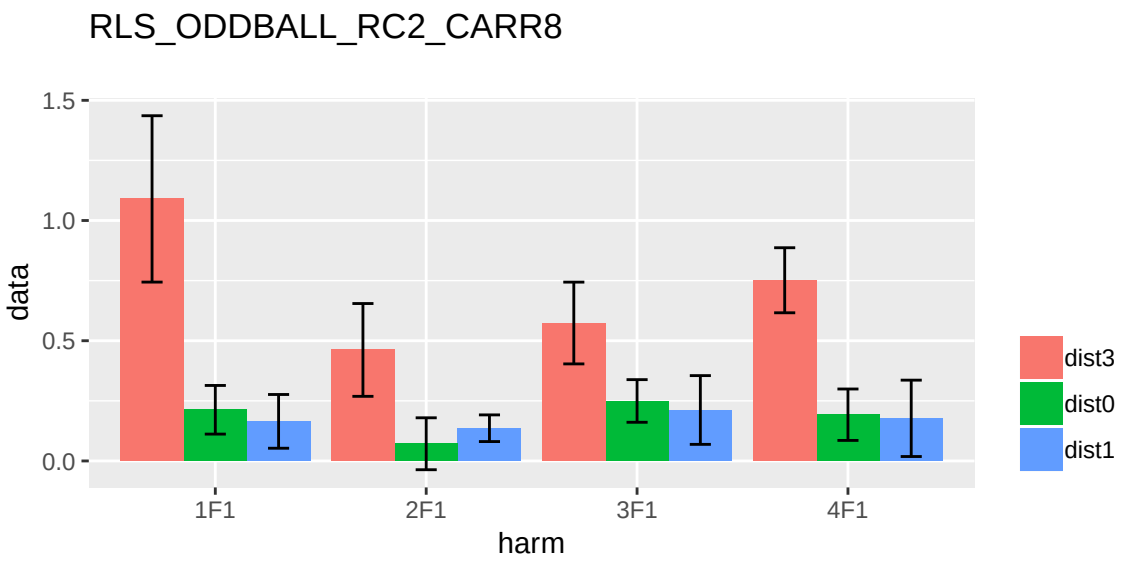



```
## LOVELY: NONE OF THE MODELS ARE SINGULAR!
##
## ANOVA TEST FOR MAIN EFFECTS AND INTERACTIONS
## Type III Analysis of Variance Table with Satterthwaite's method
##           Sum Sq Mean Sq NumDF DenDF F value Pr(>F)
## cond      1.1528 0.57642     2   154  0.9623 0.3843
## harm      0.1589 0.05297     3   154  0.0884 0.9663
## cond:harm 2.8893 0.48155     6   154  0.8039 0.5683
##
## ESTIMATED MARGINAL MEANS, SIMPLE MAIN EFFECTS OF CONDITION WITHOUT CORRECTION
##            contrast harm    estimate        SE  df    t.ratio    p.value
## 1   1 dist3 - dist0  1F1  0.27442738 0.2826119 154  0.9710399 0.33305110
## 2   2 dist3 - dist1  1F1  0.07898436 0.2826119 154  0.2794800 0.78025148
## 3   3 dist0 - dist1  1F1 -0.19544302 0.2826119 154 -0.6915599 0.49025503
## 4   4 dist3 - dist0  2F1  0.07316055 0.2826119 154  0.2588729 0.79607901
## 5   5 dist3 - dist1  2F1 -0.07384914 0.2826119 154 -0.2613094 0.79420304
## 6   6 dist0 - dist1  2F1 -0.14700969 0.2826119 154 -0.5201823 0.60368350
## 7   7 dist3 - dist0  3F1  0.38827204 0.2826119 154  1.3738703 0.17147840
## 8   8 dist3 - dist1  3F1  0.60036134 0.2826119 154  2.1243317 0.03523924
## 9   9 dist0 - dist1  3F1  0.21208930 0.2826119 154  0.7504614 0.45412194
## 10 10 dist3 - dist0  4F1 -0.12987034 0.2826119 154 -0.4595361 0.64649732
## 11 11 dist3 - dist1  4F1  0.12845158 0.2826119 154  0.4545159 0.65009756
## 12 12 dist0 - dist1  4F1  0.25832192 0.2826119 154  0.9140519 0.36211843
##
## TEST OF WHETHER OR NOT THE INTERACTION PROVIDES A BETTER FIT
## Data: cur_data
## Models:
## m2: data ~ cond + harm + (1 | subject)
## m1: data ~ cond * harm + (1 | subject)
##    Df    AIC    BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## m2  8 431.55 457.10 -207.78   415.55
## m1 14 438.47 483.17 -205.23   410.47 5.0886      6     0.5325
```

RLS_CARRIER_RC1_CARR8

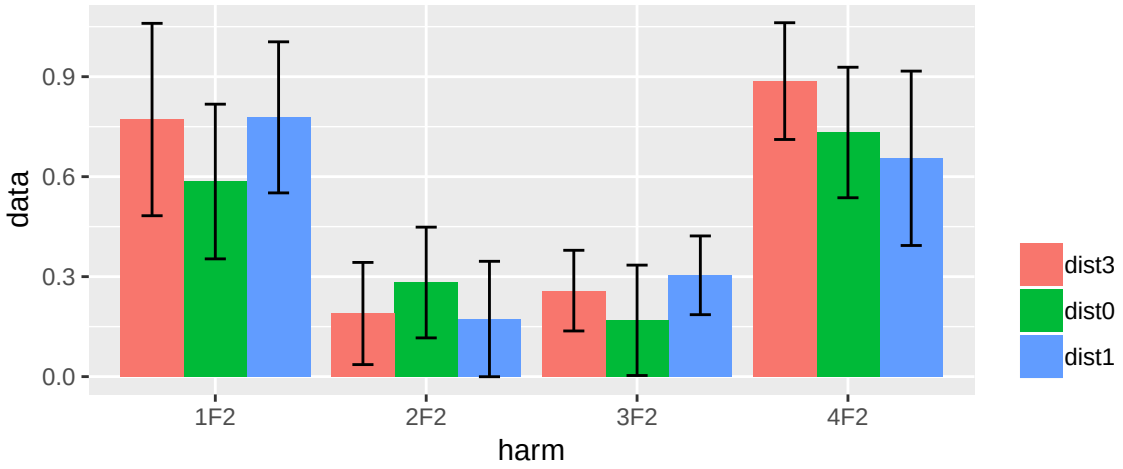



```
## LOVELY: NONE OF THE MODELS ARE SINGULAR!
##
## ANOVA TEST FOR MAIN EFFECTS AND INTERACTIONS
## Type III Analysis of Variance Table with Satterthwaite's method
##           Sum Sq Mean Sq NumDF DenDF F value    Pr(>F)
## cond       0.259  0.1294     2   154  0.0371 0.9635658
## harm      62.942 20.9807     3   154  6.0169 0.0006665 ***
## cond:harm  0.211  0.0351     6   154  0.0101 0.9999953
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## ESTIMATED MARGINAL MEANS, SIMPLE MAIN EFFECTS OF CONDITION WITHOUT CORRECTION
##            contrast harm    estimate        SE  df     t.ratio   p.value
## 1    1 dist3 - dist0  1F2  0.06761737 0.6818548 154  0.09916682 0.9211348
## 2    2 dist3 - dist1  1F2  0.04763711 0.6818548 154  0.06986401 0.9443925
## 3    3 dist0 - dist1  1F2 -0.01998026 0.6818548 154 -0.02930281 0.9766610
## 4    4 dist3 - dist0  2F2 -0.02713281 0.6818548 154 -0.03979264 0.9683100
## 5    5 dist3 - dist1  2F2 -0.04494424 0.6818548 154 -0.06591468 0.9475312
## 6    6 dist0 - dist1  2F2 -0.01781144 0.6818548 154 -0.02612204 0.9791938
## 7    7 dist3 - dist0  3F2  0.17442880 0.6818548 154  0.25581516 0.7984349
## 8    8 dist3 - dist1  3F2  0.11188552 0.6818548 154  0.16408994 0.8698755
## 9    9 dist0 - dist1  3F2 -0.06254328 0.6818548 154 -0.09172521 0.9270356
## 10 10 dist3 - dist0  4F2  0.15656073 0.6818548 154  0.22961006 0.8186995
## 11 11 dist3 - dist1  4F2  0.07911295 0.6818548 154  0.11602610 0.9077830
## 12 12 dist0 - dist1  4F2 -0.07744778 0.6818548 154 -0.11358397 0.9097155
##
## TEST OF WHETHER OR NOT THE INTERACTION PROVIDES A BETTER FIT
## Data: cur_data
## Models:
## m2: data ~ cond + harm + (1 | subject)
## m1: data ~ cond * harm + (1 | subject)
##    Df    AIC    BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## m2  8 749.84 775.39 -366.92   733.84
## m1 14 761.78 806.48 -366.89   733.78 0.0648      6          1
```




```
## LOVELY: NONE OF THE MODELS ARE SINGULAR!
##
## ANOVA TEST FOR MAIN EFFECTS AND INTERACTIONS
## Type III Analysis of Variance Table with Satterthwaite's method
##            Sum Sq Mean Sq NumDF DenDF F value    Pr(>F)
## cond      11.7624  5.8812     2   154 15.9932 4.887e-07 ***
## harm       1.6114  0.5371     3   154  1.4607    0.2275
## cond:harm  2.0897  0.3483     6   154  0.9471    0.4633
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## ESTIMATED MARGINAL MEANS, SIMPLE MAIN EFFECTS OF CONDITION WITHOUT CORRECTION
##             contrast harm    estimate        SE  df     t.ratio      p.value
## 1    1 dist3 - dist0  1F1  0.87707989 0.2214296 154  3.96098709 1.138077e-04
## 2    2 dist3 - dist1  1F1  0.92526444 0.2214296 154  4.17859368 4.899393e-05
## 3    3 dist0 - dist1  1F1  0.04818455 0.2214296 154  0.21760660 8.280237e-01
## 4    4 dist3 - dist0  2F1  0.39025717 0.2214296 154  1.76244333 7.997827e-02
## 5    5 dist3 - dist1  2F1  0.32564867 0.2214296 154  1.47066441 1.434222e-01
## 6    6 dist0 - dist1  2F1 -0.06460850 0.2214296 154 -0.29177892 7.708483e-01
## 7    7 dist3 - dist0  3F1  0.32416960 0.2214296 154  1.46398475 1.452364e-01
## 8    8 dist3 - dist1  3F1  0.36173167 0.2214296 154  1.63361909 1.043816e-01
## 9    9 dist0 - dist1  3F1  0.03756207 0.2214296 154  0.16963434 8.655203e-01
## 10 10 dist3 - dist0  4F1  0.55922555 0.2214296 154  2.52552270 1.256373e-02
## 11 11 dist3 - dist1  4F1  0.57435929 0.2214296 154  2.59386828 1.040590e-02
## 12 12 dist0 - dist1  4F1  0.01513374 0.2214296 154  0.06834558 9.455992e-01
##
## TEST OF WHETHER OR NOT THE INTERACTION PROVIDES A BETTER FIT
## Data: cur_data
## Models:
## m2: data ~ cond + harm + (1 | subject)
## m1: data ~ cond * harm + (1 | subject)
##    Df    AIC    BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## m2  8 346.45 371.99 -165.23   330.45
## m1 14 352.47 397.17 -162.24   324.47 5.9789      6     0.4256
```

RLS_CARRIER_RC2_CARR8




```
## LOVELY: NONE OF THE MODELS ARE SINGULAR!
##
## ANOVA TEST FOR MAIN EFFECTS AND INTERACTIONS
## Type III Analysis of Variance Table with Satterthwaite's method
##            Sum Sq Mean Sq NumDF DenDF F value    Pr(>F)
## cond       0.2140  0.1070     2   154  0.2059 0.8141210
## harm      11.5697  3.8566     3   154  7.4233 0.0001122 ***
## cond:harm  0.8077  0.1346     6   154  0.2591 0.9549237
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## ESTIMATED MARGINAL MEANS, SIMPLE MAIN EFFECTS OF CONDITION WITHOUT CORRECTION
##            contrast harm    estimate        SE  df     t.ratio   p.value
## 1   1 dist3 - dist0  1F2  0.18598282 0.2631909 154  0.70664601 0.4808543
## 2   2 dist3 - dist1  1F2 -0.00652778 0.2631909 154 -0.02480245 0.9802446
## 3   3 dist0 - dist1  1F2 -0.19251060 0.2631909 154 -0.73144847 0.4656168
## 4   4 dist3 - dist0  2F2 -0.09299893 0.2631909 154 -0.35335160 0.7243081
## 5   5 dist3 - dist1  2F2  0.01650671 0.2631909 154  0.06271763 0.9500727
## 6   6 dist0 - dist1  2F2  0.10950564 0.2631909 154  0.41606923 0.6779386
## 7   7 dist3 - dist0  3F2  0.08905689 0.2631909 154  0.33837372 0.7355425
## 8   8 dist3 - dist1  3F2 -0.04596407 0.2631909 154 -0.17464155 0.8615907
## 9   9 dist0 - dist1  3F2 -0.13502096 0.2631909 154 -0.51301527 0.6086758
## 10 10 dist3 - dist0  4F2  0.15426546 0.2631909 154  0.58613520 0.5586428
## 11 11 dist3 - dist1  4F2  0.23166719 0.2631909 154  0.88022483 0.3801091
## 12 12 dist0 - dist1  4F2  0.07740172 0.2631909 154  0.29408963 0.7690854
##
## TEST OF WHETHER OR NOT THE INTERACTION PROVIDES A BETTER FIT
## Data: cur_data
## Models:
## m2: data ~ cond + harm + (1 | subject)
## m1: data ~ cond * harm + (1 | subject)
##    Df    AIC    BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## m2  8 411.14 436.69 -197.57   395.14
## m1 14 421.49 466.19 -196.74   393.49 1.6575      6     0.9484
```