Behavioral analysis

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In this document, we show the results of an analysis including the 39 participants of the behavioral study who fulfilled the strict inclusion criteria.

Let's load the required libraries:

```
library(reshape2)
library(MASS)
library(lme4)
library(effects)
library(ggplot2)
library(viridis)
library(RColorBrewer)
library(ordinal)
library(cowplot)
library(kableExtra)
library(knitr)
library(broom)
library(broom.mixed)
library(dplyr)
```

Now, load the data:

```
d <- read.table('clean_data/dataset.csv', header = T, sep = ',') # load data

## To reproduce the original analyses with the stricter inclusion criteria
## (39 participants) uncomment these lines to select the subjects:

d <- d[d$prof < 2,] # self-declared as non-musicians
d <- d[d$yomt < 4,] # less than 4 years of musical training
d <- d[d$somt > 9|d$somt ==0,] # started musical traingin at 10 or older
```

After calculating d-prime scores (see Rmd script for the code), we run a t-test on them:

```
t.d <- t.test(d~cond, data= dprime, paired = T)
kable(tidy(t.d)%>%mutate_if(is.numeric,round,3))
```

estimate	statistic	p.value	parameter	conf.low	conf.high	method	alternative
0.646	5.15	0	38	0.392	0.9	Paired t-test	two.sided

The results show a clear effect of condition on d-prime scores. Now we run another t-test for criterion scores:

```
t.cr <- t.test(c~cond, data= dprime, paired = T)
kable(tidy(t.cr)%>%mutate_if(is.numeric,round,3))
```

estimate	statistic	p.value	parameter	conf.low	conf.high	method	alternative
0.067	0.692	0.493	38	-0.129	0.262	Paired t-test	two.sided

The results show no significant effect of condition on criterion scores. Now we fit a (full) cummulative link mixed model of confidence ratings with the two factors and their interaction:

```
conf <- clmm(as.factor(conf)~cond*deviance + (1|sub), data = d, link = "logit")
```

We inspect the parameters (odds ratios) of the model and the p-values:

```
kable(tidy(conf,conf.int=T, conf.level = 0.95,exponentiate = T) %>%
        select(-c('std.error','coefficient_type')) %>%
        mutate_if(is.numeric,round,3))
```

term	estimate	statistic	p.value	conf.low	conf.high
1|2	0.010	-13.399	0.000	0.005	0.019
2|3	0.044	-9.379	0.000	0.023	0.085
3|4	0.133	-6.176	0.000	0.070	0.252
4|5	0.281	-3.906	0.000	0.149	0.531
5|6	1.410	1.063	0.288	0.748	2.658
6|7	6.775	5.867	0.000	3.576	12.839
condatonal	0.541	-5.007	0.000	0.425	0.688
condatonal:deviancestd	0.776	-1.493	0.136	0.556	1.083
deviancestd	0.874	-1.112	0.266	0.689	1.108

The results show that participants were less confident in the atonal condition. There was not a significant condition*deviance interaction, but participants still tended to give particularly lower ratings to the standard melodies in the atonal condition.

Given this result, we explore whether a similar pattern can be seen for deviance detection. We therefore run a logistic regression on accuracy, with condition (tonal/atonal), deviance (standard/deviant) and their interaction as predictors.

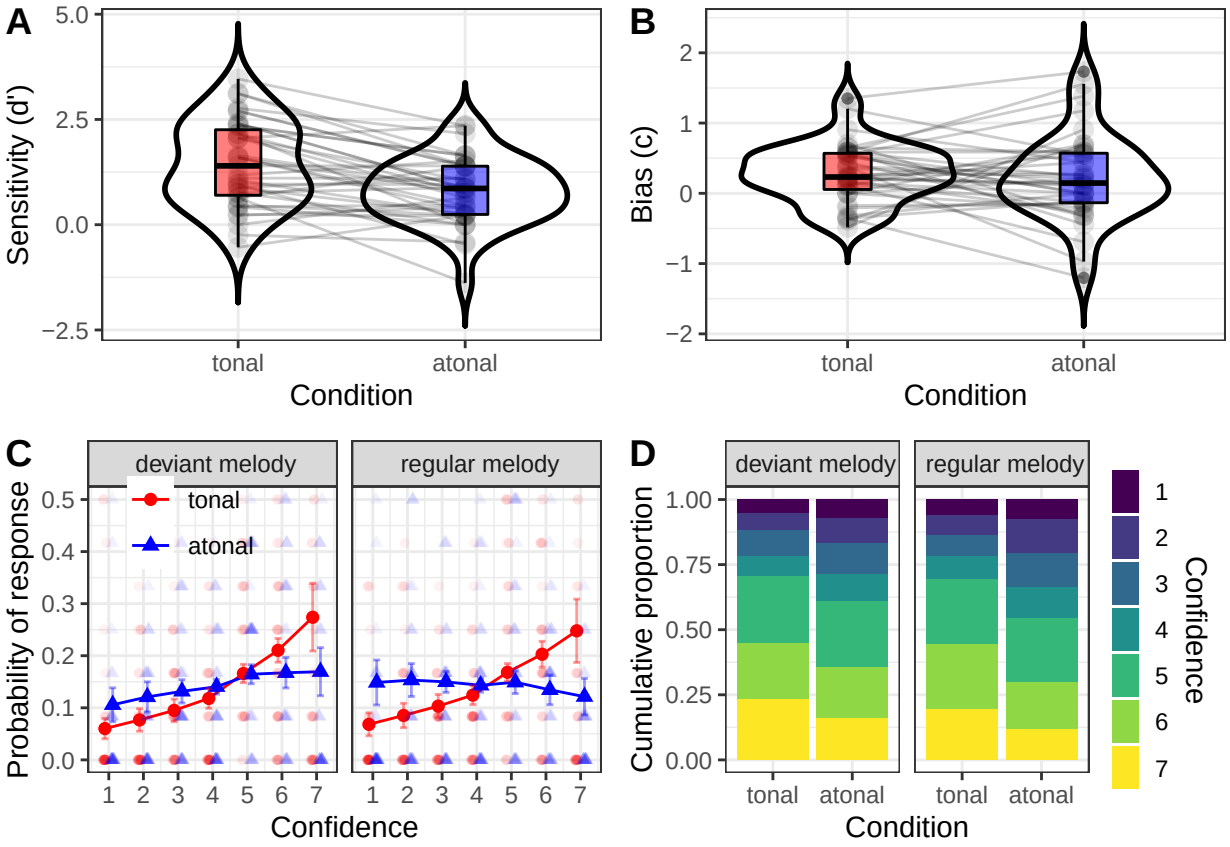
```
lr <- glmer(acc~cond*deviance+(1|sub),data=d,
            family=binomial(link = "logit"))

kable(tidy(lr,conf.int=T, conf.level = 0.95,exponentiate = T) %>%
        select(-c('std.error','effect','group')) %>%
        mutate_if(is.numeric,round,3))
```

term	estimate	statistic	p.value	conf.low	conf.high
(Intercept)	1.849	4.578	0.000	1.421	2.406
condatonal	0.729	-2.282	0.023	0.556	0.956
deviancestd	2.723	6.336	0.000	1.998	3.713
condatonal:deviancestd	0.694	-1.720	0.085	0.458	1.052
sd___(Intercept)	0.561	NA	NA	NA	NA

Notably, the same (non-significant) trend can be seen here. Participants tended to be less accurate in atonal melodies, and more so when the melody was a standard. Nevertheless, note that accuracy was already lower for deviant melodies.

Finally, we make the corresponding plots (se Rmd script for the full code)

```
plots <- align_plots(d.plot,c.plot,conf.plot2,conf.plot1,align = 'v',axis ='1')
joint_plots <- plot_grid(plots[[1]],plots[[2]],plots[[3]],plots[[4]],
                         labels = c('A','B','C','D'), ncol =2,nrow =2)
ggsave("joint_plots.png", plot=joint_plots,width = 180, height = 180,
       units = 'mm', dpi = 600)
joint_plots
```


A
Sensitivity (d')
5.0
2.5
0.0
−2.5
tonal
atonal
Condition
B
Bias (c)
2
1
0
−1
−2
tonal
atonal
Condition
C
deviant melody
regular melody
tonal
atonal
Probability of response
0.5
0.4
0.3
0.2
0.1
0.0
1 2 3 4 5 6 7
Confidence
D
deviant melody
regular melody
Cumulative proportion
1.00
0.75
0.50
0.25
0.00
tonal
atonal
Condition
Confidence
1
2
3
4
5
6
7