

Biostatistics

Report about the Scientific Study:

”dogs recognize dog and
human emotions”
From Natalia Albuquerque
et. al (2015)

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Chapter 1

Introduction

In this report, we will discuss the scientific study "Dogs recognize dog and human emotions" from Albuquerque et al. The study was published on rsbl.royalsocietypublishing.org in December 2015. We will be going through the experiment design, statistical methods and results of the study.

Chapter 2

Experiment Design

2.1 Subjects

In this experiment the scientists tested twenty-three adult domestic pet dogs without auditory, visual or chronic health problems in this cross-modal preferential looking paradigm; however, five subjects had to be excluded due to lack of attention and restlessness during testing. Thus, the scientists analysed the responses of seventeen dogs (9 males and 8 females, 2–7.5 years old of various breeds).

2.2 Stimuli

As there was a need for congruent visual and acoustic cues of specific emotional valence from the same individuals the scientists generated their own stimuli. Stimuli were sampled from two (one male and one female) adult drama students and adult police dogs. For each emotional valence (positive and negative), the corresponding facial expression and vocalization was recorded from each individual - faces and vocalizations were taken and recorded in one single session per model, in naturalistic situations. For the humans, the scientists generated the stimuli in a sound proof room with controlled lightning, asking the models to evoke the emotions (happiness and anger) and express them through their faces and voices. For the dogs, the scientists photographed and recorded the models in naturalistic situations, during play and agonistic encounters with another dog.

2.3 Experimental Procedure

During testing dogs stood in a quiet, dimly-lit test room and viewed the display. One researcher (R1) controlled stimulus presentation, while another (R2) stood behind the dog, with her hands on the subjects shoulders. R2 wore headphones

(always listening to the same music) and could not see the screens (looked down) and so was unaware of the location of the visual stimuli for any specific trial and could not interfere with the subjects response. As vocalisations could only be classed as congruent or incongruent depending on the position of the images, the experimenter could not, even unconsciously, cue the animals.

The trial started by flashing a LED panel placed between the two projection screens to attract the dogs attention. Once the dogs gaze was oriented towards the middle, stimuli was presented. Subjects spontaneously and passively viewed the face-pair for as long as they wanted; their head and eye movements were monitored and recorded by a video camera (Sanyo CCD camera VVC-3312P) placed at the bottom of the LED panel. This camera was connected to a monitor that allowed R1 to monitor stimulus presentation as well as the subjects attention in real time.

Chapter 3

Statistical Methods

3.1 Data Set

3.1.1 Congruence Index

The researchers calculated a congruence index $= (C - I)/T$, where C and I represent the amount of time the dog looked at the congruent (facial expression matching emotional vocalization, C) and incongruent faces (I), and T represents total looking time (looking left / looking right / looking at the centre) for the given trial, to measure the dogs sensitivity to audio-visual emotional cues delivered simultaneously.

3.1.2 Variables

##	val_con	sex_sti	spp_sti	side_con	index	dog
## 1	negative	female	dog	left	0.30769231	2
## 2	negative	male	dog	left	-0.07692308	2
## 3	negative	female	dog	right	0.36000000	2
## 4	negative	male	dog	right	0.55000000	2
## 5	positive	male	dog	right	-0.42307692	2

The data set consists 19 variables with 188 entries per variable. The important variables that are used in the model are:

- 1)spp_sti: Represents the type of the stimulus. The variable has two levels, either dog or human.
- 2)val_con: Represents the valence of the stimulus. The variable has two levels, either positive or negative.
- 3)sex_sti: Represents the sex of the stimulus. The variable has two levels, either male or female.
- 4)side_con: Represents the side of the stimulus. The variable has two levels, either left or right.

3.2 Statistical Model

3.2.1 Generalized Linear Mixed Model(GLMM)

The researchers analyzed the congruence index with a Generalized Linear Mixed Model with individual dog included in the model as a random effect. The researchers first built the model with the variables from section 3.1.2 including their first and second order conditions.

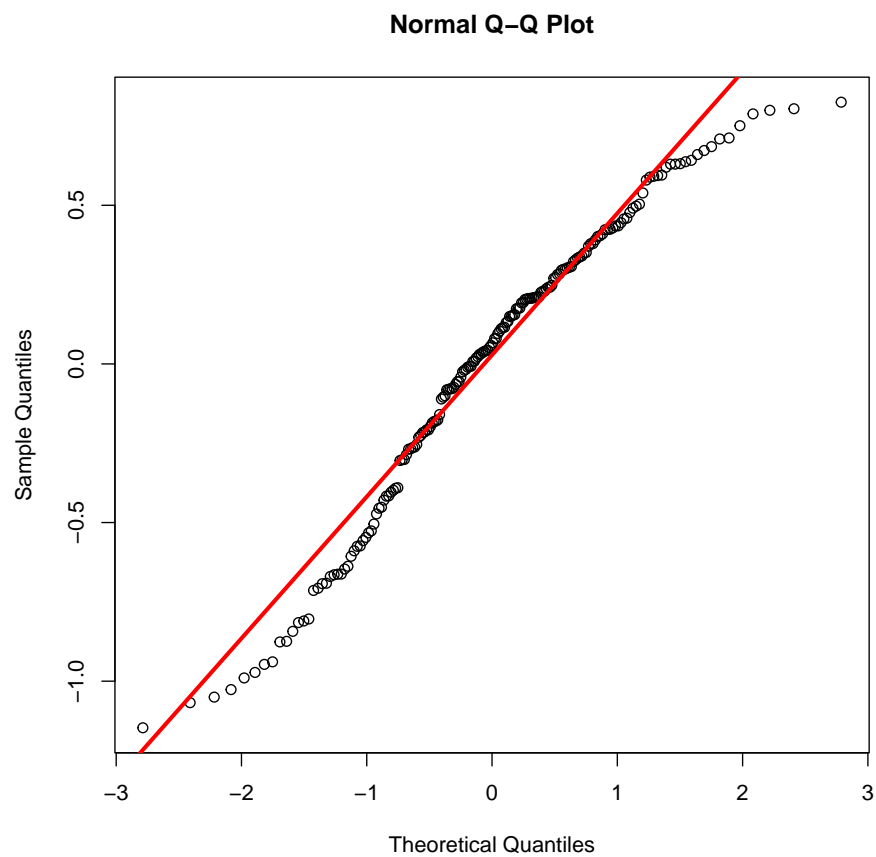
3.2.2 Final Model

Since the first and second order conditions are not significant in the model, the final model did not include them. Our final model is,

Variables	Value	Std.Error	t-value	p-value
intercept	0.27	0.0733	3.71	0.0003
valconpositive	-0.0989	0.0678	-1.4571	0.1469
sex_stimale	-0.0413	0.0681	-0.6071	0.5446
spp_stihuman	-0.1392	0.0681	-2.04	0.0426
side_conright	0.1143	0.6783	1.6825	0.0943

3.2.3 Normality Assumption

The normality assumption of the data was verified by visually inspecting the plots of residuals.



Chapter 4

Results

Dogs showed a clear preference for the congruent face in 67% of the trials.

```
## [1] 0.6648936
```

The mean congruence index across all trials was significantly greater than 0. With $t_{16} = 5.8721$ $p - value = 0.0159$.

4.1 Marginal Tests

We calculate the marginal t-tests by hand for each variable and level.

4.1.1 Marginal Tests for the Type of Stimulus

Variables	Marginal Mean	Std.Error	Lower CI	Upper CI
dog	0.26	0.0482	0.1575	0.362
human	0.12	0.0486	0.0175	0.223

Mean for the level "dog" is 0.26 and SE = 0.0482.
So the p-value is:

```
## [1] 0.00002981982
```

Mean for the level "human" is 0.12 and SE = 0.0486.
So the p-value is:

```
## [1] 0.01259419
```

The results are indicating that the dogs show a clear preference to the congruent faces regardless of the type of stimulus.

4.1.2 Marginal Tests for the Emotional Valence of Stimulus

Variables	Marginal Mean	Std.Error	Lower CI	Upper CI
negative	0.24	0.0478	0.1382	0.341
positive	0.141	0.0488	0.0372	0.244

Mean for the level "negative" is 0.24 and SE = 0.0478.
So the p-value is:

```
## [1] 0.0000627319
```

Mean for the level "positive" is 0.141 and SE = 0.0488.
So the p-value is:

```
## [1] 0.005337206
```

The results show us that the dogs have a clear preference to look at the congruent faces. The emotional valence either negative or positive doesn't change their attitude.

4.1.3 Marginal Tests for the Sex of Stimulus

Variables	Marginal Mean	Std.Error	Lower CI	Upper CI
female	0.211	0.0476	0.1098	0.312
male	0.169	0.0491	0.0653	0.274

Mean for the level "female" is 0.211 and SE = 0.0476.
So the p-value is:

```
## [1] 0.0002089197
```

Mean for the level "male" is 0.169 and SE = 0.0491.
So the p-value is:

```
## [1] 0.001674994
```

The results indicate that the dogs have a clear preference to the congruent faces independent of the sex of stimulus.

4.1.4 Marginal Tests for the Side of Stimulus

Variables	Marginal Mean	Std.Error	Lower CI	Upper CI
left	0.133	0.0486	0.03	0.236
right	0.247	0.0481	0.145	0.349

Mean for the level "left" is 0.133 and SE = 0.0486.
So the p-value is:

```
## [1] 0.007315331
```

Mean for the level "right" is 0.247 and SE = 0.0481.
So the p-value is:

```
## [1] 0.00004987591
```

These results show us that the dogs keep having a preference to the congruent faces regardless of the side of stimulus.

4.2 Model with the only Significant Variable: "spp_sti"

Variables	Value	Std.Error	tvalue	pvalue
spp_stihuman	-0.1435	0.0682	-2.1025	0.037

The congruence index for this model is significantly higher for viewing dog rather than human faces.

Variables	Estimate	Std.Error	tvalue	pvalue
dog_human	0.144	0.0683	2.103	0.037

indicating that dogs demonstrated greater sensitivity towards conspecific cues. The original p-value in the paper was 0.04.

4.3 Model with subject sex and stimulus sex

The researchers observed no significant interaction effect between subject sex and stimulus sex.

Variables	Value	Std.Error	t-value	p-value
sexmale	0.0498	0.0988	0.5047	0.6211
sex_stimale	0.0278	0.1018	0.2736	0.7847
sexmale_sex_stimale	-0.1594	0.1382	0.1382	0.2505

With $p - value = 0.25$ and the main effects sex and stimulus sex are also not significant.

4.4 Do the dogs prefer negative or positive valence?

The researchers compared the mean of the valence index to zero with a t-test. The result indicates that there was no difference in the proportion of viewing time between positive and negative facial expressions across trials. $t_{16} = -0.93869, p = 0.3618$.

Chapter 5

Conclusion

In this chapter we will be comparing the demonstrated results with the results from the paper.

The researchers calculated the preference for the congruent faces as 67% and when we compare it to our result in Chapter 4, we see that the results are identical.

The t-test for the mean congruence index delivers nearly the same result in the paper with $t_{16} = 5.8721$. In the paper it was 5.53.

Our marginal tests are nearly identical to the results in the paper.

Type of Stimulus	Paper	Report
Dog	0.0001	0.00002981982
Human	0.01	0.01259419
Emotional Valence	Paper	Report
negative	0.0001	0.0000627319
positive	0.005	0.005337206
Sex of Stimulus	Paper	Report
male	0.001	0.001674994
female	0.0001	0.0002089197
Side of Stimulus	Paper	Report
left	0.01	0.007315331
right	0.0001	0.00004987591

Indicating that we achieved nearly identical p-values comparing to the ones in the paper.