

# PSYC 4165: Homework 2 (Confidence Ratings)

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## Homework Assignment 2 - 10 Points

**Due by 23:30, Friday, 14 September 2018**

### Part 1

In this homework you will apply the techniques you used in Homework 1 to analyze another set of data. In Study 1 of a recent paper (Axelsson et al., 2018) subjects were shown individual photographs of 16 (8 men; 8 women) people who, two hours earlier, had been injected either with an influenza virus (*Escherichia coli* endotoxin), the **LPS** condition or with saline (0.9% NaCl), the **placebo** condition. The subjects were asked to decide if each photograph was of a “sick” person or a “healthy person”. Two composite photos from their study, each made up of the average of eight women two hours after injection of placebo (right) and the same 8 women after injection of the virus (left) are shown in Figure 1.

Table gives the number of “healthy” and the number of “sick” judgments made by 62 subjects shown the 32 individual photographs one at a time. Each subject saw both sick and placebo photos of the 16 people (for a total of 32 photographs) in a random order with the constraint that no photograph of the same person was shown immediately following the other photo of that person.

Table 1: The number of ‘healthy’ and the number of ‘sick’ judgments made by 62 subjects shown the 32 individual photographs one at a time. The data are from Axelsson et al. (2018)

	condition	healthy	sick
s0	placebo	1028	440
s1	lps	702	775

As in Homework 1, treat these data as a signal detection task of trying to detect the photograph of the person who will become sick. The data table shows that there were 775 hits and 440 false alarms. Convert these numbers (as you did in Homework 1) into signal detection measures of sensitivity, bias and accuracy ( $d'$ ,  $c$ , and  $A_z$ ). Draw a probability ROC curve with the single hit rate and false alarm rate plotted as a point on the graph. Using the value of  $d'$  for the coefficient  $b_0$  and setting  $b_1$  equal to 1, compute a range of z-score hit rates from a range of z-score false alarm rates (use `seq(-2.5, 2.5, 0.1)` to generate a range of z-score FARs). Plot these z-scores on the z-score ROC graph using the `lines()` command. Transform the z-scores into probabilities and plot them on the probability ROC graph, just as you did in Homework 1.

What is your conclusion about the ability of the subjects to detect the sick people from the photographs and were they biased to say “sick” or biased to say “healthy”? How do your signal detection values compare to the  $d'$  and  $A_z$  reported in the Axelsson paper? (They will not be exactly the same because Axelsson computed  $d'$  for each subject and averaged them, whereas you are computing a single  $d'$  from the combined data from all the subjects).

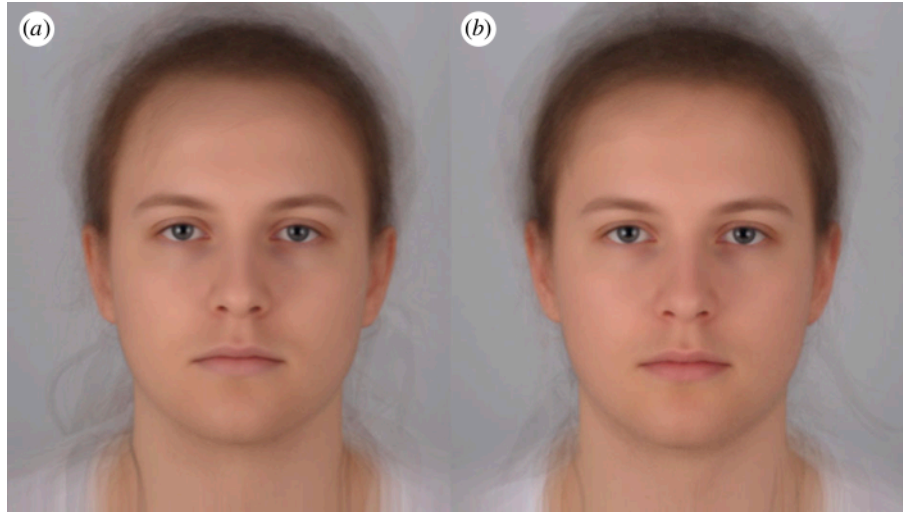


Figure 1: Figure 3 from Axelsson et al., 2018. A pdf copy of this paper is assigned for Week 3 reading and is available through Canvas.

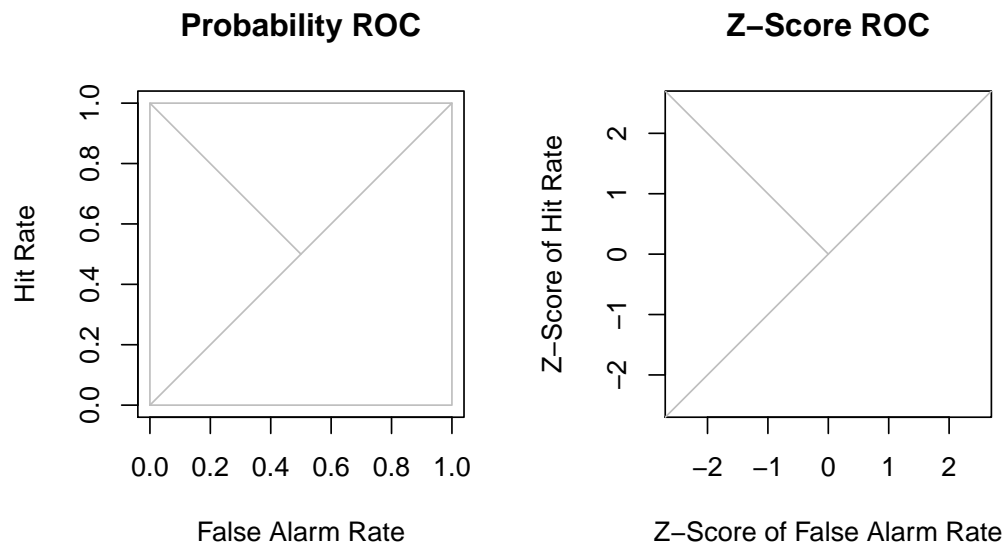


Figure 2: Receiver operating characteristic of subjects judging photographs as 'sick' or 'healthy'. The filled circle is the resulting hit rate and false alarm rate for detecting the sick photos, computed from the aggregated data of all subjects. The smooth curve represents the predictions of the equal-variance signal detection model. The gray positive diagonal represents the hit rates and false alarm rates that would occur if there was no ability to detect the sick photos. The gray negative diagonal represents the hit rates and false alarm rates that could occur with an unbiased observer.

## Part 2

Axelsson et al. (2018) reported a second study with these photographs. They asked 60 new subjects to rate each of the 32 photographs on how sick the person appeared to be using a confidence rating scale that ranged from 1 (“very poor”) to 7 (“very good”). Table 2 shows the number of times each rating was given for each type of photograph. Since we are considering this task to be one of detecting the sick person, I have reversed the order of the ratings, putting 7 (“very health”) in the left-most column and 1 (“very sick”) in the right most column.

Table 2 gives the number of times each confidence rating was used for each image condition:

Table 2: The number of times for each condition that the subjects rated the photograph using a 1 to 7 confidence rating scale.

	condition	R1	R2	R3	R4	R5	R6	R7
s0	placebo	617	2917	3451	3025	2109	673	81
s1	lps	476	1799	3032	2892	2784	1640	294

Transform the data into a table of probabilities corresponding to false alarm rates (using condition s0) and hit rates (condition s1) by accumulating the frequencies starting with the most conservative response category, i.e., rating 7. Show these values in a new table. Then transform these frequencies into probabilities by dividing by the number of trials condition (row sums of Table 2) These probabilities are the false alarm rates (s0) and the hit rates (s1). Show the values in a new table. You can use the same method you used in Part 2 of Homework 1.

Plot two ROC graphs from these data: one graph in linear probability coordinates (axes ranging between 0.0 and 1.0), the other in z-score coordinates (axes ranging from -3 to 3). Make the x- and y-axes of your graph equal in length so that each graph forms a square. Hint: in the `plot()` command you can specify the limits of the x- and y- axes using the `xlim` and `ylim` arguments (for example `xlim = c(0, 1)` for probabilities or `ylim = c(-2.5, 2.5)` for z-scores). You can force the plot to be square using the parameter command `par(pty = "s")`. Properly label the graphs. The graphs will look like this (with data in them of course): Finally, add smooth curves to your ROC plots. Consult the help file for hints about how to generate predictions and add them to the plots.

Making use of the fact that the Gaussian signal detection model predicts that the ROC will be a straight line with y-intercept of  $b_0$  and a slope of  $b_1$ , fit a straight line to the z-score data for the conditions and report your value of  $b_0$  and  $b_1$  for the Z-Score ROC:

$$z(HR) = b_0 + b_1 z(FAR)$$
$$qnorm(HR) = b_0 + b_1 qnorm(FAR)$$

The help file will show you how to fit a straight line to the data using the `lm()` function in R and how to extract  $b_0$  and  $b_1$  from the model. Use Equation 9a in the Detection Theory handout to compute the detection sensitivity ( $d_a$ ). Then use Equation 14 compute the area under the ROC ( $A_z$ ) as a measure of accuracy. Organize your  $b_0$ ,  $b_1$ ,  $d_a$  and  $A_z$  values in a table. The index  $d_a$  is a generalized version of d-prime that is used when the signal detection model does not have equal variance distributions.

## Conclusions

What do you conclude about peoples’ ability to judge health from photographs? How does the  $d'$  from Study 1 compare with  $d_a$  from Study 2? How do these subjects compare to the Warner-Lambert E.P.T you examined in Homework 1?

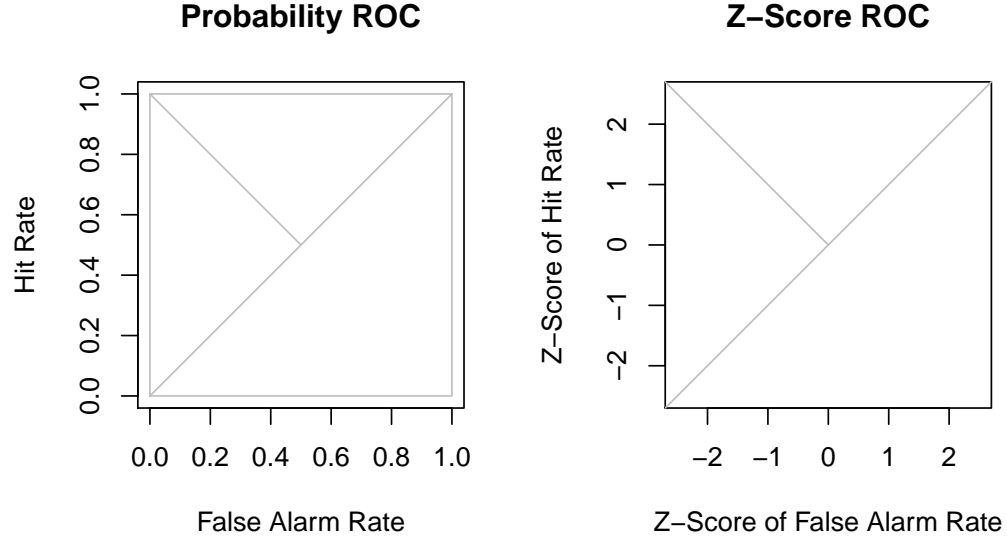


Figure 3: Receiver operating characteristic of subjects judging photographs as 'healthy' to 'sick' using a 7-point rating scale. The filled circles are the resulting hit rate and false alarm rate for detecting the sick photos, computed from the aggregated data of all subjects presented in Table 2. The smooth curve represents the predictions of the unequal-variance signal detection model. The gray positive diagonal represents the hit rates and false alarm rates that would occur if there was no ability to detect the sick photos. The gray negative diagonal represents the hit rates and false alarm rates that could occur with an unbiased observer.

## References

- Axelsson, J., Sundelin, T., Olsson, M. J., Sorjonen, K., Axelsson, C., Lasselin, J., & Lekander, M. (2018). Identification of acutely sick people and facial cues of sickness. *Proceedings of the Royal Society B: Biological Sciences*, 285(1870).