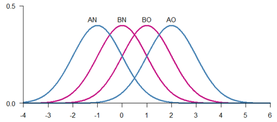
The Mirror Effect within Perception: Not another Recognition Memory Study

Adriana F. Chávez De la Peña
National Autonomous University of Mexico (UNAM); Faculty of Psychology
Lab 25; PAPIIT IN307214 - PAPIME PE310016

Introduction: A memory phenomenon?

Signal Detection Theory has been applied to Recognition Memory studies to describe subjects' ability to discriminate between stimuli that have been presented before from a new set of stimuli (Wixted, 2007). When comparing subjects' performance between two classes of stimuli, one being more easily recognized (A) than the other (B), the response patterns obtained show that the difference in their discriminability is reflected in the identification of both target and lure stimuli, suggesting that the stimuli distributions involved move along the decision axis in such a way that it has been identified as the Mirror Effect (Glanzer, Adams, Kim, 1993).



Evidence in favor of the Mirror Effect has been reported across different SDT-alike procedures. In typical Yes/No tasks, the Mirror Effect appears as:

$$FalseAlarms(A) < FalseAlarms(B) < Hits(B) < Hits(A) \quad (1)$$

When Confidence Rating procedure is implemented, the following pattern appears:

$$R(AN) < R(BN) < R(BS) < R(AS) \quad (2)$$

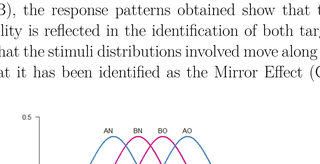
However, the Mirror Effect has only been studied within Recognition Memory and so, most theories and models proposed to explain it tend to do it in terms of high-level processes engaged in the study phase (DeCarlo, 2007, Glanzer et. al, 1993). The main goal of the present study was to explore the existence of the Mirror Effect outside Recognition Memory, thus testing these assumptions.

Method: A perceptual task

Ebbinghaus illusion: Two levels of perceptual discriminability (Massaro, 1971).

- High accuracy (A): Ebbinghaus illusions with 2 or 3 surrounding circles.
- Low accuracy (B): Ebbinghaus illusions with 7 or 8 surrounding circles.

1. **Detection Task:** Are the central circles the same size?



2. **Confident Rating:** How confident are you of your response?

Two experiments:

- Experiment 1: Just the right circle is shown as part of an Ebbinghaus illusion.
- Experiment 2: Both circles were constructed as Ebbinghaus illusions.

Technical details:

- 640 trials (total)
- 40 different stimuli, (10 repetitions, at least)
- 1.5 s exposure
- Space-bar between trials

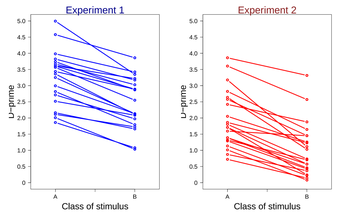
What did we find? (Spoiler alert!)

We had 20 and 21 participants on Experiments 1 and 2 respectively. In both cases, we found evidence for the Mirror Effect in at least 85% of the participants. In Experiment 1, we had 17 cases showing the Mirror Effect pattern within the hits and false alarm rates and 18 in terms of Confidence Ratings. In Experiment 2 we had 19 participants, out of 21, showing the Mirror Effect in both patterns of response. All these proportions have proven to be of great significance against chance when we apply a simple Binomial Test (p=0.002577 and p=0.0004025, for Experiment 1, and p=0.0002213 for Experiment 2).

Classical Analysis

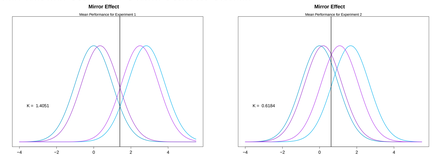
The following analysis was conducted as reported by Glanzer & Adams, 1990.

1. D' differences: Are conditions actually different?



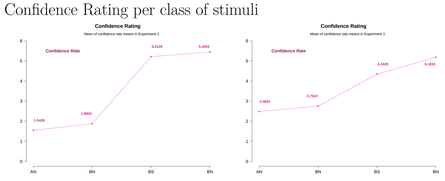
T-test	μ A	μ B	T	P value
Experiment 1	3.2403	2.44895	-3.0587	0.002034
Experiment 2	1.950238	1.022381	-3.4972	0.0005853

2. Differences across Hit and False Alarm Rates



T-test .		μ A	μ B	T	P value
Exp 1	Hits	0.9225	0.8609375	-2.4348	0.00989
Exp 1	FA	0.08	0.14375	1.917	0.03148
Exp 2	Hits	0.853869	0.6782738	-3.4757,	0.0006423
Exp 2	FA	0.2681548	0.3366071	1.769	0.04254

3. Mean Confidence Rating per class of stimuli

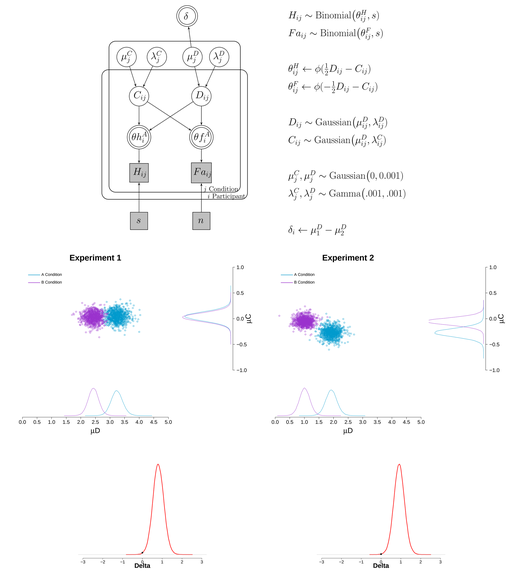


T-test .		μ A	μ B	T	P value
Exp 1	Signal	5.445312	5.212813	-1.7778,	0.04185
Exp 1	Noise	1.542812	1.883437	-1.7208	0.04724
Exp 2	Signal	5.183333	4.342857	-3.6752,	0.0004103
Exp 2	Noise	2.386905	2.752381	-1.809	0.03919

4. Checking for any RT correlation.

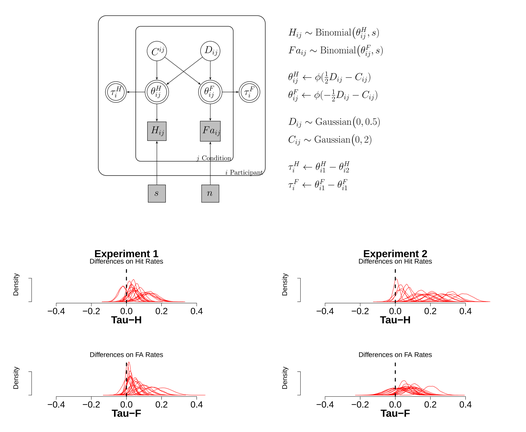
Bayesian Modeling

1. D' differences: Are conditions actually different?



$$H_{ij} \sim \text{Binomial}(\theta^H_{ij}, s)$$
$$Fa_{ij} \sim \text{Binomial}(\theta^F_{ij}, s)$$
$$\theta^H_{ij} \leftarrow \phi(\tfrac{1}{2}D_{ij} - C_{ij})$$
$$\theta^F_{ij} \leftarrow \phi(-\tfrac{1}{2}D_{ij} - C_{ij})$$
$$D_{ij} \sim \text{Gaussian}(\mu^D_{ij}, \lambda^D_{ij})$$
$$C_{ij} \sim \text{Gaussian}(\mu^D_{ij}, \lambda^C_{ij})$$
$$\mu^C_j, \mu^D_j \sim \text{Gaussian}(0, 0.001)$$
$$\lambda^C_j, \lambda^D_j \sim \text{Gamma}(.001, .001)$$
$$\delta_i \leftarrow \mu^D_1 - \mu^D_2$$

2. Hit and False Alarm Rate Differences



$$H_{ij} \sim \text{Binomial}(\theta^H_{ij}, s)$$
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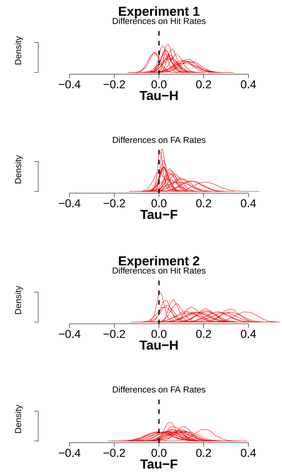
$$\theta^H_{ij} \leftarrow \phi(\tfrac{1}{2}D_{ij} - C_{ij})$$
$$\theta^F_{ij} \leftarrow \phi(-\tfrac{1}{2}D_{ij} - C_{ij})$$
$$D_{ij} \sim \text{Gaussian}(0, 0.5)$$
$$C_{ij} \sim \text{Gaussian}(0, 2)$$
$$\tau^H_i \leftarrow \theta^H_{i1} - \theta^H_{i2}$$
$$\tau^F_i \leftarrow \theta^F_{i1} - \theta^F_{i1}$$

...



Conclusion

The present study is the first to show evidence of the Mirror Effect patterns of response, on a SD task that does not involve recognition memory. The perceptual task here presented lacked a pre-experimental phase where participants had the chance to manipulate how powerful were the illusions elicited in each condition, contradicting what has been proposed within recognition memory studies and suggesting that there might be a much more basic principle regulating the observed pattern of responses.

References

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Acknowledgments & Contact Information

This project was supported by PAPIIT IN307214 and PAPIME PE310016. And last but not least, I thank Lab 25 crew!

Web: https://sites.google.com/site/adaptabilidad25/
Email: adrifelcha@gmail.com