# Order Effect on Optimality-Accuracy Trade-off in Perceptual Decision Under Uncertainty

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## Keywords

Perceptual Decision, Optimality-accuracy trade-off, Signal Detection Theory, Order Effect.

## Extended Abstract

In this paper, we investigate order effect between visual stimuli and payoff information in perceptual decisions. More precisely, we reveal a recency effect on the position of individuals' strategy between payoff and accuracy maximization (optimality-accuracy trade-off). Furthermore, we find new experimental results that standard Signal Detection Theory (SDT) cannot take into account.

Perceptual decisions under uncertainty have been extensively studied using Signal Detection Theory (SDT) (Green and Swets, 1966). In this framework the world is either in a "signal" or a "noise" state, unknown for a Decision Maker (DM). The DM rely on an uncertain stimuli and has incentives to report the true state of the world. In presence of symmetric incentives (type I and type II errors are equally costly), the optimal decision of a DM is to maximize his accuracy (minimize the probability of errors). Whereas, if the DM faces asymmetric incentives, e.g. if Type I errors are more costly than Type II errors, to maximize her payoff she should decrease the probability of the former by increasing the probability of the latter. This optimal substitution between type I and type II error mechanically leads to a decrease in the DM's accuracy (compared to symmetric stakes).

A consensus has been established on the fact that in presence of asymmetric payoffs, DMs' decisions are biased toward accuracy: they do not substitute enough the most costly error for the least costly error and use decision strategies leading to too many accurate answers, compared to an optimal classifier (Bogacz et al., 2006; Maddox and Bohil, 1998). Several explanations of this bias have been formulated. The under-adjustment can be attributed to the fact that marginal changed in payoffs around the optimal strategy are not salient enough to enable decisions to converge to optimality (Erev, 1998; Myung and Busemeyer, 1989; Busemeyer and Myung, 1992). Another explanation lies in the impact

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of the subjective value of being correct (Maddox et al., 2003; Balci et al., 2011) and maximization a combination of reward and accuracy.

Most of the latter results are obtained by a repetition of hundreds trials with different visual stimuli while the payoff structure is given at the begin of the experiment and kept identical during most trials. Thus, this bias toward accuracy may be due to a recency effect, as the visual stimuli is the last information receiving subjects' attention. Indeed, many studies had highlighted the existence of order effects. The order questions are presented in a survey impacts individuals' answers (Schuman et al., 1981; Moore, 2002). McKenzie et al. (2002) shows that the order evidences are presented to a jury matters in their confidence rating about guilt. Bergus et al. (1998) find recency effect (between physical examination and laboratory data) in physician diagnosis.

To investigate this hypothesis, we ran an experiment where we controlled the order visual stimuli and information about payoffs are presented to subjects. A visual stimulus was displayed during 700 ms and was composed of two circles on the left and right part of the screen with a different number of points in each one of them. Subjects had to report which circles contained the more dots. We communicated payoffs through a matrix providing the earning of each of the four outcome (being "correct" or "incorrect" when the answer was "left" or "right"). Thereby, we proposed three different payoff matrices varying in the net cost of errors, while the ratio between the costs of type I and type II errors was kept constant across matrix. As the optimal rate of substitution between the two types of errors is the same for all payoff matrix, Signal Detection Theory predicts identical behavior in all treatment. Increasing the cost of errors may attract more subjects' attention and impacts the optimality-accuracy trade-off.

Our results shows a recency effect on this optimality-accuracy trade-off: when individuals receive the visual stimuli last, they are more accurate but less optimal. Furthermore, we find that increasing the cost of errors conducts to a more optimal decision. Finally, contrary to SDT assumption, we find that subject ability to discriminate between the two states depends both of the order information is provided and the cost of the errors. We suggest that the existence of unobserved cognitive cost is a possible explanation of such results.

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