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Aiming to choose correctly or to choose wisely? The optimality-accuracy trade-off in decision under uncertainty

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To reach optimality individuals ought to maximize expected payoffs. Most of the time, aiming to take the accurate decision leads to optimality. However, some cases of decision under uncertainty may imply a divergence between optimality and accuracy. In such circumstances, individuals should give away some accuracy during their decision process to reach optimality. Individuals may not consider this unusual divergence between accuracy and optimality and adopt an accuracy-maximizing behavior instead of the optimal one. Aiming to choose correctly instead of optimally induces an optimality-accuracy trade-off. As an example we can think of a doctor establishing a diagnosis based on ambiguous symptoms. He is facing two potential types of successes (correctly classifying the patient as seek or not) and thus two types of errors. Maximizing the number of successes will not be optimal as both errors do not have the same impact.

We want to study how individuals solve this optimality-accuracy trade-off using a context of asymmetric payoffs in a task of perceptual discrimination. Signal Detection Theory (SDT hereafter; Green and Swets (1966), Wickens (2001)) offers a normative benchmark to understand how individuals make decisions under uncertainty. Individuals

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face a discrimination situation task in which they have to identify the presence or not of a signal in a noisy environment. While the whole process cannot be fully understood, SDT provides theoretical foundations to identify the main components of the decision. It allows to disentangle the impact of the stimulus itself on the decision from the impact of the decision strategy. Applying this framework to the optimality-accuracy trade-off, it offers precise predictions of the expected behaviors as well as potential estimations of treatments effects. Overall using a narrow set of assumptions, SDT enables to compute decision criteria based on observed decisions and provide a powerful tool to evaluate the decisions resulting from an optimal or an accurate decision process.

The optimality-accuracy trade-off has been extensively studied in cognitive sciences. Different ways to induce an asymmetrical situation have been proposed as well as different modelizations of these situations. A consensus has emerged in favor of a conservative criterion placement *i.e.* the strategy of decision is too close to the accuracy maximizing strategy (Snodgrass and Corwin, 1988; Maddox and Dodd, 2001; Bohil and Maddox, 2003; Maddox and Bohil, 2005; Martín-Guerrero et al., 2016). However, it is still unclear if this behavior is driven by an actual valuation of accuracy or if individuals suffer from a systematic bias. Several studies have concluded in a tendency from individuals to give over-accurate answers (Maddox and Bohil, 2003, 2004; Balci et al., 2011; Bogacz et al., 2006). Their approach is based on model goodness-of-fits analysis. As a result, Maddox and Bohil (2003, 2004) argue that subjects attempt to maximize payoff on each trial, but erroneously believe that maximizing accuracy fulfil this objective. The priority of accuracy could also been interpreted as an induced value associated with successes. This importance of induced values has been first tackled by Smith (1976). In related setting based on unequal base rate, Siegel (1959) obtained that individuals classifying correctly the less likely outcome benefit from an additional non-monetary reward compared to correct classification of the more likely outcome.

The present work is based on two within-subjects experiments of perceptual decision making. It complements existing researches on several points. The first experiment highlights the trade-off existence using a signal-in-noise task while previous studies implemented two-alternative force choice (2AFC) task. Contrary to a 2AFC setting, a signal-in-noise framework enables us to reproduce the link signal/high stakes, increasing the external validity of the results. Additionally, the trade-off has been highlighted only in mixed gain-loss framework but never in a pure-loss frame. It thus implements an innovative pure-loss framework to link the impact of losses on decisions to the optimality-accuracy trade-off reaction. The second experiment is based on a design enabling a direct evaluation of the value of being right and thus completes previous studies arguing for an over-representation of accuracy resulting from a biased search of optimality. Our experiments use a signal-in-noise discrimination task. Subjects face a screen with two circles containing a certain number of dots during a limited amount of time. They have to indicate if they think that both circles contain the same or a different number of points. The major experiment manipulation is based on how the four possible outcomes are rewarded (the "payoff matrix"). After each trial, they receive a feedback indicated if they were right or wrong and the reward earned during the trial.

In the first experiment, we use four treatments matching four different payoffs matrices. The first one is the baseline: same payoffs for the kinds of successes and the two kinds of errors ("symmetric" payoff matrix), positive values. The second one is used to test the trade-off in gains: payoffs higher when the correct answer is "Different", positive values. The third one tests the robustness to a loss framework: same values than the second treatment minus a constant term to make all payoffs negative. The last trial is designed to disentangle the translation effect (adding the same value to all payoffs) to the loss effect: same values than the second treatment plus the same constant term. Finally subjects have to answer to a risk and ambiguity preferences test in gain and losses based on Eckel and Grossman (2008) method with the presentation proposed by Eckel et al. (2012) in order to control for risk, ambiguity and loss attitudes. It confirms the existence of the optimality-accuracy trade-off as answers' patterns exhibit a deviation from accuracy in the direction of optimality but do not approach the optimal solution. This tendency is so pronounced that we observe a leading role of accuracy in the trade-off. Based on the pure-loss framework, we reject the hypothesis of an impact of losses on the trade-off behavior and extend previous findings based on a mixed gain-loss framework (Maddox et al., 2003).

In the second experiment, we want to disentangle the effects of reward and accuracy on the decision criterion. Thus, we implement two treatments: symmetric incentivized payoffs matrix and a symmetric flat payoffs matrix. For the symmetric incentivized payoffs matrix a valuation of either a combination of reward and accuracy or only reward leads to the exact same behavior: to report the more likely outcome. For the symmetric flat payoffs matrix a valuation of either a combination of reward and accuracy or only reward leads to two diametrically opposed behaviors. If the behavior is driven by a combination of reward and accuracy, the subject is better-off by keeping the same decision criterion. In fact, the reward would be the same but the accuracy rate would improve. If the behavior is driven by reward maximization, flat payoffs suppress all the incentive to complete the task. All criteria are thus maximizing utility. In line with the leading role of accuracy, we find that even when removing all monetary incentives, we obtained that individuals are driven by a search for accuracy. We conclude that the value of being right plays a central role in the trade-off solution.

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