EYE-TRACKING AND DECISION UNDER UNCERTAINTY

Alessandro Innocenti

(University of Siena)

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Extended abstract. The role of the visual system in the functioning of human brain has been the object of investigation for decades. The passages leading from the electrochemical signals transmitted by the retina to the brain for neuronal processing have been exhaustively described by cognitive scientists and neurobiologists. What remains still controversial is how these neurobiological processes are first activated and finally translated in actual decisions. Both the mechanisms underlying gaze direction and orienting behavior and the relations between image processing and decision-making are currently scrutinized by a variety of different approaches with conflicting results. The importance of these research areas for providing a cognitive framework to the understanding of human decision processes is evident. A particularly interesting application for cognitive economists is given by decisions that are not driven by individual preferences but concern a future event to be guessed on partial-information clues. In decisions under uncertainty, factors like subjective inclinations or tastes do not affect choices and the role of visual attention in determining actual decisions can be investigated in a more neutral setting.

In a previous set of experiments, Shimojo et al. (2003) tested how subjects orient attention in both preference and non-preference tasks. Their main result is that, in choices between two alternative forced-choice tasks, subjects exhibit a statistically significant tendency to gaze increasingly towards the chosen object. This *gaze cascade effect* would provide insight in the mechanisms underlying the mental processing of images. It supports the hypothesis that gaze participates directly in the preference formation process. The brain would use gaze direction to reinforce preference by increasingly looking at the eventually chosen item and by decreasing inspection time for the other one. An attractive consequence of this finding is that gaze bias could be interpreted as preference at subconscious level.

To explore further the relationship between preference and ordering, we consider a more general interpretation of cognitive processes, proposed, among others, by Stanovich and West (2000) and by Kahneman and Frederick (2002). According to the theory of dual reasoning, cognitive processes are of two types, named System 1 and System 2. System 1 includes all the cognitive processes characterized by automatic functioning and heuristic purposes, while System 2 encompasses all the rational and analytic processes. The key difference between the two is that System 1 is activated immediately and often unconsciously by external stimuli, while System 2 is slower and deliberately controlled. According to Kahneman and Frederick (2002), the interaction between the two systems could be described in the following way: "Highly accessible impressions produced by System 1 control judgments and preferences, unless modified or overridden by the deliberate operations of System 2." Moreover, being both systems an evolutionary product, it would not necessarily follow that errors on tasks from the heuristics and biases literature are universal. On the contrary, this view would provide an explanation of people heterogeneity as the result of individually specific patterns of interaction between the two systems. In this theoretical framework, gaze direction could be a revealing signal of how automatic and immediate reactions to visual stimuli are modified or sustained by more conscious and rational processes of information collecting.

In order to investigate this hypothesis, we performed some experiments by using the stylized decisional framework of informational cascade. In this non-preference task, experimental subjects are asked to guess an event about which they have probabilistic assessments, which are both private and publicly revealed. The process of detecting these partial-information signals is investigated by means of eye-tracking methods.
Our first result is that gaze direction gathers information according to automatic and unconscious mechanisms depending on the individually specific cognitive biases. In particular, we find significant statistical correlation between subjects' first fixation and their revealed patterns of choice. Overconfident subjects, who rely exclusively on private signals to take decisions, look initially at their own private signals by displaying a mechanism of attention orienting seemingly dependent on System 1, while Bayesian subjects, who process rationally both private and public information, do not exhibit any gaze bias. In a slightly different experimental design, we also find experimental confirmation of the gaze cascade effect postulated by Shimojo et al (2003).
In terms of the dual reasoning theory, our findings support the hypothesis that cognitive processes classified as System 1 determines initial gaze direction and that patterns of interaction between System 1 and System 2 revealed by attention orienting are individually specific and cognitively based. Our conclusion is that information collection and decision processes are individually related to somatic-based behaviors, such as gaze orienting. Initial gaze direction is driven by cognitive biases in a way that is not necessarily consistent with efficient information processing.

Keywords : decision under uncertainty, eye-tracking, gaze cascade effect, overconfident behavior

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* Dipartimento di Politica Economica, Finanza e Sviluppo, Università di Siena, Italy, *innocenti@unisi.it*