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Decisions, premonitions and hunches: Is there any rationality?

Rational thought and calculative decision-making abilities are evolutionary assets. In terms of how complex these can be, primates fall in a class quite apart from the rest of the fauna on earth. One may term these abilities as attributes of neural supremacy. Even though they can be labelled—not described—with relative ease, there are facets to them which escape definition. At times they end up being classified within the mystical realm—as premonition, sixth sense and even extra sensory perception. One might think that the serious business of day-to-day decision making is far too complex to be passed off so trivially. In fact, recent experiments suggest a hitherto unsuspected reliance of decision making on these 'extra' or 'emotional' elements.

Making a decision implies the execution of a choice subsequent to the successful completion of a series of events in the brain. These include (i) gathering of information on the situation, (ii) comparison of the current situation with previous experience (in an attempt to correlate long term repercussions of similar choices), (iii) computation of the choice that would reap the best benefit and (iv) initiation of appropriate motor activities concerned with the execution of the decision.

The first of the above processes, i.e., those concerned with the assimilation of information, have been extensively studied in the visual system of primates. The studies make use of a number of psychophysical assays like the direction discrimination task, the binocular rivalry task, visual search task, the delayed match-to-sample task etc. (Leon and Shadlen 1998). Many of these tasks reveal the animal's ability to pick out the information most relevant to the situation from a background of insignificant inputs. It is intriguing to speculate to what degree information-gathering and decision making run in parallel. The brain could encourage input from all available visual fields but choose to compute its decisions based largely on the dominant input. Or, it could focus all its information-gathering potential towards the dominant field. The latter would risk the loss of possible nuggets of useful information in ignored or discarded fields, while the former would require a continual weighting mechanism to define a dynamic dominance.

Studies on the visual cortex of monkeys using functional magnetic resonance imaging (fMRI) show that multiple stimuli in neighboring receptive fields compete with each other for functional access to the processing centers (Kastner *et al* 1998). The outcome of the competition seems to be biased by a weighting mechanism that is manifest in the animal's spatially directing its attention to a particular object. The authors argue on the basis of this that only a limited amount of what we see reaches the centers of consciousness. However, it is quite likely that the 'recessive' fields of information are not altogether discarded. The extent to which an explicit awareness of their existence impinges on the final decision is not easily estimated, but the activity of sensory centers suggests that this information is acquired. One might argue that it would be expected of an animal to demonstrate awareness (by the activity of effector circuits) of only a subset of what it is actually aware of (at higher levels of neural processing). Then it would be seen to tackle its most pressing concerns first, but its subsequent behaviour would be modulated on the basis of 'afterthoughts' that resulted from a rational computation of all the available data—dominant or not.

Perception of the situation and its relay to the centers of computation are not enough to ensure that a rational decision is made. In the early 90's Damasio and others noted that patients with damages to the ventromedial prefrontal cortex are capable of normal recognition, memory and intelligence tasks but lack the ability to take rational ('wise') decisions. Such patients (from Damasio's index of 2000 brain damaged patients) appeared perfectly normal but went through their lives with a string of failed marriages, lost jobs and so on. The phenomenon was dissected via a mock gambling game using four decks of cards (Bechara *et al* 1997). The players (armed with fake bills worth 2000 dollars) were asked to turn the cards from either of the A, B, C or D decks, knowing that turning A or B would earn an immediate reward of $ 100 while C or D would yield only $ 50. Unknown to them, the researchers also introduced some penalty cards, which would (in the long run) harm a player who exclusively played from decks A and B. The players had no way of computing the penalty, nor did they know when the game would get over. In the course of the game, normal patients were gradually able to discriminate between the good and the bad decks and eventually pick cards preferentially from the C and D decks. Patients with bilateral damage to the ventromedial prefrontal cortex did not seem to make a discriminatory decision and continued to pick from the disadvantageous decks.

Bechara *et al* (1997) also found a correlate in the skin conductance response (SCR, a measure of changes in conductance due to sweating) of the participants during the course of the experiment. Soon after the penalties started coming at them, normal patients showed anticipatory variations in SCR as they reached towards bad decks. The Damasio laboratory repeated these experiments, interrupting them with questions aimed at revealing the amount of conscious thought which went into the decision to avoid bad decks and also timed the onset of anticipatory SCRs. In an initial ('pre-punishment') period all the decks were favoured equally and the participants generated no SCRs. However, by about card 10 (corresponding to the onset of losses due to penalties), normal players started demonstrating significant SCRs whenever they tended to approach the A or B decks. Interestingly, even by card 20 the participants had no idea how the game was progressing or which decks were risky. By card 50 most normal players mentioned a hunch that A and B were disadvantageous (but could not explain why), while by card 80, many (7/10) normal players could articulate the risk of choosing from the A and B decks. None of the brain-damaged patients displayed any anticipatory SCRs (towards A and B) nor modulated their choices towards decks C and D. Even after being able to conceptualize the danger of choosing the risky sets, such patients tended to pick from all four sets, revealing very poor judgmental abilities.

Although the findings were in tune with the expected defects associated with prefrontal lesions, the surprising revelation of the experiment was the onset of SCRs in normal people much before a logical deduction of risk could be made. This is suggestive of a distinct layer of neural awareness which not only computes consequences much ahead of the declared consciousness, but also initiates motor activity as soon as it derives an advantageous strategy. This could very well represent what is commonly known as intuition or premonition and might play a critical part in decision making. It is tempting to wonder whether there are layers of neural computation which work on data from seemingly irrelevant inputs at the same time as the brain is executing decisions based on the dominant fields. Such layers could possibly elucidate solutions which may not be immediately apparent, but are quite relevant to the executed behaviour.

A large body of work remains to be done before the finer points of such processes can be confidently discussed. But if anything, these findings should instruct us not to ignore our impulses—a seemingly irrational urge might well be rational but for reasons beyond our comprehension at that time.

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