Expected Subjective Value Theory: A Representation of Decision in Time Under Risk

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Over the past few years there has been growing interest in the notion that a representation involving divisive normalization (a canonical neural computation in sensory systems) normatively encodes option value in the brain. The divisive normalization algorithm has been shown to rationalize behaviors previously labeled as anomalous in economic theory, including violations of the independence of irrelevant alternatives (Louie, 2013). There is growing understanding that such anomalies in decision-making are in fact a result of an efficient value coding by a system that has limited neural resources (Glimcher, 2010; Woodford, 2012, 2014; Hunt et al, 2014). The implications of the efficient value coding through the divisive normalization algorithm

$$v(x_{i,t}) = \frac{x_{i,t}^{\beta}}{x_{i,t}^{\beta} + (\sum_{0}^{t-1} \delta(t) x_{i,t})^{\beta}} + \varepsilon$$

have, however, not yet been carefully considered with respect to the decision making under risk.

This paper presents a near-normative model of choice under risk that incorporates neurobiological constraints and costs into a traditional economic framework via divisive normalization. It yields an expected utility-like model that captures many of the behavioral phenomena around which prospect theory was built, but without recourse to a completely descriptive approach. The model defines the reference point as an adaptive mechanism that optimizes precision at expectation. It captures the same 'representative agent' choice behavior as prospect theory but unlike prospect theory also captures single agent behavior. It accounts for such behavioral phenomena as lack of a reflection effects on the individual level and the non-independence of loss aversion and risk seeking in individuals. It makes novel predictions about how risk attitudes and loss aversion depend on the history of experienced rewards - their timing, value and variation – in a more normative fashion. It also captures heterogeneity in individual preferences related to individual differences in neural constraints (such as those present in aging or illness), thus allowing us to unify numerous previously observed associations between a host of brain changing variables and risk attitudes and loss aversion.

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