

Value-Based decisions : situational influences and neural mechanisms

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Chapter 7

Summary and Conclusions

Value-based decisions are a central aspect of life. Drawing from theories and research methods in psychology, neuroscience, and economics, the studies presented in this thesis aimed towards understanding how value-based decisions are made, and how they can best be investigated.

One puzzle in the study of value-based decisions is why people give in to temptations such as overeating, or drug abuse, despite the fact that they explicitly state that they do not wish to do so. The explanations that have emerged for this phenomenon in psychology, neuroscience, and economics highlight the role of the decision situation and the stimuli it contains. Not only decisions regarding food intake or drug abuse are influenced by the stimulus situation, but also typical economic decisions such as intertemporal choice. **Chapter 2** of this thesis summarizes the literature on situational control of economic decisions. There is evidence that exposure to reward, or to stimuli that are associated with reward, affects economic decisions in several different domains. When faced with reward predicting stimuli in intertemporal choice, people decide less patiently. In choice under uncertainty they are more risk averse, and in consumer decisions they show higher willingness to pay (WTP) and biased choice. We note that well-known biases in decision making, namely dynamic inconsistency, certainty effects, and the endowment effect, occur in decision situations that naturally entail some form of immediacy to reward. Therefore, we argue that these biases could be driven by a similar mechanism. This approach could help to organize a

large amount of previously unconnected experimental results across different decision domains.

In studies of individual decision making it is often necessary to measure the value a person assigns to a good. To encourage participants to give true and accurate answers, many studies make use of an incentivised value elicitation task, the Becker-DeGroot-Marschak (BDM) mechanism. **Chapter 3** of this thesis shows that in this task, people do not behave according to the predictions of standard economic theory. Expected utility theory predicts that a person should always report the same WTP for a given consumer good, irrespective of the distribution of possible prices used in the BDM mechanism. Instead, we observe that individual bids for the same good vary. Specifically, subjects report higher WTP if this yields a significantly higher chance of obtaining the item, i.e. they show distributional dependence with a mass-seeking bias. Importantly, this bias persists over on average 140 value elicitation trials per subject, strongly suggesting that distributional dependence is a persistent phenomenon that is not abolished by experience. This study casts doubt on the commonly held assumption that the BDM mechanism induces truthful revelation of a fixed value a person assigns to a goods. As the observed pattern is not in line with existing theories of anchoring or reference-dependent preferences, this study highlights a novel violation of expected utility theory that may provide useful insights on the processes underlying valuation.

Individual time and risk preferences are an important component of economic models and they are measured in many studies on human decision making. Since they are defined by economic theory, the question whether they exist as psychological constructs, and — if so — how they are best described and measured, has received little attention in the economic literature. In **Chapter 4** we show that commonly used elicitation tasks for time and risk preferences generate reproducible results and thus possess satisfactory reliability. Further, as the measured parameters are differentially stable over several weeks, individual time and risk preferences can be understood as individual characteristics that are at least moderately stable over time. However, our data suggest that time and risk preferences measured with monetary choice tasks are specific to the domain of financial decisions. Thus, if researchers or policy makers measure time and risk pref-

erences using monetary choice tasks, the results cannot be generalized to other domains, such as health- or career-related decisions. In order to refine the definitions of time and risk preferences, future research should measure indicators of time and risk preferences in different decision domains, both in the laboratory and in the field.

Recent neuroscientific evidence suggests that stable interindividual differences can be explained by interindividual differences in brain structure. Identifying relationships between brain structure and stable interindividual differences can provide useful information on the relationship between brain function and behaviour that is complementary to results from functional neuroimaging. In **Chapter 5** we investigate whether interindividual differences in impulsiveness are associated with differences in brain structure. We use diffusion weighted magnetic resonance imaging to assess the integrity of white matter. Specifically, we compute fractional anisotropy (FA), which reflects the microstructural organization of connections between brain regions and is an indicator of structural connectivity. Employing two different methods to spatially co-register the individual datasets, we find converging evidence that people who score higher on self-reported impulsiveness have higher white matter integrity in regions that contain connections from the frontal cortex to subcortical regions. This result suggests that stable interindividual differences in impulsiveness might not arise from a lack of inhibitory control by the frontal cortex, but from an excess of motivation or drive. Measuring white matter integrity and comparing it across subjects is a new and still rapidly developing neuroscientific technique. Therefore these findings must be interpreted with caution.

The neuroeconomic model of choice postulates that value-based decisions are performed by computing subjective value of each option under consideration and choosing the option with the highest subjective value. Subjective value of an option incorporates all aspects that are relevant to the desirability of the option and can then be compared to that of other options. To enable choice between fundamentally distinct options, subjective value must be independent of the type of reward and represented on one common scale of desirability. It is hypothesised that such an abstract subjective value signal is represented in the ventromedial prefrontal cortex. In **Chapter 6** of this thesis, we test this hypothesis using multivoxel pattern analysis of func-

tional magnetic resonance data. We find that it is possible to predict individual preferences from brain activity in the ventromedial prefrontal cortex. Moreover, a model that is only trained to predict preferences over one specific category of reward, e.g. snack food items, can also predict preference over a fundamentally distinct category of reward, e.g. engaging activities. Therefore, subjective value representation for these two categories must be similar. This is the case although engaging activities, such as playing tennis or reading a book, have nothing in common with snack foods, are not easily substitutable by money and are not normally traded. This result strongly suggests that subjective value representation in the ventromedial prefrontal cortex is abstract and maps subjective value on one common scale of desirability for fundamentally distinct options.