04: Decision Theory and Habitual Processes

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1. Decision Theory

To exhibit *instrumental rationality* is to select those actions which you expect to best satisfy your preferences (textbook: Jeffrey 1983).

2. Game Theory

A game is 'any interaction between agents that is governed by a set of rules specifying the possible moves for each participant and a set of outcomes for each possible combination of moves' (Hargreaves-Heap & Varoufakis 2004, p. 3)

'A game is a description of strategic interaction that includes the constraints on the actions that the players can take and the players' interests, but does not specify the actions that the players do take' (Osborne & Rubinstein 1994, p. 2).

'All situations in which at least one agent can only act to maximize his utility through anticipating (either consciously, or just implicitly in his behavior) the responses to his actions by one or more other agents is called a game' (Ross 2018).

When two or more agents interact, so that which outcome one agent's choice brings about depends on how another chooses, how do their preferences guide their choices?

'we wish to find the mathematically complete principles which define "rational behavior" for the participants in a social economy, and to derive from them the general characteristics of that behavior' (von Neumann et al. 1953, p. 31)

Decision Theory is about how individuals decide which of several available actions to perform (textbook: Jeffrey 1983). Game Theory is a development which focusses on how interacting individuals select actions when which outcome one individuals's action brings about depends on how another acts.

2.1. Common Knowledge of Rationality

Keynesian Beauty Contest

'It is not a case of choosing those [faces] that, to the best of one's judgment, are really the prettiest, nor even those that average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practice the fourth, fifth and higher degrees' (Keynes 1936).

The *Harsanyi-Aumann Doctrine*: 'in every finite game, the prior beliefs of every rational player who knows the rules of the game are the same' (Hargreaves-Heap & Varoufakis 2004).

Consequence: 'rational players with common knowledge of rationality will not be able to agree to disagree on the likelihood of any action in the game.'

3. Decision Theory Is Agnostic about Processes

On explanation: 'Many events and outcomes prompt us to ask: Why did that happen? [...] For example, cutthroat competition in business is the result of the rivals being trapped in a prisoners' dilemma' (Dixit et al. 2014, p. 36).

1. Applications of game theory range from interactions between microbial populations to interactions between countries.

2. The explanations are of the same type in every case.

3. The underlying processes probably differ.

4. Therefore, game theory is agnostic about processes.

4. Processes: Habitual vs Instrumental

What kinds of processes in individual animals guide actions?

Habitual processes are characterised by *Thorndyke's Law of Effect*: 'The presentation of an effective [=rewarding] outcome following

an action [...] reinforces a connection between the stimuli present when the action is performed and the action itself so that subsequent presentations of these stimuli elicit the [...] action as a response' (Dickinson 1994, p.48).

Instrumental processes are characterised by a different principle: performing actions enables agents to form expectations about their outcomes; and the occurrence of outcomes enables agents to learn about how valuable these outcomes are. Whether an agent performs an action depends on (a) her expectation about its outcome; and (b) her preferences concerning that outcome.

5.   A Puzzle about Action

To *devalue* something is to eliminate or reverse an agent's preference for it. For example, a food that is novel to an agent can be devalued by making the agent ill shortly after she has consumed it and then confronting her with the food again. This will cause the agent to become averse to the food.

'the laboratory rat fits the teleological [instrumental] model; performance of this particular instrumental behaviour really does seem to be controlled by knowledge about the relation between the action and the goal' (Dickinson 1985, p. 72)

'we did not conclude that all such responding was of this form. Indeed, we observed some residual responding during the post-revaluation test that appeared to be impervious to outcome devaluation and therefore autonomous of the current incentive value, and we speculated that this responding was habitual and established by a process akin to the stimulus-response (S-R)/reinforcement mechanism embodied in Thorndike's classic Law of Effect (Thorndike, 1911). (Dickinson 2016, p. 179)

The puzzle:

1. If the action is habitual, why is it modulated by devaulation?

2. If the action is instrumental, why does it still occur (albeit less frequently) after devaluation?

6.   A Dual-Process Theory of Action

Some actions are 'controlled by two dissociable processes: a goal-directed [instrumental] and an habitual process' (Dickinson 1985, 2016).

Dickinson's dual-process theory is supported by (a) confirmation of its predictions concerning observed behaviour; and (b) neurophysiological discoveries.

On neurophysiological discoveries: 'goal-directed and habitual control have been doubly dissociated in two brain regions. In the PFC, lesions of the prelimbic and infralimbic areas disrupt goal-directed and habitual behavior

These dissociations suggest that different neural circuits mediate the two forms of control' (Dickinson 2016, p 184)

7.   Stress

'instrumental behavior itself involves two systems, the goal-directed and the habitual' (Dickinson & Pérez 2018, p. 12)

When stressed, your preferences matter less: habits dominate (Schwabe & Wolf 2010).

8.   Training Effects

Whether you learn about the effects of an action can influence whether that action becomes dominated by instrumental or habitual processes (Klossek et al. 2011).

'We argued that the variation in the development of behavioral autonomy arose from the different contingency experienced of the two groups. Once responding at a high and constant rate in the single-action condition after extended training, agents no longer experience the full causal contingency, speci cally episodes in which they do not respond and do not receive the outcome. As a result, the action-outcome causal representation necessary for goal-directed action is not maintained' (Dickinson 2016, p. 181).

9. Construals of Decision Theory

My proposal:

> Decision Theory (like Game Theory) specifies a model of action. Models can be construed in several different ways. Decision Theory says nothing about how the model should be construed.

Alternatives exist. For instance, Binmore (1994) claims the axioms of game theory are tautologies; on his story, the games are the models.

9.1. Models

'Theories, as they are usually understood by philosophers, make claims about the world [...] Models, in my sense, do not themselves say anything about the world. Models are structures that can be used by scientists to say various different things about the world, by means of commentaries that accompany models but are distinct from them' (Godfrey-Smith 2005, p. 4).

'Two scientists can use the same model to help with the same target system while having quite different views of how the model might be representing the target system. I will describe this situation by saying that the two scientists have different construals of the model' (Godfrey-Smith 2005, p. 4)

'one scientist might [construe] some model simply as an input-output device, as a predictive tool. Another might [construe] the same model as a faithful map of the inner workings of the target system' (Godfrey-Smith 2005, p. 4)

'it is ... possible to have facility with the model, and have a sense of which target systems are appropriate for it, while not having much of a construal at all' (Godfrey-Smith 2005, p. 5).

9.2. Link to Mindreading

'Basic facility with the folk-psychological model does not require using a particular construal of it. Many construals are possible. And it is also possible to have facility with the model, and have a sense of which target systems are appropriate for it, while not having much of a construal at all' (Godfrey-Smith 2005, p. 5).

'we should think of meanings and beliefs as interrelated constructs of a single theory just as we already view subjective values and probabilities as interrelated constructs of decision theory' (Davidson 1984, p. 146)

9.3. Possible construals

'we should think of meanings and beliefs as interrelated constructs of a single theory just as we already view subjective values and probabilities as interrelated constructs of decision theory'

(Davidson 1984, p. 146)

Is the revealed preference theory construal trivial? 'Completeness applies to preference as choice, while transitivity applies to preference as a set of judgments of well-being. Convincing arguments for the axioms taken together cannot be assembled on either definition.' (Mandler 2001, p. 374)

9.4. Rationality

'the laws of decision theory (or any other theory of rationality) are not empirical generalisations about all agents. What they do is define what is meant ... by being rational' (Davidson 1987, p. 43)

9.5. Normativity

On the normative construal, what does decision theory demand of rational agents? 'As ordinarily understood, the prescription to maximize your expected utility presupposes that there is some measure of expected utility that applies to you and that your preferences are therefore obliged to maximize. But in the context of decision theory, the utility and probability functions that apply to you are constructed out of your preferences, and so your expected utility is not an independent measure that your preferences can be obliged to maximize; rather, your expected utility is whatever your preferences

do maximize, if they obey the axioms. Hence, the injunction to maximize your expected utility can at most mean that you should have preferences that can be represented as maximizing some measure (or measures) of expected utility, which will then apply to you by virtue of being maximized by your preferences' (Velleman 2000, p. 149)

10. An Interface Problem

'Our version of dual-system theory assumes that the outputs of the goal-directed and habitual systems summate in generating behavior but fails to offer commensurate psychologies for the two systems that would allow for such summation. We appeal to an intentional psychology involving the process of practical inference to explain goal-directed action, whereas habitual responding is attributed to a mechanistic psychology in which the process of excitation (and inhibition) operates through associative connections' (Dickinson & Pérez 2018, p. 19)

'Dickinson (2012) has suggested that this disjunction might be resolved by an associative account of practical inference within the processing architecture of an associative-cybernetic model' (Dickinson & Pérez 2018, p. 19).

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