Available online at www.sciencedirect.com

ScienceDirect

Current Opinion in Behavioral Sciences

The role of intelligence in economic decision making

Aldo Rustichini

Research on the link between intelligence and economic decision making is a recent development in the more general attempt to introduce theories of individual differences and personality traits into the analysis of economic behavior. We lay down here what we know from behavioral studies, from imaging studies, both functional and anatomical, and insights from decision theory and game theory. All the results point to a correlation and perhaps a deeper link between cognition and decision making, both in single-player and in strategic environments. We see several pieces of a puzzle, and provide some suggestions on how future research will discover the hidden image.

Address
Department of Economics, University of Minnesota, United States

Corresponding author: Rustichini, Aldo (aldo.rustichini@gmail.com)

Current Opinion in Behavioral Sciences 2015, **5**:32–36

This review comes from a themed issue on **Neuroeconomics**

Edited by **John P O'Doherty** and **Colin C Camerer**

For a complete overview see the Issue and the Editorial

Available online 21st July 2015

http://dx.doi.org/10.1016/j.cobeha.2015.07.002

Introduction

An operational way of defining intelligence [1] begins with the empirical observation that test scores on cognitive tasks are positively correlated. If one then looks for an explanation of this regularity through exploratory factor analysis, one finds that scores in specific tests can be explained in a satisfactory way by a general factor (which Spearman called *g*) and an independent, task-specific factor. These conclusions have long been controversial, but they seem to be now widely accepted [2]. We will focus here on *g* (and call it intelligence) as the measurable individual characteristic of performance in general cognitive processes.

Economic decision making is the selection of one from a feasible set of options, each one having a value to the decision maker, and involves the processing of information on several relevant variables describing the options. This process is already complex in the case of an individual acting in isolation, as it requires an understanding of the options offered, whether at the supermarket or in the laboratory, an introspective evaluation of the prospective pleasure derived from each, perhaps on the basis of previous experiences, and the risk or time delay involved in the case of monetary payments. Information processing is even more complex in decision making in a strategic environment, where the consequences depends both on the choice made by the individual and the choices made by others. We will examine here the relation between intelligence and economic decision making; we ignore the obviously important, related but different issue of intelligence and economic outcomes (which is discussed instead for instance in [3–7]).

Intelligence and the method of choice

It seems natural to consider decision making as a special cognitive task, provide a definition of performance in this case, and expect (because of the *g* factor) this performance to be correlated with that exhibited in other tasks. The definition of performance in economic choices should not bind the individual to a particular preference over options, but should only constrain the method of choice. For example, if **a**, **b**, and **c** are lotteries with monetary payments, the choice between **a** and **b** and that between **b** and **c** should be entirely a matter of taste, and have no bearing on the general cognitive ability of the person who is doing the choosing. However, a reasonable consistency requirement (called *transitivity*) in choice is that if you prefer option **a** to **b**, and **b** to **c**, then you should not prefer **c** to **a**. That this is the case has been experimentally verified in recent years [8–12]: individuals with higher scores in IQ tests (e.g. Raven matrices) are more likely to be consistent. Similarly, individuals with higher intelligence should be less sensitive to irrelevant details in the presentation of the options (framing).

A similar correlation might also seem reasonable in strategic environments, although in this case the restrictions on behavior are substantially weaker. This is a consequence of the fact that, since the outcome of an action depends on the actions of others, and prediction of what the other will do depends on what *they* think you will do, different actions might be equally reasonable depending on appropriate beliefs about what the others will do. A solution concept (that is, a theory that selects some joint behavior of players among all the possible ones) exists [13,14] that only requires an action to be justifiable for some belief on what the others are going to do. This is the case if the action is the best choice given some belief about the choice of others, provided those beliefs are in turn a best choice given some belief about the choice of others, and so on. Even if one adopts this criterion (called *rationalizability*, which is weaker than the usual Nash equilibrium concept), some restrictions on behavior follow. For example, no action **b** should be taken that gives a worse outcome than **a** no matter what the others are doing (that is, no rational player should use a dominated action). There is still no systematic experimental test for the relation between intelligence and some appropriate definition of performance in choice, or rationalizability in games, although this is clearly an interesting field for future research.

A substantially more interesting line of research, however, is motivated by the finding that the role of intelligence goes well beyond the positive correlation between performance in choice and in cognitive tasks; instead, it discovers a relation between preferences and intelligence. In this survey we will focus on this second aspect of the relation between intelligence and what preferences are, rather than how they are implemented in choices.

Intelligence and preferences

A famous example of the relation between intelligence and preferences is in the realm of choice among rewards delivered at different points in time. In psychology, this has been known since Mischel's [15] marshmallow experiment: children's ability to postpone eating a marshmallow now, in exchange for an additional one later, was found to be correlated with performance in SAT tests, and in general with educational and economic success later in life. Some recent research has shown that a similar correlation holds for other domains of choice, in particular choice under risk and uncertainty. For example, we have argued elsewhere that there is no reason why we should consider the choice of a fifty–fifty chance of 100 dollars over 40 dollars more reasonable than the opposite. Nevertheless, just as with preferences over dated rewards, the pattern of choices under risk exhibits a correlation with intelligence. This relation, discussed in [8–12] cited earlier, is complex, but in general a greater willingness to risk is associated with higher intelligence.

A correlation between intelligence and behavior is also found in strategic behavior. This relation has probably deep roots: the social intelligence hypothesis [16–20] suggests that the richness of the social interaction in humans demands the development of flexible cognitive strategies, as opposed to adaptive rules of thumb. A natural way to predict how behavior in a strategic environment correlates with intelligence is to assume that higher intelligence will bring individuals closer to the behavior predicted by game-theoretic equilibrium concepts, based on the assumption of rationality of the players. When the game-theoretic prediction is unique, the restriction is powerful. This prediction has been experimentally tested, and has found some support [21–24]. However, there are some interesting exceptions to this rule when players do not have opposing interests, and there are potential gains from cooperation. An important example is provided by the sequential two-player *trust game*: the first mover has to choose an investment, paid for out of his own funds; the investment gives a return which is paid to the second player, who is informed of the amount paid by the first player and has to decide how much to give to the first out of his new total wealth. A rational second player who is only interested in his payoffs will transfer nothing back, and the first player, anticipating that his investment will give no benefit to him, will invest nothing. The assumption suggested earlier that higher intelligence is associated with more rational behavior would lead to the prediction that players with higher intelligence will transfer less. Instead, the opposite holds in experimental tests [9]: higher intelligence players transfer more as first mover and are more reciprocal as second mover. Similar results hold for the one-shot Prisoner's Dilemma [25].

When the game-theoretic prediction is not unique strategic analysis provides little guidance to the relation between intelligence and behavior. A lack of a unique prediction is the rule in *repeated games*, where two players play the same simultaneous move game for many rounds, for example the Prisoner's Dilemma [26,27•]. In experimental setups, the probability that the repeated encounters come to an end in each round is decided by a random device; the higher the continuation probability, the higher a consideration of future rounds will weigh on the current decision, and make cooperation today to induce cooperation tomorrow more appealing. Note that the set of possible equilibria is still very large, and since intelligence is not explicitly considered in game theory, the theory is silent on the relation between intelligence and behavior. There are, however, interesting regularities. For instance, (Proto E, Rustichini A, Sofianos A, under review) if players are allocated to two groups of high and low IQ score, then the cooperation rate is very similar across groups in the early stages but diverges substantially over the experimental session, with high IQ score players reaching a cooperation level close to 100%, and low IQ score ones drifting to lower cooperation rates.

Model-free learning and intelligence

Research on neural correlates into the way intelligence modulates information processing on rewards has so far been confined to *model-free learning theories*. These theories view learning as adjusting the assessment of the value of an action in proportion to the difference (called *prediction error*) between the reward obtained and the expectation of the reward according to an earlier assessment. This adjustment does not require an understanding or a modeling of the structure of the transition probability among states of nature that affect rewards: this transition is instead explicitly introduced in *model-based theories*, which assume that the individuals learn what the transition is.

Even this simple class of models provides some insight into the role of intelligence in learning [28,29]. In [30•]