Commentary/Todd & Gigerenzer: Simple heuristics of performance, comparable to human performance in a range of tasks. They show, for example, that decision making based on a single piece of evidence, rather than integrating across all available evidence, can lead to close optimal performance in a wide range of estimation tasks (Gigerenzer et al. 1999, Ch. 4, p. 75, Gigerenzer & Goldstein). Gigerenzer et al. interpret these results as hav- ing radical implications for cognition in general—in particular, as undercutting the view that cognition must involve well-optimized cognitive machinery which behaves in accordance with classical rational norms of probability theory, logic, and decision theory. This line of thought raises the attractive possibility that the complexity of the mind may have been dramatically overestimated. Perhaps the mind is really just a collection of smart heuristics, rather than a fantastically powerful general-purpose problem solver. This is an exciting and important thesis. This commentary focuses on three challenges to this approach, which may open up avenues for fu- ture research.

1. Empirical evidence. Gigerenzer et al. focus on providing a feasibility proof for the viability of a particular kind of simple rea- soning heuristic. This task primarily involves providing computer simulations showing that simple heuristics give good results on specific decision problems, in comparison to conventional meth- ods such as linear regression, and to other heuristic approaches, such as unit-weighted regression. But there is little by way of ex- perimental evidence that people actually do reason in this way, aside from important but preliminary evidence reported in Chap- ter 7. This is particularly important precisely because the simu- lations in this book show that a wide range of algorithms give very similar levels of performance. Hence, prima facie, all these algo- rithms are equally plausible candidates as models of how people might perform on these problems.

In the absence of a broader set of experimental tests there is some reason to doubt that people make decisions by relying on one cue only. As Gigerenzer et al. note, in perception and lan- guage processing there is ample evidence that multiple cues are integrated in recognition and classification, in extremely complex ways (e.g., Marr 1987). Gigerenzer et al. argue that these cases are in sharp contrast to the operation of conscious decision- making processes—determining whether this divide is a real one is an important area for empirical research.

2. Scope. One of the most startling findings in psychology is that, across a very wide range of judgment tasks, including med- ical diagnosis, expert performance does not exceed, and is fre- quently poorer than, results obtained by linear regression over sets of features of the cases under consideration (Medhi 1954; Sawyer 1966).

An equally startling finding, this time from artificial intelligence and cognitive science, has been that in everyday reasoning, people vastly outperform any existing computational model (Ontologica- tion project & Chater 1998a). Even the inferences involved in understanding a simple story are conducted on a purely symbolic basis and the model is applied to data that are highly and rapidly. Attempts to model such processes computationally have become mired in the vast of difficulties known as the “frame problem” (Pylshyn 1987).

So cognition is, in some regards, remarkably weak; and in other regards it is remarkably powerful. In the present context, the crucial point is that the simple heuristics discussed in this book are aimed at modeling areas where cognition is weak—indeed, where cognitive performance is already known to be frequently outper- formed by linear regression. But it is by no means clear that the picture of the mind as a set of simple heuristics will generalize to everyday reasoning, where cognitive performance appears to be remarkably strong. Indeed, it may be that it is not that simple heuristics make us smart (as Gigerenzer et al. title suggests), rather it may be that we resort to simple heuristics to do the very thing we are not smart at.

3. Why do heuristics work? Gigerenzer et al. downplay the im- portance of traditional conceptions of rationality in their dis- cussion of reasoning methods. Indeed, they note that a heuristic such

How smart can simple heuristics be?

Nick Chater

Department of Psychology, University of Warwick, Coventry, CV4 7AL, United Kingdom. nick.chater@warwick.ac.uk

Abstract: This commentary focuses on three issues raised by Gigerenzer, Todd, and the ABC Research Group (1999). First, I stress the need for fur- ther experimental evidence to determine which heuristics people use in cognitive judgment tasks. Second, I question the scope of cognitive mod- els based on simple heuristics, arguing that many aspects of cognition are too sophisticated to be modeled in this way. Third, I note the comple- mentary role that rational explanation can play to Gigerenzer et al’s “ecological analysis” of why heuristics succeed.

Gigerenzer and Todd, and the ABC Research Group have provided a series of impressive demonstrations of how simple “fast and fru- gal” cognitive heuristics can attain surprisingly impressive levels

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as Take the Best has not been derived from "rational" principles of probability or statistics. Instead, they focus on an ecological notion of rationality—that the heuristics work in practice on real world data?

The viewpoint may appear to be an alternative to more traditional notions of rationality as used in psychology (Anderson 1990; Chater et al. 1999; Oaksford & Chater 1994b), economics (Kreps 1990) and behavioral ecology (McFarland & Houston 1981), in which behavior is assumed to approximate, to some degree, the dictates of rational theories, such as probability and decision theory. But it may be more appropriate to see the viewpoints as complementary. Gigerezen et al. (1999) are concerned to demonstrate rigorously which particular heuristics are successful, by computer simulation on realistic data sets. Traditional rational theories aim to explain why heuristics work. They characterize the optimization problem that the cognitive process, economic actor or animal faces, using rational theories (probability, decision theory, operations research) to determine the "rational" course of action; and conjecture that the heuristics used in actual performance approximate this rational standard to some degree. From this point of view, rational methods can be viewed as compatible with the "ecological" view of rationality outlined in Gigerezen et al. (1999). Focusing on simple cognitive heuristics does not make the application of rational standards derived from formal calculi unnecessary. Instead, it gives a defined role for rational explanation—to explain why and under what conditions these heuristics succeed in the environment. This perspective is, indeed, exemplified in Gigerezen et al.'s formal analysis of the conditions under which the Take the Best heuristic is effective (Ch. 6) and consistent with Gigerezen et al.'s valuable comparisons between Take the Best and Bayesian algorithms (Ch. 8).

This book shows an important direction for research on human reasoning. It should act as a stimulus for empirical, computational, and theoretical developments in this area.

Simple heuristics could make us smart; but which heuristics do we apply when?

Richard Cooper
School of Psychology, Birkbeck College, University of London, London, WC1E 7HX United Kingdom r.cooper@psychology.bbk.ac.uk www.psyc.bbk.ac.uk/staff/rc.html

Abstract: Simple heuristics are clearly powerful tools for making near-optimal decisions, but evidence for their use in specific situations is weak. Gigerezen et al. (1999) suggest a range of heuristics, but fail to address the question of which environmental or task cues might prompt the use of any specific heuristic. This failure compromises the falsifiability of the fast and frugal approach.

Gigerezen, Todd, and the ABC Research Group (1999) are right to criticize much contemporary psychological decision-making research for its focus on mathematically optimal approaches whose application requires unbounded time and knowledge. They have clearly demonstrated that an agent can make effective decisions in a range of ecologically valid decision-making situations without recourse to omniscient or omnipotent demons. They have also cogently argued that biological decision-making agents cannot have recourse to such demons. The question is therefore not "Do such agents use heuristics?", but "Which heuristics do such agents use (and when do they use them)?" Gigerezen et al. acknowledge that this question is important, but address it only in passing.

Gigerezen et al.'s failure to specify conditions that might lead to the use of specific fast and frugal heuristics compromises the falsifiability of the fast and frugal approach. Difficult empirical results may be dismissed as resulting from the application of an asset-unidentified fast and frugal heuristic or the combination of items from the "adaptive toolbox" in a previously unidentified way.

Gigerezen et al. criticize the heuristics-and-biases approach of Tversky and Kahneman (1974) on much the same grounds. They note, for example, that both base-rate neglect and conjunction fallacy (two apparently opposing phenomena) can be "explained" by appealing to the appropriate heuristic or bias (because Tversky & Kahneman provide insufficient detail on the conditions that are held to evoke particular heuristics or biases). Gigerezen et al. contend, quite reasonably, that such a post-hoc appeal does not amount to an adequate explanation of the behavior. It is suggested that the use by the ABC Research Group of precise computational simulation techniques avoids this criticism. The computational simulations are very welcome and add a dimension often lacking in decision-making research, but they do not, in their disembodied form, address the question of which heuristic might be applied when.

The issue of heuristic selection is not entirely ignored by Gigerezen et al. The suggestion is that heuristics are either selected (or built from components within the adaptive toolbox) on a task-by-task basis. The challenge therefore lies in specifying: (1) the conditions under which different heuristics are reliably employed; (2) the conditions that provoke the construction of novel, task-specific heuristics; (3) the base components available in the adaptive toolbox; and (4) the mechanisms by which appropriate heuristics may be constructed from these components. Of these, only the third is discussed at any length—the building blocks are held to involve elements that are pre-existing and applied heuristics. However, the results of the selection process may be insufficient to allow the fourth constraint to be addressed.

At several points in the book, the heuristic selection is conceived of as a meta-level component that selects one of two possible heuristics. The fast and frugal heuristic is called to give a result in any given situation. The question of which heuristic to apply when remains.

The importance of heuristic selection is compounded by the lack of evidence presented in favor of the use by human decision makers of many of the heuristics discussed. For example, both Quick-Est and CBE are presented solely as heuristics that are certain to be fast and frugal. No comment is made on the psychological reality of either of these heuristics. This seems particularly odd when robust psychological findings that would appear to be of relevance (such as those addressed by Tversky and Kahneman's (1974) heuristics-and-biases approach) are ignored. How, for example, might the fast and frugal approach address the phenomena that Gigerezen et al. use to demonstrate the difficulties present in the heuristics-and-biases approach (base-rate neglect and conservatism), or the confirmation bias often seen in decision versions of categorization? The latter, in particular, appears to be in direct conflict with the only categorization heuristic proposed (CBE).

Fast and frugal heuristics have great promise. Human decision making cannot result from the application of algorithms with unbounded costs. Gigerezen et al. have shown that fast and frugal heuristics can yield good decisions. They have not shown that humans use such heuristics, and by not addressing the question of which heuristics might be applied when, they have, like Tversky and Kahneman, given us a theory of human decision making that is unfalsifiable.

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