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On the Binary Quality of Recognition and the Inconsequentiality of Further Knowledge: Two Critical Tests of the Recognition Heuristic

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ABSTRACT

The recognition heuristic is claimed to be distinguished from notions of availability and fluency through its categorical or ''binary'' treatment of information and the ''inconsequentiality'' of further knowledge to inferences based on recognition. Using the city-size task of Goldstein and Gigerenzer (2002) we demonstrate that: (1) increasing the validity of other information in the environment decreases the reliance on recognition; (2) cities that are both recognized and have other information known about them (e.g. they have a soccer team) are chosen more often than those which are simply recognized; and (3) there is a negative correlation between the time taken to identify a city and the proportion of times it is selected as the larger of a pair. None of these results is predicted by the process model of the recognition heuristic. The implication of the results for the distinction between the recognition, availability and fluency heuristics is discussed. Copyright © 2006 John Wiley & Sons, Ltd.

KEY WORDS recognition; fluency; availability; fast-and-frugal heuristics; ecological rationality

INTRODUCTION

Gigerenzer and colleagues have proposed a number of ''fast and frugal'' heuristics, which use minimal time (fast) and minimal information (frugal), and yet lead to judgements no less accurate than those generated by more traditional ''rational'' algorithms (e.g. Gigerenzer & Goldstein, 1996; Gigerenzer, Todd, and the ABC Research Group, 1999). The success of these heuristics is said to lie, in part, in their ''ecological rationality''—the ability to exploit the structure of information in natural environments (Goldstein & Gigerenzer, 2002). The remarkable performance of fast and frugal heuristics—achieved in spite of their economical use of time and information—has led a number of commentators to hail the programme as moving us into a

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''new era'' of understanding human rationality (Sternberg, 2000; Wimsatt, 2000). It has even been suggested that, given the success of the fast and frugal heuristics, they should be formalised and institutionalized in decisions within the legal system and in medical diagnosis (Engel, 2000).

The prototypical fast and frugal heuristic is the ''recognition heuristic'', defined as follows:

> Recognition heuristic: If one of two objects is recognized and the other is not, then infer that the recognized object has the higher value with respect to the criterion' (Goldstein & Gigerenzer, 2002, p. 76).

The recognition heuristic is prototypical because it is the fastest and most frugal of those contained within the mind's ''adaptive toolbox''. Furthermore, not only can the recognition heuristic be used in isolation, but it is also a fundamental building block of other heuristics in the toolbox; for example, it is the first step of the ''Take-The-Best'' heuristic (Gigerenzer & Goldstein, 1996).

As a number of commentators have noted, the notion that recognition can be relied on to make decisions is not novel, although some of the findings concerning the use of recognition are surprising and counter-intuitive (e.g., the ''less is more'' effect in which optimal performance is found when only half the objects in a reference class are recognized, Goldstein & Gigerenzer, 2002). Nevertheless, the central claim made about the usefulness of recognition appears to overlap with those commonly made for heuristics such as availability (e.g. Gilovich, Griffin, & Kahneman, 2002; Tversky & Kahneman, 1973) and fluency (e.g. Jacoby & Whitehouse, 1989; Schooler & Hertwig, 2005). The common ''mechanism'' underlying these tools for inference is in the utilisation of information that is recognized, is familiar or is easily processed. Fluency of processing is defined as the experienced ease with which an item is processed—that is, the ease with which its perceptual and/or conceptual features are brought to awareness (Shapiro, 1999). This ''ease of cognition'' has clear parallels with the availability heuristic, as noted by Jacoby and Whitehouse (1989): '' . . . we have related the feeling of familiarity to fluency of processing . . . The fluency heuristic that we believe underlies the feeling of familiarity is in some way similar to the availability heuristic that Tversky and Kahneman (1973) proposed as underlying judgements of probability . . . by the fluency heuristic, an item seems familiar if it can be easily brought to mind, [that is,] fluently processed''.

In spite of the similarities between inferences made on the basis of fluency, availability and recognition, proponents of the recognition heuristic are keen to demonstrate that it is distinct. For instance, Goldstein and Gigerenzer (1999) state that:

> [w]e treat recognition as a binary phenomenon: one either recognizes or one does not. How often one has been exposed to something is both hard to assess subjectively and irrelevant for the frugal recognition heuristic. These two features, the binary quality of recognition and the inconsequentiality of further knowledge, set the recognition heuristic apart from notions such as availability . . . (p. 56).

In this paper we report two tests of the empirical validity of the recognition heuristic, taking the two features identified by Goldstein and Gigerenzer (1999)—the binary quality of recognition and the inconsequentiality of further knowledge—as our guide. Experiment 1 examines the evidence for inconsequentiality—also described as ''non-compensatory'' decision making, while Experiment 2 tests the claim for the binary treatment of recognition. The study is a part of a programme of research aimed at bridging the gap between the proposed psychological plausibility of ''fast-and-frugal'' models and empirical evidence demonstrating their use in experimental environments (e.g. Bröder, 2000, 2003; Bröder & Schiffer, 2003; Newell, 2005; Newell & Shanks, 2003; Newell, Weston, & Shanks, 2003; Newell, Rakow, Weston, & Shanks, 2004; Rakow, Newell, Fayers, & Hersby, 2005).

The first question to ask in designing an empirical test is to ask in what kind of environments the recognition heuristic is said to be employed. Todd and Gigerenzer (2000) state that ''there are two conditions that are necessary and sufficient to make the recognition heuristic useful: recognition must be correlated with a criterion (e.g. recognition of city names is correlated with their size) and recognition must be partial (e.g. a person has heard of some items in the test set, but not all)'' (p. 771).

A number of environments can be imagined that satisfy the first condition (e.g. stock markets, Borges, Goldstein, Ortman, & Gigerenzer, 1999; sports competitions, Andersson, Edman, & Ekman, 2005; Ayton & Onkal, 2004). Receiving the most attention in the literature to date is the ''cities task'', in which participants are required to estimate which of two cities is larger (Bröder & Eichler, 2006; Goldstein & Gigerenzer, 1999, 2002; Oppenheimer, 2003; Reimer & Katsikopoulus, 2004). In estimating city size, if a city is recognized, it can, for instance, be assumed to have had a greater number of mentions in the media, and thus, on average, be larger in population (Goldstein & Gigerenzer, 2002; Schooler & Hertwig, 2005; though see Oppenheimer, 2003 for exceptions). Recognition information is thus structured in such a way as to be correlated with the decision criterion in the cities task. Indeed, it has been found that, where subjects recognized only one city from each pair in this task, they estimated the recognized city to be larger in population approximately 90% of the time (Goldstein & Gigerenzer, 2002).

However, Newell and Shanks (2004) have pointed out that where recognition information is correlated with a decision criterion and *no further information is available*, subjects will rely on recognition information according to virtually any model of decision-making, regardless of whether there exists a ''recognition heuristic''. As such, Newell and Shanks argue that the defining characteristic of the recognition heuristic is its purported non-compensatory nature. The term ''non-compensatory'' refers to the proposed feature of the recognition heuristic by which ''if one object is recognized and the other is not, the inference is determined; no other information about the recognized object is searched for and therefore, no other information can reverse the choice determined by recognition'' (Goldstein & Gigerenzer, 2002, p. 82). This is what is meant by the ''inconsequentiality of further knowledge'' in the earlier quote from Goldstein and Gigerenzer (1999). This non-compensatory use of information is opposite to the compensatory mechanism, assumed by most classical models of decision-making, whereby additional cues would be searched for and combined with the recognition cue before a judgement is made. Whenever an additional cue conflicts with the recognition cue, it can potentially compensate for the influence of recognition.

The non-compensatory feature of the recognition heuristic is essential in distinguishing it from other decision-making algorithms. Without this feature, the recognition heuristic can be re-stated as saying simply that people will use the only piece of information available to them in a given environment—a claim that is common to any ''theory'' about how people make judgements. Is there any evidence, then, for a non-compensatory recognition heuristic? The findings of an experiment reported by Goldstein and Gigerenzer (2002) provide the best evidence for the strong claim that recognition information is used in a non-compensatory fashion—thus the best evidence for the existence of a recognition heuristic. They conducted two experiments, each using a ''cities task'', as described above. The first experiment was a basic version of the cities task, with no information provided other than city names. Participants were found to choose the recognized city as larger on 90% of occasions, where no other information was available. Subsequently, in a second experiment, they found that subjects relied on recognition to approximately the same degree (92% of occasions) even when provided with additional information (i.e. whether or not a city had a soccer team) which conflicted with the recognition cue.

Goldstein and Gigerenzer (2002) concluded from these findings that ''it appears that the additional information about soccer teams was not integrated into the inferences, consistent with the recognition heuristic. This result supports the hypothesis that the recognition heuristic was applied in a noncompensatory way'' (p. 83). This conclusion followed from the description given by Goldstein and Gigerenzer regarding the nature of the information available to participants. ''[In the experiment] an unrecognized city either does or does not have a soccer team. If it does—a 5 in 22 chance from the information presented [to participants]—then there is a 78% chance that it is larger. If it does not, then the soccer team information is useless, and a guess must be made [because the soccer team cue does not discriminate]. Any chance of the unrecognized city having a soccer team suggests that it is probably larger. Participants who do not put any value on recognition should always choose the unrecognized city'' (p. 83). (In the next section we will discuss in detail the exact design used by Goldstein and Gigerenzer 2002).

However, this description is flawed, and as such, the conclusions drawn by Goldstein and Gigerenzer (2002) from their second experiment do not necessarily follow from their results. The reason this description is flawed is that it creates a false dichotomy: it suggests that participants will either place *no* value on recognition information, or else use it *exclusively*. The third option—that recognition information may be used, not exclusively, but rather in a compensatory manner like any other cue—must be taken into account. Recall the first condition above, the requirement that there be a plausible correlation between recognition and the decision criterion, a requirement which Goldstein and Gigerenzer (2002) claim to constrain use of the recognition heuristic. In a task that satisfies this assumption—such as the cities task—why would participants place no value on recognition information? Virtually any model would assume that participants would, in such a task, use recognition information. The question is do they use it in a non-compensatory way, as Goldstein and Gigerenzer claim, or rather, in a compensatory way, in accordance with the third, ignored option?

In this third scenario, even if the soccer team information were useless, it does not follow that ''a guess must be made''—rather, recognition would be the only relevant cue, and the recognized city would therefore be chosen. Furthermore, it is not true that ''*any* chance of an unrecognized city having a soccer team suggests that it is probably larger'' [emphasis added], but rather that the chances of an unrecognized city having a soccer team, and of having a soccer team indicating it to be large, must *outweigh* the information provided by recognition. Thus, the findings of Goldstein and Gigerenzer (2002) can be interpreted either as indicating that the soccer team information was ignored as a result of a non-compensatory recognition heuristic, or that it was considered, in a compensatory decision-making process, not to sufficiently outweigh the influence of the recognition cue. A true test of the non-compensatory recognition heuristic must be able to distinguish between these two ways in which recognition information can be used (c.f., Bröder & Eichler, 2006).

The conclusions drawn by Goldstein and Gigerenzer (2002) are especially unwarranted in light of the relatively low usefulness of the soccer team information. Participants were not told which unrecognized cities had soccer teams; this omission was deliberate so as to more closely approximate the real world where information about items that one does not recognize cannot be available to one's memory. Thus, Goldstein and Gigerenzer merely told participants that 9 of the 30 cities had soccer teams; given that four of the eight they had already studied had soccer teams, this left a remaining 5 out of 22 (23%) unstudied cities that had soccer teams. That is, on any critical pair, there was a mere 5 in 22 chance that the unrecognized city had a soccer team; furthermore, there was a 78% chance that *if* it had a soccer team, it would be larger. As Bröder and Eichler (2006) have pointed out, this arrangement means that the actual predictive validity of the soccer team information was much lower than 78%. Specifically, in the expected 17 out of 22 (77%) cases in which the unknown city had *no* soccer team, a guess on the basis of the soccer team cue would lead to 50% correct responding (because the cue fails to discriminate), thus, the expected success rate of the cue is only $0.77 \times 0.50 + 0.23 \times 0.78 = 0.56$. Given this low value it is much less surprising that participants appear to ignore the soccer team information.

A true test of the claim that recognition information is used in a non-compensatory way must, firstly, occur in an environment in which there is a correlation between recognition and the decision criterion. Secondly, it must be able to distinguish between a state of affairs in which recognition is relied upon in a compensatory manner—just like any other cue—and one in which it is relied upon in a non-compensatory manner. This is in contrast to the test created by Goldstein and Gigerenzer (2002), in which the recognition cue was claimed to be either non-compensatory, on the one hand, or useless on the other.

Recent investigations have attempted to create such environments in order to test the claim for non-compensatory use of recognition information (e.g. Bröder & Eichler, 2006; Newell & Shanks, 2004;

Oppenheimer, 2003). However, each of these studies has been criticized for using experimentally induced recognition[1] (Bröder & Eichler, 2006; Newell & Shanks, 2004) or an unrepresentative sample of stimuli that do not satisfy the condition of a positive recognition-criterion correlation (Oppenheimer, 2003).

Although we do not necessarily agree with these criticisms, we suggest that a more direct way of addressing the ambiguity in the findings of Goldstein and Gigerenzer is to use their city size task and create an environment in which the relative validity of the soccer team information is considerably higher, via a simple modification to the instructions given to participants. For instance, rather than inform participants that ''9 out of the 30 largest cities have soccer teams'', (hereafter referred to as Low-value Predictive Information, or LPI), participants can be informed that ''7 out of the 12 cities you will see have soccer teams'' (hereafter referred to as High-value Predictive Information, or HPI). The probability that an unrecognized city has a soccer team is thus increased from 5 in 22 for participants given the LPI instruction to 3 in 4 for participants given the HPI instruction (see Method section). This change in instructions can be made without modifying the design of the experiment or the nature of the stimulus environment in any way.

Furthermore, the analysis of participants' responses in such a task yields considerably more information than that reported by Goldstein and Gigerenzer (2002). In their analysis, only the ''critical pairs''—in which one city was recognized, but known to have no soccer team, and the other was unrecognized—were analysed. There is at least one other pair type which is of equal interest when testing a non-compensatory recognition heuristic: pairs in which a recognized city which is known to have a soccer team is paired with an unrecognized city. This pair type—here referred to as ''corresponding-cue pairs'' (since both the recognition cue and the soccer team cue point to the same city)—is informative because, if the soccer team information is in fact ignored when mere recognition can be used to make a judgement between two cities, then the recognized city should be chosen with the same frequency in both the ''critical pairs'' and the ''corresponding cue pairs''. This is a stronger test of the non-compensatory recognition heuristic, but a necessary one (cf. Ayton & Önkal, 2004).

These two questions were addressed in Experiment 1 which was a direct replication and extension of Goldstein and Gigerenzer (2002). In order to model the conditions employed by Goldstein and Gigerenzer as closely as possible, items were sampled from the same subset of cities that they used (that is, the 30 largest cities in Germany). Furthermore, consistent with their methodology, no specific information was given to participants regarding any particular unrecognized city. Rather, the only manipulation was an increase in the perceived probability that the unrecognized cities have soccer teams, for one group. This procedure satisfied all of the necessary environmental parameters for the recognition heuristic to be employed; both the task specifications (''choose the larger of the two cities'') and the sample of items used (taken from the 30 largest cities in Germany) are identical with those in Goldstein and Gigerenzer (2002). The only difference was a quantitative change in the instructions given to participants, regarding the potentially conflicting soccer team information. The additional analysis of the corresponding-cue pair responses did not require any alteration to Goldstein and Gigerenzer's (2002) methodology.

If there is a non-compensatory recognition heuristic, there should be no effect of increasing the probability of an unrecognized city having a soccer team on participants' willingness to choose the recognized city, since this information is supposedly ignored if and when recognition can be used. If, on the other hand, recognition information is used, like any other cue, in a compensatory fashion, then the increased probability that unrecognized cities have soccer teams would be expected to increase participants' reliance on the soccer team information. Furthermore, if there is a non-compensatory recognition heuristic, participants

[1]Some experiments have used the repetition of items within an experimental task to artificially induce recognition. Proponents of the recognition heuristic may argue that this form of recognition differs from the pre-existing recognition knowledge that is the focus of the heuristic. However, the distinction between induced and existing recognition knowledge is not explicitly addressed by Goldstein and Gigerenzer (2002) so the extent to which the heuristic is applicable to both remains an open question (see Bröder & Eichler, 2006 and Newell & Shanks, 2004 for further discussion).

should choose the recognized city as larger than an unrecognized one. This pattern should hold regardless of whether the recognized city has a soccer team or not (i.e. there should be no difference in responding on critical and corresponding-cue pairs).

EXPERIMENT 1

Participants

Participants were 47 first-year psychology students from the University of New South Wales. They participated in order to receive course credit. There were 21 males and 26 females, ranging in age from 17 to 25 with a mean age of 19.4 years.

Design

There were two groups in the experiment: one group received a replication of experiment 2 of Goldstein and Gigerenzer (2002); this group is referred to as the ''low-value predictive information'' (LPI) group ($N = 24$). The other group differed only in the instructions, such that the predictive validity of the soccer team information was higher; this group is referred to as the ''high-value predictive information'' or HPI group ($N = 23$). Participants were assigned randomly to the two groups.

Stimuli

On the basis of pilot data from acquaintances of the experimenter, the four most recognizable cities *with* soccer teams in the German major league were selected to make up subset A (Hamburg, Frankfurt, Munich, Stuttgart); the four most recognizable cities *without* soccer teams were selected to make up subset B (Berlin, Bonn, Düsseldorf, Leipzig); and the four least recognizable cities were selected such that three out of these four cities had soccer teams; these made up subset C (Bochum, Chemnitz, Dortmund, Mönchengladbach). The same stimuli were shown to both groups. All possible pairs were shown in the main test phase, giving a total of 66 pairs. (Note: Hereafter the shorthand ''city with/without soccer team'' refers to a soccer team in the German major league—the Bundesliga).[2]

Procedure

The experiment consisted of a training phase, followed by a decision task involving 66 pairs of cities. Half of the participants were asked to fill out a recognition checklist upon entering the experiment, by circling the cities they had heard of ''before today''. The other half received it after completing all parts of the experiment.

Training phase

At the beginning of the training phase, participants were given a ''Summary of Information'' sheet summarising the main information that would be shown on the instructions screens in the study phase. Participants were seated at a computer and told to pay attention to the information that was about to be presented, and take additional notes if they wanted (that is, in addition to the Summary of Information

[2]We used the data provided in Gigerenzer and Goldstein (1996) and used by Goldstein and Gigerenzer (2002) to determine whether a city had a soccer team. As one reviewer helpfully pointed out the teams in the German major league (Bundesliga) vary from year to year and so it is plausible that participants' knowledge of the current composition of the Bundesliga might have conflicted with the information we provided. However, in post-test questioning only one participant indicated any knowledge of the Bundesliga (and this participant only knew of one team) thus it is unlikely that specific recent knowledge had any impact on participants' decisions.

sheet). They were told that they would be required to pass a brief test on this information before proceeding to the main experiment.

Participants were then informed that they would see cities taken from the 30 largest in Germany. They were told that, of these cities, those with soccer teams in the German major league were larger than those without on 78% of occasions. They were told that when they clicked the two buttons on the right of the screen, they would be shown four cities with soccer teams, and four cities without soccer teams, randomly chosen from among the 30 largest cities in Germany. One button read ''Randomly select cities with soccer teams'' (which revealed the cities in Subset A), while the other read ''Randomly select cities without soccer teams'' (which revealed the cities in Subset B). They then clicked these two buttons, and were told by the experimenter to note these cities down. The cities were not actually chosen randomly; all participants were shown the same eight cities.

On the third screen, participants were informed that they would see only 12 of the 30 largest cities in Germany in the main test phase, and that the 8 cities they had just seen would be included in those 12, while the other 4 cities had been chosen randomly from among the 22 remaining largest German cities. The final instruction on this screen was different for each group, and constituted the independent variable for experiment 1.

The LPI group was told:

> You should note that 9 out of the 30 largest cities in Germany have soccer teams (as in Goldstein & Gigerenzer, 2002).

The HPI group was told:

> You should note that 7 out of the 12 cities you will see have soccer teams.

As such, the only difference between the instructions given the HPI group, and those given the LPI group is quantitative. The original 5 in 22 chance that the cities in subset C had soccer teams was increased to 3 in 4.[3]

The next screen was the test screen, in which participants were required to re-enter the relevant information. They were told that they had to answer everything correctly before proceeding to the main experiment. If participants entered an incorrect answer, their answers cleared, and they had to re-start the test.

Decision task

After correctly completing the test screen, the decision task began. There were 66 pairs presented, constituting all possible pairs derived from the set of 12 cities. For each pair, participants were asked to choose the city that they believed had the larger population.

Results

There was no effect of the order of recognition checklist presentation on either the number of cities recognized, or response patterns on any pair type.

[3]Both groups saw the 12 cities selected from the 30 largest in Germany. For the LPI group participants were informed that 9 out of the 30 cities in Germany have soccer teams. They were then shown four cities, which they were told have a soccer team (Subset A), as well as four cities which they were told have no soccer team (Subset B). Thus there are 22 cities they have not seen, and five out of these would have soccer teams. For the HPI, group participants saw the same 12 cities selected from the original 30 but were told that 7 of the 12 that they will see have soccer teams. As with the LPI group they are then told the names of four of these 12 cities which have soccer teams, and four which do not have soccer teams. This leaves four cities which may or may not have soccer teams; because they know that 7 out of the total 12 have soccer teams, three of the cities which they are unsure about must have soccer teams. Thus the probability is raised to three out of four. Consistent with Goldstein and Gigerenzer (2002) all participants had to learn this information and enter it into a test screen on the computer before proceeding to the choice phase.

Participants in the LPI group chose the recognized city on an average of 72.6% ($SD = 29.3$) of occasions. In contrast, participants in the HPI group chose the recognized city on an average of 55.5% ($SD = 35.0$) of occasions. This large numerical difference was statistically significant ($t(45) = 1.82$, $p < 0.05$, *one-tailed*). The clear evidence of decreased reliance on recognition in the group given the more predictive soccer team information (HPI) is consistent with the prediction that the value of the conflicting soccer team information would affect participants' decisions. The difference in selections is inconsistent with the claim that recognition is used in a non-compensatory manner in the cities task.

Collapsing across the LPI and HPI groups, and comparing responses across all participants in the Corresponding-versus Conflicting-Cue Pair types, revealed that participants chose the recognized city more often, on average, when the recognized city was also known to have a soccer team ($M = 98.4\%$, $SD = 4.17$) than when the recognized city was known *not* to have a soccer team ($M = 64.1\%$, $SD = 32.24$). The difference between these means was significant ($F\ (1, 46) = 48.28$, $p < 0.001$), and the size of the effect was large to extremely large (standardised $CI = (1, 1.9)$). This extremely large difference is not predicted by a non-compensatory recognition heuristic; it is however predicted by a compensatory strategy, in which recognition of cities and information about the presence or absence of a soccer team are integrated before a judgement is made (cf. Ayton & Önkal, 2004; Bröder & Eichler, 2006; Newell & Shanks, 2004).

DISCUSSION

We found little evidence to suggest that recognition information was used in a non-compensatory manner in the German cities task. Increasing the perceived validity of additional information reduced reliance on recognition, and the presence of known additional information increased choice of a recognized alternative. The results are consistent with a number of other recent investigations in finding evidence for the compensatory use of recognition in decision-making tasks (Ayton & Önkal, 2004; Bröder & Eichler, 2006; Newell & Shanks, 2004; Oppenheimer, 2003; Richter & Späth, 2006).

The results of Experiment 1 question the psychological reality of the "inconsequentiality of further knowledge" claimed by Goldstein and Gigerenzer to be a distinguishing feature of the recognition heuristic. There is little evidence to suggest that recognition alone terminates search for further information in an environment in which (a) other information is present and (b) that information is perceived to be useful. We suggest that without evidence for this distinguishing feature it becomes increasingly difficult to dissociate patterns of data that can be explained in terms of recognition from those that can be explained in terms of the well-established notions of availability and processing fluency (e.g. Jacoby, Kelley, Brown, & Jasechko 1989; Tversky & Kahneman, 1973).

EXPERIMENT 2

Recall that the second feature said to distinguish the recognition heuristic is the 'binary quality of recognition'. Echoing the sentiment in the earlier quote from Goldstein and Gigerenzer (1999), Goldstein and Gigerenzer (2002) claim that the recognition heuristic "treats recognition as a binary, all-or-none distinction" (p. 77), explicitly distinguished from Tversky and Kahneman's notion of "availability", defined by Goldstein and Gigerenzer (2002) as the "graded distinction among items in memory . . . measured by the order or speed with which they come to mind or the number of instances of categories one can generate" (p. 77). According to this account then, the speed with which an object is recognized is irrelevant for the adoption of the recognition heuristic.

To test this claim in Experiment 2 we replicated the 'standard' cities task (i.e. with no soccer team information, as in Experiment 1 of Goldstein and Gigerenzer, 2002) but employed a speeded categorization task which was given to participants prior to the cities task. In this additional task participants were simply asked to decide whether a presented word was the name of a city as quickly as they could. We reasoned that the speed with which participants correctly categorized cities that they recognized (when intermixed in a series together with non-word foils) would provide an operational measure of the differential ease of retrieval of the recognized cities. These reaction time data can then be correlated with participants' choices in the critical pairs. (The notion that people might be sensitive to differences in the time taken to recognize cities and that reaction time data might be a good index of this sensitivity has recently been explored in detail by Schooler and Hertwig (2005)).

According to the recognition heuristic, there should be no correlation between the relative speed of categorization of a recognized city and decisions in critical pairs involving that city. Decisions on critical pairs should rely exclusively on recognition; any variations that exist should be randomly distributed, due perhaps to fatigue or inattention, and not systematically correlated with the differential speed of categorisation of the city names.

Method

Participants

Twenty first year psychology students from the University of New South Wales participated in exchange for course credit. There were 4 males and 16 females, ranging in age from 18 to 23, with a mean age of 19.6 years.

Stimuli

Choice of stimuli was determined by the speeded categorization task involving cities and non-words. By calculating participants' latencies when categorizing each recognized city as a ‘‘city'' item, the speed with which that city came to mind, was operationalized. The cities for this task were again chosen from among the 30 largest cities in Germany. However, the basis for selection of cities was no longer related to soccer teams, but rather the physical similarity of the city names to each other. That is, only cities whose names were 2 syllables long, and 6–8 letters long, were used. This resulted in four cities with 6 letter names (Berlin, Munich, Bochum, Bremen), five with seven letters (Hamburg, Cologne, Leipzig, Dresden, Manheim) and three with eight letters (Chemnitz, Augsburg, Dortmund). In this way, it was ensured that differential response latencies in the speeded task were due to differential access of the city names to memory, rather than superficial physical characteristics of the city names.

The first speeded task served the primary purpose of providing practice for the second task, so as to reduce variability in the second speeded task. This first task—a lexical decision task—also served to provide a baseline reaction time for each participant, according to which the reaction times in the second speeded task could be adjusted (see Results and Discussion section below for details). It also served to confirm that the difference in word length (6, 7 or 8 letters long) had no effect on reaction time. As such, all 12 words were also 2 syllables in length, and 6–8 letters in length, with the same proportion of 6-, 7- and 8- letter words. Words were also matched on frequency of occurrence in everyday texts, according to Hofland and Johansson's (1982) norms. In this way, a comparison between the 6, 7 and 8 letter words, could determine if even these minor word length variations had a significant impact on reaction times in the speeded city task.[4]

In addition to the 12 words and 12 cities, 12 non-word items were created for each list. Each non-word was derived from one of the word or city items, by replacing each consonant with an adjacent consonant, and

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[4]In the lexical decision task, average response latencies were 604 ms for six-letter words, 606 ms for seven letter words, and 609 ms for eight letter words. An ANOVA revealed no significant differences ($F\,(2, 225) = 0.03$, $p > 0.9$). As such, variability in response latencies to recognized cities in the second speeded task can be confidently assumed to reflect differential availability to memory of the different recognized cities, rather than superficial physical characteristics of the city names.

each vowel with an adjacent vowel (except where doing so resulted in an unpronounceable/illegal letter string, e.g. the non-word pair for Berlin was Cismop).

Procedure

The experiment consisted of two reaction time tasks, the city-pairs decision task and the recognition checklist. The checklist was administered either before or after completing the pairs task. Participants were seated at a computer, and completed the two reaction time tasks—first the word/non-word task and then the city/not a city task. They were told that they were to categorize the words (cities) as quickly and accurately as possible. There were 24 items (12 words (cities) and 12 non-words (non-cities)), each presented twice, resulting in a total of 48 items in each of the tasks. Order of presentation was randomized.

Finally, participants completed the cities task in which they were presented with the 66 pairs of cities (i.e. a complete paired-comparison of the 12 cities listed in the stimuli section) and asked to choose the larger one in each pair.

Results and discussion

There was no effect of the order of recognition checklist presentation on either the number of cities recognized, or response patterns on any pair type.

For the reaction time tasks, ''errors'' (defined as responding ''non-word'' to words, or ''non-city'' to cities which participants claimed to recognize on the recognition checklist) were not included in the reaction time analysis. The average reaction time that each participant took to correctly categorize each recognized city was calculated by averaging the response latencies for the two presentations of each city. Subsequently, to adjust for individual variability in ''baseline'' reaction times, the average reaction time for the lexical decision task was calculated, and this value was subtracted from the response latencies in the speeded city categorization task for each participant. The resulting values are referred to as ''adjusted reaction times''. Thus each participant had an adjusted reaction time for each correctly classified city. These values were assumed to provide an accurate measure of the relative accessibility of each recognized city for each participant.

Next we examined all of the correctly classified cities and recorded the percentage of occasions on which each recognized city (as indicated by the response on the checklist) was chosen as larger when paired with an unrecognized city (in the ''critical pairs'') in the cities task. This analysis resulted in each participant contributing a number of pairs of data points with each pair comprising (1) an adjusted reaction time for a particular city and (2) the percentage of times that city was chosen in the critical items. (The exact number of data-point pairs per participant was a function of the number of cities correctly classified and recognized). All the available pairs of data points were then used in a single correlation analysis reported in the next paragraph.

In the critical pairs participants chose the recognized city on 91.7% of occasions ($SD = 11.76$). This is consistent with the 90% reported by Goldstein and Gigerenzer (2002, Experiment 1). Crucially, there was a significant negative correlation ($r = -0.426$, $p < 0.001$) between adjusted reaction times in correctly categorizing a city and proportions of critical pairs in which that city was chosen as larger. When we partialled out the effect of participants and conducted the correlation again, the negative correlation remained significant ($r = -0.382$, $p < 0.001$). This correlation indicates that, within the set of recognized cities, the faster a city name was correctly categorized the more likely participants were to choose that city as larger when it was paired with an unrecognized city.

The results clearly show that there is a relation between the speed with which participants' correctly categorize names of cities and their use of recognition in making judgements about the sizes of paired cities. This negative relation is not predicted by the ''categorical'' or binary use of recognition. The relation is, in fact, more consistent with the idea that participants are relying on sensitivity to the differential ease with which city names can be retrieved from memory.

GENERAL DISCUSSION

In two experiments we tested the empirical validity of the recognition heuristic and explored its links with the related notions of availability and processing fluency. Guided by the aspects of the heuristic that proponents see as distinguishing it from these related concepts we examined evidence for the ''inconsequentiality of further knowledge'' and the ''binary'' nature of recognition (Goldstein & Gigerenzer, 1999, p.56). Experiment 1 provided clear evidence that further knowledge was not inconsequential, but rather that it was used in a compensatory manner. Experiment 2 provided clear evidence for the graded rather than binary use of recognition information. Taken together the results appear to question the psychological reality of a distinct recognition heuristic.

Boundary conditions

Some theorists might prefer to interpret the current results as establishing further boundary conditions for the operation of the recognition heuristic. A central aim of the on-going programme of research on fast-and-frugal heuristics is to understand more about why heuristics are successful, and when and how they are used (e.g. Hogarth & Karelaia, 2005; Katsikopoulus & Martignon, in press; Rieskamp & Otto, in press). Thus one could argue that the current results contribute to this aim by suggesting that recognition will not be relied on (exclusively) when other information in the environment is perceived to be relevant and useful to drawing an inference. We also know that recognition is not used when people have independent knowledge of the criterion—such as realizing that Chernobyl is recognized because of a famous nuclear accident and not because it is large (Oppenheimer, 2003).

The problem with such a ''boundary conditions'' argument is that it presupposes that there is good evidence for the claim that recognition information is used in the manner described by the search and stopping rules of the recognition heuristic. As we stressed in the introduction, without evidence for the non-compensatory stopping rule one is reduced to saying that people use information that is available in the environment—if the *only* information available is recognition then they will use it—this is not a particularly interesting claim. We contend that the current results along with a number of other recent investigations in both experimental and real-world environments (Ayton & Onkal, 2004; Bröder & Eichler, 2006; Newell & Shanks, 2004; Richter & Späth, 2006) fail to find any support for the claim that recognition is used in a non-compensatory manner.

Recognition, Availability and Processing Fluency

The claim that ''availability'' or ''processing fluency'' might provide a better account of performance than the operation of a recognition heuristic, could be interpreted as vacuous, given the vague and ill-specified nature of these notions. Nevertheless, we believe the onus is on proponents of the recognition heuristic to clearly explicate how the heuristic differs from these notions and to provide empirical evidence that can be interpreted as indicating exclusive reliance on the search and stopping rules of the recognition heuristic. The standard finding of 90% recognition-based responding in an environment in which no other information is present does not favour either the recognition heuristic or availability or fluency, since recognized items will always be more available and fluent—that is, come to mind quicker—than unrecognized items which, by definition, do not come to mind at all (Newell & Shanks, 2004; Oppenheimer, 2003, 2004).

Progress on this issue has been made in an excellent recent discussion by Schooler and Hertwig (2005). The authors propose a process model of fluency—the ''fluency heuristic''—that they suggest could be used to provide a precise definition of availability thus overcoming the criticism that availability has only been vaguely ''sketched'' (e.g. Gigerenzer, 1996). They are also conscious of the fact that the recognition and fluency heuristics could be thought of as the same thing, but argue that because the heuristics process information in different ways they should be considered as separate. Specifically, they claim that the recognition heuristic can proceed immediately to a decision once one of its conditions is matched (e.g. recognizing only one object of a pair). In contrast the fluency heuristic requires an additional step whereby the retrieval times of the two objects are compared. Though this distinction is clear in the processing steps of the models and indeed leads to different patterns of performance for the two heuristics in the simulations reported by Schooler and Hertwig (2005), it does not appear to be as clear cut in our data. In experiment 2 the retrieval time for the recognized city impacted on the likelihood of relying on recognition even in those situations in which only one city in a pair was recognized. It seems then that the additional step of comparing, or at least being influenced by retrieval time, also occurs in situations in which the recognition heuristic is claimed to be used.

How frugal is recognition?

In the discussions of the prototypical nature of the recognition heuristic there is an emphasis on recognition being the most frugal of all cognitions, constituting a categorical distinction between items in and out of memory, whereas availability, and fluency require further cognitive processing in order to distinguish between items in memory (Goldstein & Gigerenzer, 2002; Schooler & Hertwig, 2005).

Is there any evidence that recognition is more cognitively frugal than processing fluency? Such a suggestion, in fact, appears to contradict conclusions drawn by investigations into the effects of processing fluency upon memory. The most important finding for present purposes, relates to the relationship between recognition, familiarity and processing fluency. Jacoby and colleagues, along with others (e.g. Whittlesea & Leboe, 2003), have shown that recognition judgements are constituted by attributions of processing fluency of items to past experience with those items. These recognition judgements are argued to involve a "separate act" of "conscious deliberation" as to the probable source of fluency (Jacoby & Whitehouse, 1989). Relating this to the cities task, participants, upon reading the recognition checklist, were often observed to hesitate before circling some cities as recognized, making comments such as "I think I've heard of this one". The processing fluency account suggests that such responses reflect a subjective feeling of fluency for these city names, but difficulty in attributing this fluency to actually having encountered the name before. Regardless of this conscious attribution to the past—that is, regardless of the binary distinction between "recognized" and "unrecognized" objects—responses on the cities task appear to be informed by differential fluency of processing, or availability, of the city names. Insofar as recognition judgements are based upon an additional, categorical attribution of this processing fluency to the past, recognition is arguably less fast and frugal than processing fluency.

Conclusions

Insofar as the recognition heuristic is the prototypical "fast-and-frugal heuristic", the present analysis provides an important challenge to proponents of that theoretical framework. We failed to find empirical evidence for the two features—inconsequentiality of knowledge and the binary treatment of recognition—that are claimed to distinguish the recognition heuristic from existing notions such as fluency and availability. A generous interpretation of the results is that we have identified further boundary conditions on the use of the recognition heuristic; a more provocative one is that we have challenged its psychological reality.

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REFERENCES

Andersson, P., Edman, J., & Ekman, M. (2005). Predicting the World Cup 2002 in soccer: Performance and confidence of experts and non-experts. *International Journal of Forecasting, 21*, 565–576.

Ayton, P., & Önkal, D. (2004). *Effects of ignorance and information on judgmental forecasting*. Unpublished Manuscript, City University: London.

Borges, B., Goldstein, D. G., Ortmann, A., & Gigerenzer, G. (1999). Can ignorance beat the stock market? In G. Gigerenzer, P. M. Todd, & The ABC Research Group (Eds.), *Simple heuristics that make us smart* (pp. 3–34). Oxford: Oxford University Press.

Bröder, A. (2000). Assessing the empirical validity of the ‘‘Take-the-best’’ heuristic as a model of human probabilistic inference. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 26*, 1332–1346.

Bröder, A. (2003). Decision making with the adaptive toolbox: Influence of environmental structure, personality intelligence, and working memory load. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 29*, 611–625.

Bröder, A., & Eichler, A. (2006). The use of recognition information and additional cues in inferences from memory. *Acta Psychologica, 121*, 275–284.

Bröder, A., & Schiffer, S. (2003). ‘‘Take-the-Best’’ versus simultaneous feature matching: Probabilistic inferences from memory and the effects of representation format. *Journal of Experimental Psychology: General, 132*, 277–293.

Engel, C. (2000). Psychological research into heuristics meets the law. *Behavioral & Brain Sciences, 23*, 747.

Gigerenzer, G. (1996). On narrow norms and vague heuristics: A reply to Kahneman and Tversky (1996). *Psychological review, 103*, 592–596.

Gigerenzer, G., & Goldstein, D. G. (1996). Reasoning the fast and frugal way: Models of bounded rationality. *Psychological Review, 103*, 650–669.

Gigerenzer, G., Todd, P. M., & The ABC Research Group (1999). *Simple heuristics that make us smart*. New York: Oxford University Press.

Gilovich, T., Griffin, D., & Kahneman, D. (2002). *Heuristics and Biases: The psychology of intuitive judgment*. Cambridge: Cambridge University Press.

Goldstein, D. G., & Gigerenzer, G. (2002). Models of ecological rationality: The recognition heuristic. *Psychological Review, 109*, 75–90.

Goldstein, D. G., & Gigerenzer, G. (1999). How ignorance makes us smart. In G. Gigerenzer, P. M. Todd, & The ABC Research Group (Eds.), *Simple Heuristics that Make us Smart* (pp. 37–58). Oxford: Oxford University Press.

Hofland, K., & Johansson, S. (1982). *Word frequencies in British and American English*. Bergen: Norwegian Computing Centre for the Humanities.

Hogarth, R., & Karelaia, N. (2005). Ignoring information in binary choice with continuous variables: When is less ‘‘more’’? *Journal of Mathematical Psychology, 49*, 115–124.

Jacoby, L. L., Kelley, C., Brown, J., & Jasechko, J. (1989). Becoming famous overnight: Limits on the ability to avoid unconscious inferences of the past. *Journal of Personality and Social Psychology, 56*, 326–338.

Jacoby, L. L., & Whitehouse, K. (1989). An illusion of memory: False recognition influenced by unconscious perception. *Journal of Experimental Psychology: General, 118*, 126–135.

Katsikopoulus, K., & Martignon, L. (in press). Naïve heuristics for paired comparisons: Some results on their relative accuracy. *Journal of Mathematical Psychology.*

Newell, B. R. (2005). Re-visions of rationality? *Trends in cognitive sciences, 9*, 11–15.

Newell, B. R., & Shanks, D. R. (2004). On the role of recognition in decision making. *Journal of experimental psychology, Learning, Memory and Cognition, 30*, 923–935.

Newell, B. R., & Shanks, D. R. (2003). Take-the-best or look at the rest? Factors influencing ‘one-reason’ decision making. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*, 53–65.

Newell, B. R., Weston, N. J., & Shanks, D. R. (2003). Empirical tests of a fast and frugal heuristic: Not everyone ‘‘takes-the-best’’. *Organizational Behavior and Human Decision Processes, 91*, 82–96.

Newell, B. R., Rakow, T., Weston, N. J., & Shanks, D. R. (2004). Search strategies in decision-making: The success of success. *Journal of Behavioral Decision Making, 17*, 117–137.

Oppenheimer, D. M. (2003). Not so fast! (And not so frugal): Rethinking the recognition heuristic. *Cognition, 90*, B1–B9.

Oppenheimer, D. M. (2004). Spontaneous discounting of availability in frequency judgment tasks. *Psychological Science, 15*(2), 100–105.
Rakow, T., Newell, B. R., Fayers, K., & Hersby, M. (2005). Evaluating three criteria for establishing cue-search hierarchies in inferential judgment. *Journal of Experimental Psychology: Learning, Memory & Cognition, 31*, 1088–1104.
Reimer, T., & Katsikopoulos, K. (2004). The use of recognition in group decision making. *Cognitive Science, 28*, 1009–1029.
Richter, T., & Späth, P. (2006). Recognition is used as one cue among others in judgment and decision making. *Journal of Experimental Psychology: Learning, Memory & Cognition, 32*, 150–162.
Rieskamp, J., & Otto, P. (in press). SSL: A theory of how people learn to select strategies. *Journal of Experimental Psychology: General*.
Schooler, L. J., & Hertwig, R. (2005). How forgetting aids heuristic inference. *Psychological Review, 112*, 610–628.
Shapiro, S. (1999). When an ad's influence is beyond our conscious control: Perceptual and conceptual fluency effects caused by incidental ad exposure. *The Journal of Consumer Research, 26*, 16–36.
Sternberg, R. J. (2000). Damn it, I still don't know what to do! *Behavioral & Brain Sciences, 23*, 764–765.
Todd, P. M., & Gigerenzer, G. (2000). Précis of simple heuristics that make us smart. *Behavioral & Brain Sciences, 23*, 727–780.
Tversky A., & Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology 5*(2), 207–232.
Wimsatt, W. C. (2000). Heuristics refound. *Behavioral & Brain Sciences, 23*, 766–767.
Whittlesea, B. W. A., & Leboe, J. P. (2003). Two fluency heuristics (and how to tell them apart). *Journal of Memory & Language, 49*, 62–79.

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