Cognitive Biases: Between Nature and Culture

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Bio-sketch: Gérald Bronner is Full Professor of Sociology at Paris-Diderot University and a member of the Académie des technologies. He works on collective belief, rationality, cognitive biases, and the relationship between cognitive science and interpretative sociology. Professor Bronner is the author of several books and has won the Premio Amalfi prize and the Prix de la Revue des Deux Mondes. He has published two books in English *Belief and Misbelief: Asymmetry on the Internet* (Wiley, 2013) and *The Future of Collective Beliefs* (Bardwell Press, 2011).

Abstract: This paper explains the results of a quantitative survey on the links between the level of education and resistance to cognitive errors. Does a university education protect us from inferential divergence? Does it enable us to have a better level of awareness of the lines of reasoning we use implicitly? Does the type of studies play a role? These are important questions because they allow us to question the generally naturalist acceptance of the notion of cognitive bias as posited by orthodox error psychology. The results from this survey of 1559 people are ambiguous and should be interpreted with caution but they still tend to weaken the ambitions of overly strong naturalism or culturalism.

Keywords: methodological individualism, cognitive biases, education, natutalism, culturalism

I. INTRODUCTION

Methodological individualism is based on the assumption that there is a universal rationality that usually finds expression in terms of ordinary psychology. This universal rationality is considered to be characterized by two dimensions. The first is that of instrumental rationality, which according to the classical view originally proposed by Aristotle, assumes that an individual is rational if he or she uses the most efficient means to achieve a specific goal. The second is that of cognitive rationality that, according to Boudon (1999, pp. 148-149), requires the consistency between the propositions of a theory or the consistency between the reasons that are the presuppositions of a belief as well their validity and their consistency with the reality. These two dimensions of rationality are considered to be cognitive invariants of human mind and are supposed to allow us to understand, in Weber sense, relevant social practices that belong to cultures very different from ours. *In my opinion, if sociology is regarded as the approach that focuses on how social variables and cognitive invariants are related, cognitive invariants cannot be reduced to the self-interest principle or the logical consistency principle that outline what methodological individidualism means by rationality. Cognitive invariants must also be considered to be connected to common heuristics.* This article attempts to clarify the relationship between methodological individualism and the crucial issue of cognitive biases.

II. SOME MATERIAL FOR A DEFINITION OF COGNITIVE BIAS

In the 1970s, two Israeli psychologists, Amos Tversky and Daniel Kahneman, ran a set of experiments at the University of Jerusalem which went down in research history. These highly ingenious experiments were amusing and easy to carry out—the experimenters mostly just presented appar-

ently harmless and straightforward problem statements that looked a lot like the *Monty Hall* problem or the sort of problems we used to have fun solving in the school playground.[1] But this did not prevent these experiments from being very useful for an ambitious scientific project because their inventors aimed to shed light on how human thought processes work and thus answer the fundamental question "Is Man rational?" By answering this question, the two psychologists aimed to formulate an essentially *normative* conception of rationality for this type of conception was an orthodox way of thinking[2] in the psychology of decision making at the time. It was based on the hypothesis that individual reasoning can be effectively modelled using the rules of the maximisation of desired utility. For example, according to Kelley (1967) or Peterson and Beach (1967) human reasoning can be described using the norm from theories on statistics and probabilities. Edwards (1968) considers that natural logical more or less follows the recommendations set out in Bayes' theorem. And yet Tversky and Kahneman work undoubtedly shows up the limits of that kind of approach.[3]

Tversky and Kahneman are certainly not the first to have worked on this kind of problem4 but they indisputably played an essential role in the development of cognitive psychology. Their work inspired hundreds of other similar works which all aimed to map a cartography of cognitive errors and intuition which are responsible for leading us into that kind of error. During the decades between the modern day and the era in which these psychologists' experiments were carried out, all these researchers contributed to writing one of the most important pages in the history of 20th century humanities.

As many commentators have pointed out,5 the thesis that most of these researchers constantly posit (Kahneman, Slovic, and Tversky 1984; Nisbett and Ross 1980; Bar-Hillel 1980; Stich 1985; Joule and Beauvois 2002; Hogarth 1980; Oaksford and Chater 1993) is that human thought is not *rational*. This idea is on the back cover of a book which will remain one of the major publications from this school of thinking—"*Judgment under uncertainty: heuristics and biases*":

> The blemished portrait of human capabilities that emerges from this work thus stands in sharp contrast to the highly favourable image of 'rational man'". This is also clear in the striking and oft-used image of *a needle in a haystack* referring to lost rationality in human cognition (Fiske and Taylor 1984; Baron and Byrne, 1987).

There are numerous terms used to refer to this type of error in reasoning in literature on this subject—cognitive bias, mental tunnel, cognitive illusion, mental short-circuit, cognitive error etc. Leaving aside the latter term, which I prefer for this reason, these terms refer to an aspect of these psychologists' theory—they often consider a cognitive omission to be a reflex activity which is a point I will return to later. When they propose a definition, they characterise it as "the consequence of people limited ability to take account of and process all the information which is potentially available" (Ajzen and Kruglanski 1983) which is in fact more of a symptom than an actual definition as such. By default *cognitive biases* in their most typical form are still defined by making a distinction between them and emotional or motivational biases (Nisbet and Ross 1980).

Emotional biases derive from affective involvement which influences our reasoning and may lead to the wrong conclusions being drawn. As for motivational biases, the vested interests of an individual influence his or her beliefs and reasoning. McGuire (1960) showed, for example, that individuals tend to consider a desirable event more likely to happen.

Cognitive errors were defined in a more positive vein by Garder (1997, p. 2) as "the gap between the way we make assumptions about information and the way we should do so to make sure those assumptions are valid". In general, works on cognitive error assume there are reliable pre-established inferential validity criteria6 with which to compare subjects' judgements. When these judgements do not comply with these criteria then we call this cognitive *error*.

III. A NATURALIST POSITION

Certain problems invented by these error psychologists show how certain false and yet attractive solutions can have an effect on the way people think. I shall give examples of these below.

There are types of problems which provoke quasi-mechanical, predictable and residual replies and obviously this is a subject of some fascination for any thinkers interested in cognition phenomena, in itself an enigmatic situation. Researchers like Tversky and Kahneman and many of those who followed in their footsteps have provided *naturalist* explanations for this puzzling question. Naturalism qualifies the thesis by which mental contents are the consequence of biological and therefore natural activity. This biological activity is, of course, that of the brain and more specifically is now thought to be that of the neurons. In their view, cognitive error is therefore seen as the sign that *natural mecha-*

nisms control our thoughts. For this reason, they therefore consider reasoning errors as "reflex activities".

I consider that the majority of works on cognitive error psychology can be put in the naturalist field which generally views errors of reasoning as the mechanical consequence of the existence of bias which appears to be essentially biological in origin. The advantage of this position is that it provides an immediate reply to the problem of the character (if not collective then at least shared) of cognitive omission. Errors of this kind are common—as these authors are keen to explain—because the way our brain is organised means we possess "structures" which lead us to move away from the norm of what is true. This is also why the more robust minds can also make these kinds of errors and the biological grounding of errors further explains why we are sometimes reluctant to accept the truth.

These psychologists therefore consider that these errors are part of the biological and universal baggage of humankind. This is all the more true when considering the founding principles of *evolutionist psychology*. Cosmides and Tooby (1992), are important representatives of this school of thought which claims that psychology is a branch of biology and should therefore study how the way in which the brain processes information produces human behaviour. On this point Pinker (2000, p. 29) says: "The mind is what the brain does; specifically, the brain processes information, and thinking is a kind of computation. The mind is organized into modules or mental organs, each with a specialized design that makes it an expert in one arena of interaction with the world. The modules' basic logic is specified by our genetic program".

Thus evolutionist psychology defends the theory of assertive *innatism* considering that the way our minds work is part of our genetic heritage even when making errors of systematic reasoning. This school of thought believes that the reasoning processes which characterise human thought are the consequence of natural selection and concludes that the human mind "mental reflexes" cannot be fundamentally counter-productive or at least have not always been so. Why? Because natural selection has been doing its work for millions of years according to Darwinian logic but has still not managed to produce "elegant machines" capable of solving the persistent problems thrown up by their ecological and social environment. In other words, although cognitive biases have lost their functionality and seem to be errors of reasoning for modern man, they were still of use to our prehistoric ancestors. In fact these authors even consider the opposite to be the case—that our long-lost predecessors needed to take quick decisions and make sense of their environment and could therefore not afford the luxury of lines of reasoning which may be objectively valid but take up a lot of time and mental energy. Anyone who was not biologically equipped with the aptitude to give up on the whole idea of formal logic was simply wiped out by natural selection. In this way, cognitive biases became the biological norm for humankind because they were a selective advantage in the past. Today, although this selective advantage may well be seen as a flaw of the mind, it nonetheless remains universal. As long as these residual effects of the past do not act as obstacles to reproduction and saving the species, there is no reason for them to disappear. Nature mechanisms preserve many things in us which are not always useful. A well known example would be our appendix but there is also our appetite for sugar. During the Pleistocene, our ancestors no doubt benefited from their taste for eating sugary things by stocking rapidly available biological energy. This is less useful in our modern-day society where sugar can be mass-produced and in fact is harmful for our health. The same kind of mechanism leads to the continuing survival of ways of thinking which lead us into error in our reasoning.

Evolutionist psychology proposal is fascinating because it provides an answer to the enigma at hand by taking into account the predictable, residual and universal nature of cognitive error. As this is seen as part of our genetic heritage from our prehistoric ancestors, it is easier to understand that it occurs on such a predictable basis and also that we can get rid of it. Equally it is thus easy to understand that our intuition—often our most deeply-felt conviction—can be in strong opposition to the conclusions of mathematical calculations or formal logic.

IV. THE ORIGINS OF COGNITIVE BIASES

Once the ideas of orthodox cognitive error psychology have been taken into account, we may then move on to an important question because taking note of the results obtained by these programmes and accepting the interpretations thereof are two different operations. Can these errors be either positively or negatively correlated with an individual social characteristics?

This question echoes some of the criticisms the philosopher Jonathan Cohen (1981) from Oxford University made concerning research into cognitive error psychology and more specifically the conclusions drawn on human rationality.

Cohen explains that the cognitive psychologists who ran these experiments could not seriously expect ordinary individuals to brilliantly solve problems which could really only be solved by people with skills in statistical and probability theory. The cognitive errors made by the layman are more to do with educational rather than cognitive deficiencies.

At first sight, this argument may seem inadmissible. In an article called "Belief in the law of small numbers" which predated Cohen text having been published in 1971, Tversky and Kahneman showed in some detail that statistics specialists could make the same cognitive omissions as a layman (see Mittrof 1974 or Eddy 1984). They related an experiment they carried out at a conference for the mathematic psychology group of the American psychology association. They asked 84 conference attendees to answer the following question: "Suppose you have run an experiment on 20 subjects and have obtained a significant result which confirms your theory. You now have cause to test an additional group of 10 subjects. What do you think the probability is that the results will be significant in a test separately for this group?"

Only 9 respondents gave replies between 0.4 and 0.6 (around 0.48). Most of those asked gave estimations closer to 0.85. The first reply is of course much more reasonable which suggests that knowing about formal logic and probability theory does not stop people being influenced by erroneous intuition.

Both laymen and researchers can therefore display problems with cognition which are not just linked to their education.[7] However I still consider that this does not reply conclusively to Cohen question. Tversky, Kahneman, Mittrof and Eddy, to cite just a few of the researchers who have looked into this question, may have shown that a certain level of education does not definitely prevent people from making cognitive errors but we still do not know whether our education level increases our resistance to insidious errors in reasoning.

Basically the only sure conclusion that we can draw from the above remarks is that we are *all* subject to errors and not that we are all *equally* likely to make errors.

In general, none of the experiments on cognitive biases have ever given 100% erroneous replies. Is it possible to identify those who give into the temptation of misleading evidence on a sociological basis? And more particularly, to go back to a part of the debate initiated by Cohen, does the level of studies have any influence on the likelihood of us making cognitive errors?

V. THE SURVEY

I thought it would be useful to run a survey on this question to contribute to the debate. My research can also probably be criticised but it seems to avoid two of the most important pitfalls pointed out by critics of the cognitive psychologists' experiments namely problems with representativity and the significance of the results obtained. Indeed this research was generally carried out on groups of under 150 people who were also mostly students. The weakness of the population sample which was also too homogenous prevents there being an effective reply to the question we are asking on the sole basis of previous surveys. For this reason, I considered it would be interesting to carry out quantitative and qualitative research which would both revisit certain classic problems of error psychology and add a few new elements.

The idea was to give a questionnaire in person to 1559 subjects with varied questions on the level of studies, type and subject of studies, age, gender etc and six problems likely to induce cognitive errors.

These problems were read slowly by the researchers and simultaneously by the respondents (each of whom had a copy of the questions). They were only instructed to think about a problem when they said they had understood the terms of that problem. The problem statements were rewritten several times when the questionnaire was being put together to make sure they were as simple to understand as possible. A hundred respondents passed "mock" questionnaires to help us improve the questionnaire. The survey started in December 2002 and finished in May 2003.8 Once the respondents had understood the problems they were given 30 seconds to solve them (except for problems based on intuitive calculations for which they had 10 and 5 seconds).

I decided not to use a quota-based method as this is not the best tool for replying to the question asked. I could have chosen the population sample to reflect the level of education percentages found in the French population as a whole but each sub-group would have statistically weakened the correlation measurement. The aim was not to attempt to take a kind of photograph of cognitive errors among the French population but rather to provide answers about the link between the level of studies and cognitive error. For this reason I opted to use stratified sampling. *The sample was stratified according to the level of education. Half the respondents did not have the French high school diploma, i.e. the "baccalaureat"* (775 people)*, and the other half had "baccalaureat" plus a diploma from three years of further education* (784 people).

This meant that we intentionally excluded the third and fourth education levels from the INSEE categories so that we could compare two relatively homogenous groups quantitatively (just under eight hundred people in the two groups) but which were very different qualitatively given their statistical character (the first did not have the French "baccalaureat" while the second had done at least three years in further education after obtaining their " baccalaureat").

Finally, although this questionnaire was designed to provide answers to the question of whether there may be a correlation between the level of studies and cognitive error, I also looked for other types of correlations even though their statistical significance may be presumed to be fairly weak. For example, the type of studies (literary, scientific etc.), the time since finishing studies, gender etc. all seemed interesting exploratory questions to ask and then measure in a crossed sort with the error rates.

I could not study all the biases which cognitive psychologists have highlighted so I made sure I paid particular attention to three types of errors in my questionnaire namely those linked to the *representativeness heuristic,* the *availability heuristic* and the *anchoring heuristic*.[9]

Here are the six problems we gave the 1559 people who agreed to answer the questionnaire, the results of which are presented herein. The first three are directly inspired by the work of Tversky and Khaneman.

The first problem (hereafter referred to as problem A) (Tversky and Kahneman 1972) brings the representativeness heuristic into play. The problem statement was as follows:

> A town has two maternity wards. The first is bigger with an average of 45 births a day while the other has an average of 15 births a day. Each day when 60% or more boys are born in the wards, they note this event with a cross in a notebook. At the end of a year, which maternity ward would have the most crosses in its notebook?
>
> The small maternity ward? The bigger maternity ward? Or would they be equal? *Respondents had 30 seconds to answer.*

The answer to this problem was the first reply, the small maternity ward. I will go into this in further detail below.

> The second problem (problem B) was designed by Tversky and Kahneman (1973) who considered that it involves the anchoring heuristic.[10] The problem involves a simple calculation which is interrupted. The respondents are asked to estimate the final result of the multiplication 1 x 2 x 3 x 4 x 5 x 6 x 7 x 8 and to respect the left-to-right order. After five seconds, the "examiner" says "I am going to interrupt you here. I know you probably haven't finished your calculation but I would like you to guess the final result now."

In these circumstances, it is hard for anyone to finish the calculation and get the right result—40,320.

The third problem (problem C) is also a classic frequency estimation question (Tversky and Kahneman, 1973)[11] and is underpinned by the availability heuristic.[12]

It was presented as follows:

> In your opinion: Are there more words in the French language which begin the with the letter "A" or are there more words in the French language whose second letter is the letter "A"? *Respondents had 30 seconds to answer.*

I should point out at this point that despite the psychologists' opinion to the contrary, this problem actually led to few respondents giving the wrong answer and many guessed that the French language has more words whose second letter is A than words which begin with A. I imagine that the results are more interesting for the English language.

I also added three other problems to these famous problems from psychology literature. I created two of the three problems myself.

The next three problems involve symmetrical questions of intuition of complex calculation which cannot be done mentally. The idea is to estimate average variation rates which requires the use of an nth root.

Problem D was presented as follows:

> Let us suppose that an object costs 5000 euros and that there is a constant inflation rate (price rises) of 10% over 20 ans. How much would this object cost at the end of this period (after 20 years)? *Respondents were given 10 seconds to reply.*
>
> Answer: 33,248 euros.[13]

While problem E—symmetrical to problem D—went as follows:

> After having read the following problem, try and reply intuitively. If you invested 1500 euros on a savings account for thirty years with a constant instant rate over the whole period and if at the end of this period the sum of 1500 euros had ended up as 15,000 euros, what would you estimate (as a percentage) the annual interest rate you got to be? *Respondents were given 10 seconds to reply.*
>
> Answer: ≈ 8%[14]

The last problem (problem F) was the so-called double-faced problem which is expressed as follows:[15]

> Let us suppose you are invited to play the following game: here are two cards, one is red on both sides, the other is red on one side and white on the other. I draw one of these cards at random and place it on a table. The side showing is red. In your opinion,
>
> It is more likely to be the red-white card
> It is more likely to be the red-red card
> Or are both possibilities equally likely?
> Respondents had 30 seconds to answer.

In the stated conditions, the red-red card is more likely (66% chance) to be the card drawn at random.

We considered answers which were reasonably close to the right answer to be correct particularly for the calculation estimation problems. For example for problem B, all answers between 35,000 and 45,000 were considered correct.[16]

Error rates for these problems ranged from 22% to 95%,[17] which was a good range of situations for the purposes of our interpretation.

Three categories of information were gathered for each of the problems. Firstly we recorded the respondents' answers. Secondly we asked them about their capacity to explain the reasoning that led them to answer the way they did (I called this *verbalisation*) and finally for the two logic problems (A and F; the question did not apply to the other problems) we asked the respondents if they agreed with the answer given by the examiner.

VI. RESULTS

a) Agreement with the correct answer given

I shall begin with this point because it is relatively easy to interpret. The two problems involved are the maternity ward (which I will give more details about below) and double-faced cards problems. The answer to the first seemed a bit harder to accept than the second because a quarter of respondents who were wrong did not see why that was the case when given the answer while under 17% said this about the answer to the cards problem.

We noted that this level of acceptance of the right answers to the problems was not significantly statistically linked18 (chi2 = 1.42, ddl = 2, 1-p = 50.75%) to age (chi2 = 6.11, ddl = 4, 1-p = 80.89%), level of studies (chi2 = 4.48, ddl = 4, 1-p = 65.46%), type of studies (chi2 = 5.56, ddl = 10, 1-p = 14.93%), whether respondents came from urban or rural areas (chi2 = 6.11, ddl = 4, 1-p = 80.89%) or whether they had stopped their studies a long time (chi2 = 4.61, ddl = 6, 1-p = 40.52%) etc.

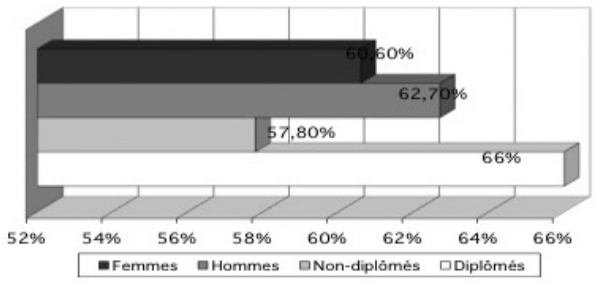
b) Verbalisation

Things were very different for verbalisation. For each problem, respondents were asked to explain why they had replied in the way they had. Certain respondents were interviewed, which made up the qualitative part of this research, but in the immense majority of cases, the examiner just noted whether or not verbalisation had occurred. This was considered to be the case when subjects did not claim to have replied through pure intuition, chance or if they remained silent or claimed not to know.

The simple arithmetic average of verbalisation for all of the problems was 62%. This result is interesting because it suggests that even when implicit rationality led to error it may have produced a reply which respondents may have initially claimed to be based on intuition but turned out to be due to reasoning when they thought about the process which led them to answer in that manner. This idea is given further credence by the fact that certain problems were found to be more easily explainable than others. This was particularly the case with the logic-based problems for which there was a verbalisation rate of nearly 69% while the calculation-based problems' verbalisation rate was close to 56%. This is hardly surprising given that the former problems are founded more on implicit reasoning than the latter.

The most interesting point of note is that this verbalisation reveals significant statistical links particularly the correlation with the level of studies (chi2 = 9.57, ddl = 2, 1-p = 99.16%). Statistically respondents with educational qualifications were more able to give verbal explanations of their reasoning than the respondents who I shall refer to (even if the name is not entirely exact) as without educational qualifications. Is this because of better levels of linguistic expression or a more refined awareness of the inferential processes involved? This study did not provide an answer to this question. However it did reveal that the simple arithmetic average of the verbalisation of those without educational qualifications was 57.8% while for those WITH qualifications the average was 66%. The largest differences were recorded for the logic problems, particularly the problem with the cards and the one on frequency estimation concerning the French language (problem C). The smallest differences were recorded for problems based on intuitive calculation (problems B, D and E) but generally, for all the problems the verbalisation rate was higher for those with educational qualifications than for those without.

Conversely no significant statistical link was found between the level of verbalisation and the type of studies of our respondents (chi2 = 4.52, ddl = 5, 1-p = 52.31%). Those with a qualification in pure science did not verbalise more or less than those who had studied more literary subjects or the social sciences for example. Similarly verbalisation was not found to be linked to the gender of respondents. Depending on the problem concerned, women or men may have verbalised a little more but the differences were negligible. The simple arithmetic average for verbalisation was 62.7% for men and 60.6% for women.



c) Errors and levels of studies

I shall now come to the key question of this section—is there an identifiable statistical link between the level of studies and the error rate? With no further suspense, I will immediately answer by revealing that this kind of correlation could be found but I should add that it only applied to certain types of errors. The link is not an immediately evident one but it nonetheless exists.

Let us begin with the problems where the difference was small or non-existent. This was the case for the two problem statements on the average variation rate (problems D and E). The first of these problems (D) involved estimating the final price of an object initially worth 5000 euros after a period of 20 years with a constant 10% inflation rate. The exact answer to this problem is nigh impossible to calculate mentally especially given that respondents only had 10 seconds to do so and that a rather complex algebraic operation is required.

The error rate for this problem was actually the highest recorded in our study because all categories together, only 3.88% of respondents managed a reply within the range close to the right answer—33,248 euros. 83% of individuals in our study sample underestimated the result, often by quite a way.

Problem E was symmetric to problem D which is why it was put at the end of the questionnaire. The error rate was also high for this problem—only 7.4% of our respondents gave answers between 7 and 9% (the right reply ≈ 8%).

For these two problems with high error rates, no significant difference was found between those with and those without educational qualifications. This is understandable insofar as these problems require an objective manner of proceeding rather than mental calculation which therefore means that respondents were on relatively equal footing because it was not a question of pure brain power.

Things were different for the other problems. The most intriguing thing for me was probably the results of the classic maternity wards problem (problem A). Here are the replies in the original survey run by the psychologists in 1972:

Large maternity ward	12	24%
Small maternity ward	10	20%
The two wards are equal	28	56%

The right answer got the least replies in Tversky and Kahneman experiment (which was confirmed in the survey): The small maternity ward has the most chance of holding the record of days with 60% and more births of boys during a whole year. This is because the larger the sample (the large maternity ward in this case), the better the chances of coming closer to the canonical average (*50% boys, 50% girls*). With a smaller sample (the small maternity ward), there is

a higher chance of the answer being different from this average.

For the rates of errors and of correct answers, there was hardly any difference between those with or without educational qualifications. 73.8% of those with educational qualifications were wrong compared to 74% of those without. However closer study of this point revealed one significant difference namely that there was more than one way of getting this problem wrong. Some respondents answered that both wards would be equal at the end of the year (this involved the representativeness heuristic) while others thought the larger maternity ward had more chance of winning the contest. In the first case, answers were based on a paralogistic conception of chance in which the random dimension is seen as homogenous and impartial (which is only the case for a large amount of occurrences) while in the second case, people think that the higher the number of occurrences, the more chance there is of an unlikely result occurring as if one were trying one luck at a difficult game and therefore that the big maternity ward would win the contest. In our survey, the former error was made by more respondents with educational qualifications and the latter error by those without qualifications. Over 51.1% of those with educational qualifications said the two maternity wards would be equal as opposed to 40% of those without qualifications whereas 34% of those without a qualification thought the big maternity ward would win while as opposed to 22.7% of qualified respondents.

For the following problem (problem B), the error rates were found to be significantly linked to whether respondents were with or without educational qualifications (chi2 = 7.58, ddl = 2, 1-p = 97.74%). The calculation involved is not complex but the time allotted for it prevented most respondents from getting the right answer apart from a few calculation prodigies (there were some in our survey). The respondents therefore tended to base their guesses on the provisional result obtained and were therefore victims of what cognitive psychologists call the anchoring heuristic. Given the procedure used to solve the problem, individuals were generally found to totally ignore geometric (or exponential) progressions and this was more the case with the educationally unqualified than the qualified. 95% of the former did not get the answer for 88.9% of the latter. The following result is probably even more revealing—among those who *did* get the right answer, 72% were educationally qualified.

The same was found with the problem involving the letter A. 18.7% of educationally qualified respondents wrongly thought there were more words beginning with the letter A in the French language than words whose second letter is A while 24.7% of the educationally unqualified gave that reply.

Whether the error rates for the whole of our sample population were high or low, the factor of the level of studies was found to have an influence. This link was even more significant statistically for the last problem (problem F), the one involving the cards.

Only 42.25% of our respondents got the correct red-red answer. However 52.2% of the educationally qualified answered wrongly as compared with the 63.7% of educationally unqualified respondents. This was the highest difference between the two categories (chi2 = 21.88, ddl = 2, 1-p = 99.99%) in our study.

d) Errors and the type of studies

We shall now discuss the impact of the type of studies on the proportion of errors respondents made. Unlike with verbalisation, we found that the former could indeed have an influence on the latter even if it is less pronounced than with the level of studies. As expected the type of studies factor had little significant effect on the average variation problems (for example, problem D: chi2 = 1.00, ddl = 2, 1-p = 39.42%) for the reasons discussed earlier. Those from a scientific background did not particularly better than those with more literary studies, for example.

Nor was there much influence on the maternity wards problem including in the distribution of errors between the two possible solutions. However "pure" scientists were less subject to the anchoring heuristic which had an effect on answers to the problem on multiplying 1 x 2 x 3 x 4 x 5 x 6 x 7 x 8 as only 79.5% of them were influenced by it compared with 93.5% of those with a literary background and 91.1% of those qualified in the humanities and social sciences. It is not impossible that their knowledge of mathematical language makes them more sensitive to geometric acceleration phenomena, albeit to a limited extent.

In parallel, and perhaps for symmetrical reasons, those from a literary background had a lower error rate (12.4%) than the "pure" scientists (18.9%) for the question on the frequency of words beginning with the letter A in the French language.

However, the scientists came out on top for the cards problem with 45.8% getting it wrong as compared with 53.8% of those with a literary background and 54% from the humanities and social sciences.

Overall however, we found that the *type* of studies had little influence (we divided respondents into the categories

"pure scientists", "literature/languages", "artistic", "humanities and social sciences" and "technical") with only the pure scientists distinguishing themselves from the other categories on just two of the problems. These results should also be interpreted with caution given that the number of respondents concerned is much smaller than when comparing replies on the basis of the level of studies or of gender for example.

e) The difficult question of gender

I considered the influence of gender on cognitive errors a delicate question but not without interest. Firstly we found that proportionally women made more errors than men on all the problems except for the letter A question. The first reservation that springs to mind is that this may be a structural effect insofar as women have a lower level of studies than men all generations together. Consequently it is possible that the differences between men and women in our survey may simply be down to an unequal distribution of educational qualifications. Furthermore when women do have educational qualifications they are more often in a literary subject rather than in sciences which could also explain why they did better on the letter A problem and less well with the cards problem. We have already seen that the types of studies had an influence on the error rates for these two problems.

To some extent the first argument can be accepted because our population sample was made up of 46.4% men without the "baccalaureat" and 53.6% of men with the "baccalaureat" and at least three years of further education. The reverse was true for women with 52% of our female respondents not having their "baccalaureat" and 48% with the "baccalaureat" and at least three years of further education.

It should however be noted that certain problems for which the error rate was no different for the educationally qualified and the educationally unqualified, such as the maternity ward question for example, *did* show a difference in error rate between men and women. A significant dependency (chi2 = 5.12, ddl = 1, 1-p = 97.63%) linking error and gender in this problem was found. Men were wrong in 72.4% of cases while the women got the wrong answer in 77.4% of cases. The same was found with the problem involving calculating an interest rate.

The last finding is the most troubling. I wished to see if there was a gender difference in error rates for just the educationally unqualified respondents. This of course eliminated the question of a difference caused by studies. The idea was to compare the respective answers of men and women without the "baccalaureat" to the cards problem for which, as we have seen, there was the highest level of discrimination between the educationally qualified and unqualified. If a gender difference in the error rates was linked to the level of studies, we would not have found a difference between both genders without the "baccalaureat" for this problem. However the opposite was the case—here too women gave more wrong answers that men, with 66.5% of women getting the answer wrong compared with 60.9% of the men in this category.

Therefore our findings show that the level of studies is quite probably not the only factor which may influence the likelihood of cognitive errors.

VI: CONCLUSION

The findings of this study no doubt provisional in nature and may perhaps be contested,19 if only because they are a little inconvenient in nature. However the possible real significance of these findings does make uncomfortable reading. Certain observers would no doubt be happy to read that this study suggests cognitive errors are not spread out through the population in as homogenous a fashion as a certain tradition of cognitive psychology had previously suggested. This would be an extremely strong argument against naturalism which considers that mental contents and cognitive biases are the consequence of biological determinism. However the idea of this paper is not to claim Cohen is right and Tversky and Kahneman are wrong. We should indeed bear in mind that even though the level of studies seems to be a discriminatory factor influencing cognitive errors, these errors contaminate our minds on a very general basis as this survey shows even more clearly. Furthermore even high-level scientific studies do not protect our ways of reasoning from the influence of "biases" which lead to us making cognitive errors.

Finally, we also need to bear in mind that the differences found between respondents with different levels of education are hardly spectacular and hardly ever exceed ten percentage points. It is also possible to discern a slight influence of social background on our capacity to analyse and deliberate which is in itself surprising given the important differences in educational qualifications in our population sample.

Therefore the idea of the half-full and half-empty glass seems the most suitable to describe how each person will react to the findings even though drinking the contents of that glass nonetheless seems essential.

NOTES

1 Try to answer the following question for example: *A woman has two children. One is a boy. What is the probability the other is a girl?* If you answer 50% and not 66.6% (which is the right answer) then you have just experienced the kind of mental phenomena which particularly interest Tversky and Kahneman.

2 On this point, the decade-by-decade description by Marcus and Zajonc (1985) of how the idea of rationality in psychology has developed is of interest.

3 By 1969, Tversky had already highlighted the descriptive weak points of the axiom of transitivity, for example.

4 We could cite numerous thinkers such as Aristotle, Cicero, Bacon, Malebranche, Descards, Condorcet among others who attempted to formalise ways of reasoning correctly by questioning evidence criteria and the attractive traps of sophism. In this context, a special place needs to be reserved for John Stuart Mill (1843) and we should also consider the contributions of Vilfredo Pareto *Trattato di sociologia generale*, Daniel Bernouilli solution for the St. Petersburg paradox in 1738 and Allais views (1953) on the model of relational choice. However, quite frankly all these contributions are just forerunners for the research carried out by Amos Tversky and Daniel Kahneman at the end of the twentieth century. Tversky and Kahneman recognise the work of their predecessors Paul Meehl (1954), and his research into the comparison between clinical predictions and statistics; Ward Edwards and his introduction, in psychology, to studies on subjective probability in the context of the bayesian paradigm; Herbert Simon (1957) and his programme for the study of reasoning strategies programme; Jerome Bruner (1957) who was among the first to provide an empirical illustration of this programme; Fritz Heider (1944) and pioneering work on the ordinary perception of causality.

5 For example Gardner (1993, p. 410): "Empirical research into reasoning carried out over the last thirty years has generally called into question the idea that humans—even the most sophisticated among them—proceed rationally and are even less likely to involve logical calculations in their reasoning" or Lewicka (1989, p. 269): "To say that they state that human cognition does not comply with the ideal of rationality would be a euphemism".

6 Some contest these "sure criteria" including Ajen and Kruglanski. Certain of Gigerenzer remarks (1991a, 1991b, 1993) can also be interpreted in this way.

7 This kind of conclusion could also be drawn regarding the study of the *Monty Hall* and "unwilling" Nobel prize winners which I discussed (Bronner 2007).

8 I would like to thank the 2002/2003 multidisciplinary degree students from the University of Nancy 2 without whose help this study could not have been carried out and also F. Mansuy who entered the data into the computer.

9 I did not choose these heuristics on an arbitrary basis—they were the three heuristics studied in the most depth by Tverksy and Kahneman.

10 The anchoring heuristic error is the tendency to base an estimation on a value which is already known and which may lead to error in some cases.

11 In fact it was the French version proposed by Lindsay Norman (1980).

12 The availability error is the tendency of individuals to estimate a probability or frequency based on the ease with which we are able to remember examples whose *type* seems to illustrate the event which is the object of estimation in a given problem.

13 $0{,}1 = \sqrt[20]{s / 5000} — 1 \Leftrightarrow s = (1{,}683)^{20}$

14 $tx = \sqrt[30]{s (15000 / 1500)} - 1$

15 For an analysis of this problem see Osherson (1990) or Bar-Hillel and Falk (1982).

16 Also, for reasons I will not go into here, the order the problems were done in was: D, A, B, C, E and F.

17 This also came to light in the 100 first "mock" questionnaires.

18 The Khi-square test was used throughout this quantitative survey.

19 However they correspond to the findings of previous studies as Boudon pointed out)2002) by referring to international comparative surveys on very different questions which nonetheless highlight the correlation between the level of education and the perception of the complexity of certain situations. Lazarsfeld (1993) showed that the main victims of Orson Welles famous radio hoax about the earth being invaded by aliens were people with a low level of education. However, among these Lazarsfeld pointed out that manual workers (with low levels of education then) with a diagnostic activity in their work were not more likely to adopt beliefs than their more educated. This last point is crucial as it suggests that the level of studies is less important in

this context than the type of intellectual activities in a person working life. This point would merit being the object of further research.

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