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The Conjunction Fallacy and the Debate on Human Rationality

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ABSTRACT: A. Tversky and D. Kahneman (1983) showed that in some contexts people tend to believe that a conjunction of events is more likely to occur than one of the events involved (a phenomenon called “conjunction fallacy”). The goal of this paper is to analyze the consequences of this phenomenon for the issue of human rationality. The key questions are as follows. Given the evidence from the conjunction fallacy experiments, are we justified to endorse some thesis on human rationality? If yes, which thesis? If not, why? The answers we give to these questions, I will argue, depends on the conception of rationality we advocate. I will then explore the consequences of the empirical evidence for three conceptions of rationality: The Standard Picture, Ecological Rationality, and the Goal Oriented View. Finally, I will compare these positions and offer a menu of philosophical options on human rationality that take into account the psychological studies in this area.

1. Introduction

In the last couple of decades cognitive psychologists have shown several disquieting phenomena about the way people reason. Particularly, they have shown that in certain contexts people tend to reason in ways that violate standard rules of logic and probability theory.¹ However, the *interpretation* of these empirical results and the *criteria* used to assess people’s performance are not straightforward matters. As a result, these issues have been source of important debates not only among psychologists but also among philosophers.²

In this paper I will focus on a particular error people seem to be prone to commit. The tendency to commit this particular error has been called “the conjunction fallacy”. The story of

¹ See Gilovich, Griffin and Kahneman, (2002) for reviews on the topic.

² See, for example, Kahneman and Tversky (1996), Gigerenzer (1996), Cohen (1981), Adler (1991), Stich (1990), Stein (1996).

this phenomenon begins in 1983. In that year, Tversky and Kahneman showed that under certain circumstances, people tend to believe that a conjunction of events (A&B) is more likely to occur than only one of the events involved (let's say, A). Here is the most famous example that tends to elicit the conjunction fallacy:

Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.

Rank the following statements according to their probability: using 1 for the most probable and 2 for the least probable:

- (a) Linda is a bank teller.
- (b) Linda is a bank teller and is active in the feminist movement.

Most people (between 80 and 90%) rank option (b) as more probable than (a), despite the fact that this violates the conjunction rule in probability theory: the probability of a conjunction cannot exceed the probability of any of the conjuncts. The justification goes as follows. If event (b) occurs, then, necessarily, event (a) will occur as well, that is, if Linda is a feminist bank teller, necessarily, she will be a bank teller. But event (a) may occur without (b) occurring, that is, Linda may be a non-feminist bank teller. Thus, (b) can never be more likely to occur than (a).

Although the existence of this phenomenon became widely accepted, many researchers (not only from psychology but also from philosophy) engaged in substantive controversies around the conjunction fallacy.

The goal of this paper is to analyze the most philosophical of these controversies, namely, the debate about the consequences of conjunction fallacy studies for the issue of *human rationality*. The key questions are as follows. Given the evidence from the conjunction fallacy experiments, are we justified to endorse some thesis on human rationality? If the response is affirmative, which thesis? If the response is negative, why can't we endorse any thesis? What kind of information is missing? The answer we give to these questions –I will argue– depends on the conception of rationality we hold.

I will first focus on what has been called the “Standard Picture of Rationality”. This is the notion usually adopted by psychologists when analyzing the results of conjunction experiments and the like. This conception of rationality has been the subject of many criticisms from psychologists and philosophers. I will evaluate these objections by reviewing the empirical evidence that bears on the matter. I will then explore two alternative conceptions of rationality that have been proposed in the literature: Ecological Rationality and the Goal Oriented View. For each of them, I will determine what are the consequences (if any) of the conjunction fallacy experiments on

the human rationality issue. Finally, I will establish a comparison among the three reviewed conceptions of rationality.

2. The Standard Picture of Rationality

Some psychologists seem to hold the idea that *at least for some problems*, classical logic, standard probability theory, and decision theory provide the appropriate standards to judge rationality. Stein (1996) calls this position the “Standard Picture of Rationality”. According to this view, conjunction fallacy experiments show specific *contexts* where people do not reason in accordance with the principles of probability theory, or more specifically, with the conjunction rule. Thus, according to the psychologists who adopt the Standard Picture of Rationality and *at least in some contexts*, people are not rational. In fact, by focusing on these contexts, some researchers drew negative conclusions about human rationality.³ However, researchers also show that in other contexts people do reason in accordance with logic, probability, and the like. Tversky and Kahneman (1983) report that when Linda’s description is reduced only to her age, almost all participants follow the conjunction rule. Furthermore, Fiedler (1988), among others, shows that people also avoid the conjunction fallacy when they estimate the frequency of the relevant events. Thus, people are not irrational in every single context. To sum up, human rationality is context-dependent. In some contexts, people’s judgments tend to be rational; in others contexts, they tend to be irrational.⁴

As Stein (1996) recognizes, the Standard Picture of Rationality has certain advantages. It accounts for the normative character of rationality, it is intuitively plausible and simple, and it coheres with well-established disciplines as logic and mathematics. Furthermore, it provides clear-cut criteria for assessing people’s judgments and behavior.

However, there are also disadvantages. Many people have raised objections against it. I will only focus on objections related to the conjunction fallacy phenomenon. Researchers in both philosophy and psychology have offered the following challenges:

1. The standard probability calculus is a reasonable criterion, but it cannot be properly applied to every single context. In particular, it is mistakenly used in the Linda problem because, in such a context, probability is applied to single events.
2. The contexts under discussion (e.g., the Linda problem) are suitable for applying some probability system, but the standard probability calculus is not the most adequate. There are non-standard probability calculi that are better suited for the contexts at stake.

³ See, for example, Kanwisher (1989).

⁴ The notion of context-dependency is ambiguous: (i) a concept X can be context-depend in the sense that what counts as X in context C1 might not be what counts as X in context C2; (ii) a concept X can be context-dependent in the sense that a set of things or people can be reliably classified as X in context C1, but not in context C2. I will use the term ‘context-dependent’ in this second sense. (I want to thank to an anonymous reviewer for pointing out the ambiguity problem and the distinction to make it clear).

3. Even if the context and standard probability calculus are adequate, the fallacy is committed only if people interpret conjunction problems in the way researchers presuppose. But if people interpret conjunction problems in a different way, their responses might turn out to be perfectly reasonable.

4. A more general criticism goes as follows. The problem with having formal systems as standards of rationality is that such systems do not take into account important aspects that should be considered when assessing human rationality. These aspects include the context or environment where an agent makes judgments or decisions, the goal or goals an agent has in mind, and the limited cognitive tools that such an agent can use to satisfy those goals. Besides pointing out these flaws, some researchers have offered alternative conceptions of rationality. I will analyze two of these proposals in Sections 4 and 5.

3. Assessment of the Objections to the Standard Picture

3.1. The Application of the Probability Calculus to Single Events

Gigerenzer (1994) raises doubts about the context to which the probability calculus is applied. He defends a strict *frequentist* conception of probability over a subjectivist or Bayesian one, which takes probability as a measure of subjective belief. In a frequentist position as the one developed by von Mises (1957), a reference class (a collective) has to be defined first, and then the probability of a *repetitive* event is the relative frequency of this event in its class. Thus, there is no place for probability of single events. So, according to Gigerenzer, it does not make sense to talk about probability of single events as Linda being a bank teller. In consequence, the question in the standard form of the Linda problem is, strictly speaking, *meaningless*. Therefore, regardless of the answer a person gives, he or she could not be regarded as irrational for answering a meaningless question. Gigerenzer sometimes justifies his position by pointing out that there are unsolved problems regarding the application of probability to the single case (e.g. the selection of the right reference class).

However, the frequentist interpretation has problems on its own. For example, it is not clear whether the definition of probability should invoke either finite or infinite reference classes. For each of these possibilities, theoretical problems immediately arise.⁵

As fascinating as these issues are, the dispute over the right interpretation of probability is beyond the scope of this paper. Thus, for the sake of argument, let us grant Gigerenzer's claim that probability should be interpreted as a relative frequency, and so, that single event probability conditions are not adequate contexts to assess people's performance. Note, though, that this criticism only applies to conditions that ask for probability of single events. Thus, an advocate of this objection could still accept that the conjunction rule is an adequate criterion of rationality, provided that it is tested under the right conditions (i.e., under frequentist formats). In other words, this criticism could still accept a modified version of the Standard Picture of Rationality,

⁵ See Hájek (2003) for details.

namely, a version that restricts the application of probability calculus to frequentist contexts. Let us review, then, the empirical evidence on conjunction problems under frequentist formats.

Hertwig and Gigerenzer (1999) show that under the following frequentist format people tend to respond in accordance with the conjunction rule of probability theory. After presenting subjects with Linda's description the problem reads:

There are 100 women that fit Linda's description. Please, give your best estimate of the following values:

- a) How many of these women are bank tellers?
- b) How many of these women are bank tellers and active in the feminist movement?
(p.291)

If a participant estimates that the second number is larger than the first one, he or she will be committing the conjunction fallacy. In this framework, most of the people (between 75 and 89%) correctly follow the conjunction rule. Fiedler (1988) systematized such a finding by showing the same effect in different problems.

What are the consequences of this evidence for the issue of human rationality? Gigerenzer has used the frequency effect to argue as follows. When people receive a conjunction problem and probability is couched in terms of relative frequencies, they tend to perform well. Given that this is the only condition that matters, we should conclude that people are, in general, rational.

Unfortunately, this argument is flawed. The problem is that people's performance under frequency conditions crucially depends on the *response mode*, that is, on the type of answer participants are required to give.⁶ In order to see this point, consider the evidence from Tentori et al (2004). Tentori and colleagues presented participants with the following frequentist version of the Scandinavian problem.

The Scandinavian peninsula is the European area with the greatest percentage of people with blond hair and blue eyes. This is the case even though (as in Italy) every combination of hair and eye color occurs. Suppose we choose at random 100 individuals from the Scandinavian population. Which group do you think is the most numerous? (Check your choice)

- a) Individuals who have blond hair.
- b) Individuals who have blond hair and blue eyes.

⁶ Hertwig and Chase (1998).

- c) Individuals who have blond hair and do not have blue eyes. (pp. 473-474)

The result is that on average 66% of the subjects commit the conjunction fallacy by either picking the second or the third option. Wedell and Moro (2008) systematized this finding by showing the same effect with different problems.

Thus, it is true that when people *estimate* frequencies, they tend to follow the conjunction rule. This result does provide support for the rationality thesis. However, this is only one part of the story. When people *choose* the group with the highest frequency, they tend to commit the conjunction fallacy again. This result, in turn, can be used for supporting the irrationality thesis. Thus, by following the criteria of the Standard Picture of Rationality, even if we stick to a strict frequentist conception of probability, we should again conclude that human rationality is context-dependent. In some contexts, people's judgments tend to be rational; in others contexts, they tend to be irrational.

3.2. The Use of the Standard Probability Calculus

Some philosophers, such as Cohen (1981), seem to agree that rationality has to do with making judgments and decisions according to certain principles. However, Cohen challenges the idea that these principles should be the ones derived from classical logic, standard probability theory, and decision theory. Cohen points out that there are different logic and probability calculi, and each of them is appropriate for certain situations or contexts, but not for every single situation. Of course, if the standard probability calculus is not adequate for our conjunction problems, the experiments mentioned above would be completely irrelevant for the issue of human rationality.

Now, this criticism is very general. The main problem is that psychologists do not usually provide any justification for the standards they use to assess people's performance. The important question is whether this criticism is applicable to the conjunction fallacy experiments. I will now examine this possibility.

Most conjunction problems consist in providing participants with some information (e.g., Linda's description), and then ask the participants to use that information to assess the probability of certain events (e.g., Linda being a bank teller). Thus, in most conjunction problems, it can be argued that the concept of probability is closer to *evidential support* rather than to relative frequencies. How does the standard conjunction rule fit this view of the concept of probability? Basically, the conjunction rule can be viewed as imposing the following restriction. The evidential support we assign to (A&B) can never be higher than the support we assign to each conjunct. Why? Because if (A&B) is true, so is each conjunct. So, whatever support we have for the conjunction, we also have it for each conjunct.

This seems reasonable, but still one may wonder whether the conjunction rule also holds in other probability calculi based on evidential support. The answer is positive. The conjunction rule does not only hold in the standard probability calculus but also, as far as I know, so it does in all non-standard probability models of evidential support.⁷ This fact, in turn, seems to support the idea that the conjunction rule is an adequate standard for the problems in the area.

⁷ See, for example, Shafer (1976) and Cohen (1977).

However, one may still have some doubts about the legitimacy of the conjunction rule as a standard to assess people's performance. Thus, the following question arises: Is there any instance of the conjunction fallacy where we can be absolutely confident that the conjunction rule is the right standard and, thus, that committing the conjunction fallacy is indeed wrong?

The answer is a resounding 'yes'. The evidence for this claim is based, again, on the results by Tentori et al. (2004) and Wedell and Moro (2008) mentioned above. The crucial point comes from the frequency choice condition. Under this condition, most participants classify the group of blond and blue eyes people as larger than the group of blond people.⁸ So, in this context, the conjunction rule is equivalent to the following norm in set theory: a subset can never be larger than its superset. This principle is as uncontroversial as a philosopher can ever dream, at least when applied to our problems. I cannot imagine any formal system in which we can derive as a conclusion that a group of Scandinavians contains more blond and blue eye people than blond people. It would be plainly absurd. This is the beauty of the frequency choice condition. Here the conjunction rule is equivalent to such a basic norm that nobody can deny its legitimacy.

3.3. The Interpretation of Conjunction Problems by Participants

Some of the advocates of the rationality thesis argue as follows. Even if we accept that the conjunction rule forms part of the criteria of rationality, the experiments would be relevant for the debate only if the participants understand problems in the way researchers presuppose, that is, in the way that allow us to apply probability or set theory. If subjects interpret the problem in a different way, however, their responses may turn out to be perfectly reasonable. Let me develop this point. Maybe, in the context of Linda's description, participants tend to interpret the option "bank teller" as "bank teller who is not a feminist" (misunderstanding of the base event), in which case there would be no conjunction fallacy. Or maybe people do not interpret the word "probability" (as it occurs in the question of the Linda problem) in the same way researchers do. Or even if they understand the options and question as researchers assume, they may not take the conjunction task as asking for the "correct" answer but rather as asking for the answer that is most *informative* given the evidence provided in the problem: Linda's description (misunderstanding of the task). All these possibilities are different versions of the misunderstanding hypothesis: the conjunction fallacy is mainly due to a misunderstanding of the problem or the task.

This objection is perfectly reasonable. Moro (2008) analyzes this problem in detail and concludes that the empirical evidence in the literature shows that no version of the misunderstanding hypothesis seems to provide an adequate account of the phenomenon of the conjunction fallacy. Again, the result for the Scandinavian problem under frequency choice condition provides the strongest piece of evidence. Notice, first, that the Scandinavian problem contains a third option: blond hair without blue eyes. Given this fact, it does not make sense to misinterpret the base event "blond hair" as "blond hair without blue eyes" because one already has this alternative among the options. Wedell and Moro (2008) presented additional evidence against the possibility that the

⁸ I am here implicitly assuming that participants interpret the problem in a standard form (for example, they interpret the term 'blond individuals' as referring to all blond individuals and not only to the blond individuals who do not have blue eyes). In the next section I will deal in detail with the problem of people's possible misinterpretations and provide empirical evidence for my assumption.

misunderstanding of the base event could explain the phenomenon of conjunction fallacy. They used the Scandinavian problem and other seven scenarios to test factors that have an influence on conjunction fallacy. Finally, after the 8 basic tests, they made subjects to solve the Linda problem to control for the possible misunderstanding of the base event. Some of the participants face a set of options equivalent to the Scandinavian problem. For example, the options were:

- Linda is a bank teller
- Linda is a bank teller and active in the feminist movement.
- Linda is a bank teller and is not active in the feminist movement.

But the crucial point was in the following question. They asked:

In the problem above, which of the two statements below best captures what you think was meant by the statement: “Linda is a bank teller”. (Check the one that you thought the author meant in writing the statement. Note that there is no “correct” answer as this is simply how you interpreted the statement.)

___ Linda is bank teller and is not active in the feminist movement.

___ Linda is a bank teller whether or not she is active in the feminist movement.⁹

The result they found is that only around 10% of the subjects picked the first option showing evidence of misinterpretation of the base event. But even if 10% of the conjunction errors can be accounted for the misinterpretation of the base event, still more than half of the subjects (around 60%) commit the fallacy without apparently misunderstanding the base event.

Furthermore, they also ran a very similar condition, except that the Linda problem did not contain the third option, that is, contained only (B) and (B&F). They found that the two-option format tends to elicit a higher percentage of misunderstandings (around 33%). However, when one moves from the two-option format to the three-option format, the tendencies are as follow. Although the percentage of misunderstanding is significantly reduced, the percentage of conjunction fallacies is still increased a little bit. Thus, a better understanding of the base event does not seem to bring a reduction of conjunction errors as the misunderstanding hypothesis predicts.

Finally, they reported a final piece of evidence by focusing on the participants who selected the interpretation of the conjunct option that researchers assume (i.e., as bank teller whether or not she is a feminist). These participants committed an average of 69% of conjunction fallacies under probability choice conditions, 69% under frequency choice conditions and, particularly,

⁹ Of course, there is no guarantee that this technique delivers accurate results. The main reason is that participants may not be conscious of their own interpretations. Nevertheless, it seems that this technique may still provide a good initial approximation of how people interpret one of the key options.

60% with regard to the Linda problem.

Second, in the frequency choice condition of the Scandinavian problem presented above, the word “probability” does not appear, so it cannot be blamed for eliciting the fallacy. Finally, as for the misunderstanding of the task, there is not enough evidence to provide a well supported answer. Maybe people are trying to be informative rather than correct. However, there is some empirical data that seems to go against this possibility. The key point comes from the comparison between the above presented frequency *choice* version of the Scandinavian problem with the frequency *estimation* version. Under this last condition, participants must estimate the size of each subgroup. Under this condition, most people follow the conjunction rule. How do the advocates of this type of misunderstanding hypothesis explain this improvement? Is it the case that people do not interpret the task as requiring an informative answer anymore? This possibility does not sound very plausible. So, the advocates of this hypothesis should provide some story to explain the difference in performance¹⁰.

Nevertheless, more empirical research is needed to explore how people actually interpret conjunction problems. It is safe to say that this is one of the important gaps in the area.

3.4. The Use of Formal Systems to Assess Human Rationality

Finally, the last criticism objects that formal systems *alone* can capture the idea of human rationality. The main point is that there are contextual aspects that should be taken into account when addressing the issue. In the following sections, I will explore two alternative conceptions of rationality that stem from this criticism. For clarity purposes, I will present them separately, but it will be clear that both conceptions can be integrated into one comprehensive view (Section 6).

4. Ecological Rationality

Gigerenzer and Selten (2001) support a notion of rationality that takes into account the factor of adaptation to the environment. They call this conception “Ecological Rationality”. The authors point out that this notion of rationality should be classified as *bounded* rationality because it takes into consideration that human agents have limited resources in time, knowledge, and computational power.¹¹ Along with time and cognitive limitations, it is argued that environments

10 An advocate of the informativeness hypothesis might respond as follows. Maybe what the subjects wants to express is that the blonde and blue-eyed group is more numerous than the blonde and not blue-eyed group. In the estimation framework, they have the possibility to express that idea and they usually do it. In the choice framework, the only way to express the same idea is by violating the conjunction rule. This version of the informativeness hypothesis is better but it also runs into similar problems. If this account were correct, one would expect that people follow the conjunction rule in all the estimation conditions. However, this does not happen. In some probability estimation conditions, most people commit the conjunction fallacy. Additionally, even within frequency estimation conditions, there is a substantial increase in conjunction fallacies when the base event is unlikely to happen (e.g. red hair individuals). This data cannot be accounted by pointing to the informativeness issue.

11 The Standard Picture of Rationality is, by contrast, a *resource-independent* conception of rationality because its principles are postulated without any consideration of possible human limitations.

have certain *informational structure*: they provide information about some (but crucially, not all) aspects, and this information is given in a specific format. By focusing on these issues, this approach studies the match between heuristics used by humans and environmental structures.

The criteria for rationality are accuracy, frugality, and speed. Accuracy refers to the match between judgments or predictions and reality; frugality refers to the amount of information that a given heuristics requires to operate; finally, speed refers to the way in which a given heuristic processes the information (the simpler the process, the quicker the judgment).

Since this approach has three different criteria, not always it will be able to classify a behavior as rational or irrational. Clearly, many situations force us to make a trade-off between accuracy, on the one hand, and frugality and speed, on the other. It is sometimes impossible to improve the two aspects at once. However, in other situations or environments, this approach will be able to offer a decision regarding rationality. Given some severe limitations on time, knowledge, and computational power, it might be more rational to use a fast and frugal heuristic than a Bayesian model. In turn, it might be more rational to use a Bayesian model “when one is in no hurry and has a computer at hand” (op. cit., p. 164). The crucial point, then, is that the rationality of a reasoning strategy or heuristic is never assessed in isolation, but rather it is evaluated in the environment where it operates.

How to apply this alternative conception of rationality to the conjunction fallacy experiments? In order to answer this question, it is important to note that the situations presented in the lab are not quite representative of the situations that people usually face in daily life. So, we should be careful when trying to derive conclusions about the relevance of conjunction fallacy experiments to real environments. Funder (1987), for example, argues that while logical and probabilistic inferences are clear given some assumptions explicitly stated in lab situations, in real life we are almost never sure whether these assumptions hold. Furthermore, real-world environments usually give people feedback that allows them to correct their judgments as a result of repeated trial and error. Thus, Funder advises to evaluate the accuracy of judgments and decisions in real world environments.

The crucial question is, then, whether there are environments or contexts in real life where we face conjunction problems as the ones presented in the literature. It has been claimed that the situations presented in typical conjunction problems do not seem to exist outside the lab. It is difficult to imagine any real situation where we face a set of options such that one of the options is nested in another option. Usually, alternatives are mutually exclusive in real world situations. Thus, if rationality has to do with adaptation to the environment, experiments like the Linda case do not provide any material to elaborate a judgment on human rationality.

However, the claim that we never face this type of problem in real environments can be called into question. The reason is that this claim is mainly based on speculation. After all, there may be contexts where this type of problem is evaluated. Some researchers have suggested that legal contexts, for example, are environments where the conjunction fallacy may occur (e.g., Hastie & Dawes, 2001).

Nonetheless, there is no systematic study of the matter. Until this is done –the advocates of the ecological approach will argue– the evidence provided does not allow to make any claim about the issue of human rationality.

5. The Goal Oriented Conception of Rationality

An additional interpretation of rationality focuses on the idea of *using adequate means to satisfy some goal*.¹² This conception is reasonable but it has problems for stipulating clear-cut criteria of rationality. The main difficulty is to determine the goal (or goals) participants have in mind when they try to solve conjunction problems. Is the goal to provide answers that are as close to the truth as possible? Or is the goal to spend as little time as possible completing the task simply in order to earn some credit for participation? If this possibility is indeed the case, the typical experiments in the literature do not allow us to question the rationality of the participants. Given the purpose of gaining credit for participation, for example, just showing up and marking any responses would be rational.

Another possibility is to tempt participants with money. A typical human goal is to try to maximize monetary gain. So, instead of asking people to rank options according to their probability, some researchers have offered participants hypothetical or real bets. For example, Bonini et al. (2004) offer 7 euros to participants to use it in a bet on predictions (to one year from the present time) about the following events:

In Italy...

- a) more than 90% of private schools will be connected to the Internet.
- b) more than 90% of private schools will be connected to the Internet and *less* than 70% of public schools will be connected to the Internet (both events must happen for you to win the money placed on this bet).
- c) more than 90% of private schools will be connected to the Internet and *at least* 70% of public schools will be connected to the Internet (both events must happen for you to win the money placed on this bet). (p. 209)

Unfortunately, this option does not work either. Bonini and colleagues report that 78% of participants committed the conjunction fallacy in the above problem. And this is a typical result. All the studies that used this betting format have found that most participants commit the conjunction fallacy.¹³

Now, even if these studies are very suggestive, there is still a possibility that subjects have other goals in mind when completing the study.

A related proposal, defended by Hertwig and Gigerenzer (1999) is that participants might be trying to be as *informative* as possible when solving these problems. As I mentioned above (Section 3 c), the evidence provided in the literature suggests that this proposal does not provide

¹² See, for example, Cherniak (1986); Stich (1990).

¹³ See, for example, Tversky and Kahneman (1983); Bar-Hillel and Neter (1993).

a satisfactory account of the phenomena. However, given the lack of a systematic study on the matter, I think it is still an open possibility.

More generally, the goal oriented conception of rationality has been mainly supported by philosophers, and psychologists have not paid much attention to it. My view is that this is a very reasonable approach and it should be explored empirically.

So, if we wonder about the conclusion of this approach regarding the rationality issue, the answer is, again, that more research is needed. It is not the case that the conjunction fallacy experiments are necessarily irrelevant for the rationality debate. Under some conditions (e.g., the *only* goal of the agent is to maximize monetary gains under a betting condition), the conjunction experiments can indeed be informative about the issue of human rationality. But as I mentioned above, there is little empirical research on whether these conditions actually hold. Until this is done, the issue of rationality for this approach is left unsettled.

6. Comparison between diverse conceptions of rationality

So far I have been trying to show that, depending on the notion of rationality one holds, empirical studies on the conjunction fallacy may or may not provide support for a claim on the issue of human rationality. However, one may go a step further and wonder whether one of these conceptions is better than the others. I do not have a straightforward response to this question. The answer, I will argue, depends on the criterion we use to compare different conceptions. I will elaborate on this point.

I think that each of the conceptions of rationality I have explored captures a different aspect of rationality. More specifically, the standard picture captures the idea that, at least for some problems, logic and probability theory seem to provide the right way of thinking about them. The conception based on ecological rationality captures the idea that if agents are rational, they will use strategies that work well in their environment. Finally, the last conception captures the idea that in order to know whether some individual is rational, we should know the goal or goals the individual is pursuing.

All of these proposals are reasonable. Depending on the relative importance we give to these intuitions, we may favor one conception over the others. Personally, I do not have any clear preference over these intuitions.

A factor that can help with the choice is our intentions regarding the selected conception of rationality. From a theoretical perspective, both the ecological view and the goal oriented view provide richer frameworks than the standard picture. The reason is that the ecological and the goal oriented views incorporate contextual aspects (goals, environments, etc.) that seem relevant when we make judgments and decisions. The aspects are blatantly ignored by the standard picture. Again, the relative importance we give to the diverse aspects (goals vs. environments) may help us to choose between the ecological view and the goal oriented view. Or one may want to support a conception that integrates both views. In fact, Samuels et al. (2004) seem to endorse a goal oriented view that incorporates information about environments. On the other hand, from a practical point of view, the standard picture of rationality provides clear-cut (and

reasonable) criteria of rationality, which are really difficult to obtain from the other two views. The ecological view seems more practical than the goal oriented view, but it still has to deal with trade-offs among its diverse criteria. Thus, depending on whether our intentions are theoretical or practical, we might want to choose one conception over the others.

Conclusion

I have explored the relation of the empirical studies of conjunction fallacy to the issue of human rationality. The crucial point is whether these experiments provide support for some thesis on human rationality. I argued that the answer to this question depends on the conception of rationality one holds. I initially focused on the standard picture of rationality because this is the conception implicitly assumed by most psychologists that run conjunction fallacy experiments. According to this view, human rationality is context-dependent. In some contexts, people tend to violate the conjunction rule; in others, they tend to follow it. I then analyzed some objections that have been raised against this approach. Many of these objections have to do with the use of the standard probability calculus as criterion to assess people's performance. The upshot of my analysis is that there is at least one condition, the frequency choice condition, in which none of the above objections applies and people still tend to commit the conjunction fallacy. I also recognized the need of additional empirical research on how people interpret conjunction problems.

Finally, I explored two alternative conceptions of rationality, the ecological view and the goal oriented view. Neither of these conceptions considers the mere violation of the conjunction rule a clear sign of irrationality. Thus, for these views, the conjunction fallacy *alone* cannot be used to support any claim on human rationality. It is true that each of these alternative conceptions does recognize that, under very specific circumstances, committing the conjunction fallacy is irrational. Thus, the conjunction fallacy phenomenon is not considered completely irrelevant. But in order to use this phenomenon to support some thesis on rationality, both conceptions require a lot more research to be done.

I finally established comparisons among the three conceptions. The big question is whether one of them is superior to the others. I argued that the answer to that question depends on our intentions regarding such a conception. There is a clear trade-off between a richer theoretical framework and a more practical classificatory approach. I do not have an argument for defending a particular criterion. In consequence, I do not have an argument for defending any particular conception of rationality over the others.

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