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## COMMENTARY

# Noisy Probability Judgment, the Conjunction Fallacy, and Rationality: Comment on Costello and Watts (2014)

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According to Costello and Watts (2014), probability theory can account for key findings in human judgment research provided that random noise is embedded in the model. We concur with a number of Costello and Watts's remarks, but challenge the empirical adequacy of their model in one of their key illustrations (the conjunction fallacy) on the basis of recent experimental findings. We also discuss how our argument bears on heuristic and rational thinking.

*Keywords:* conjunction fallacy, rationality, heuristics, inductive confirmation

An assumption shared by competing approaches to the study of cognition is that human judgment under uncertainty is governed by so-called heuristics rather than by the principles of the probability calculus (see Gilovich, Griffin, & Kahneman, 2002; Gigerenzer, Hertwig, & Pachur, 2011). Costello and Watts (2014) leveled an interesting challenge against this popular view. In their opinion, a probabilistic model of human reasoning is able to account for observed behavior provided that it embeds the role of random noise in the judgment process. They illustrated their point with analyses of some key examples, and concluded that, in none of them, is the appeal to heuristics required to explain the findings.

According to Costello and Watts (2014), the “surprising rationality” of human judgment is primarily supported by the close agreement between people's probability estimates and the requirements of probability theory for expressions such as,  $P(x \wedge y) + P(x \vee y) - P(x) - P(y) = 0$ , for which—Costello and Watts submitted—the effect of noise is cancelled out. Costello and Watts then proceeded to argue that their model explains a number of well-known biases in probabilistic reasoning. In what follows, we focus on the latter claim, particularly on the cornerstone case of the conjunction fallacy, to which a good deal of Costello and Watts's efforts were devoted. We start with some clarification remarks as to how Costello and Watts's idea of “surprising rationality” might square with the occurrence of biases like the conjunction fallacy. We then question directly their claim that the conjunction fallacy can be explained by combining probability theory with noisy reasoning processes in the way that they have proposed. This is not a minor point in their argument, because, for Costello and Watts, showing “that observed biases cannot be explained as the result of random noise” would “demonstrate conclusively that people are

using heuristics” (p. 478). Accordingly, we conclude with a brief discussion of heuristic and rational thinking.

### The Conjunction Fallacy: Neither Rational, nor Explained by Probability and Noise

Costello and Watts clearly accept that compliance of graded subjective credences with the probability calculus is an adequate norm of rationality. Although they do not elaborate explicitly, this view is popular and backed by traditional strategies of justification, such as Dutch book arguments (see Hahn, 2014; Osherson, 1995; Vineberg, 2011) or results concerning accuracy dominance avoidance (D'Agostino & Sinigaglia, 2010; Leitgeb & Pettigrew, 2010a, 2010b; Pettigrew, 2013; Predd et al., 2009). Costello and Watts also have made clear that the conjunction fallacy is real, that is, that the phenomenon is documented by experimental investigations that are methodologically compelling. Here, we will take both of the foregoing assumptions for granted (see Tentori, Bonini, & Osherson, 2004; Tentori & Crupi 2012a; Crupi & Girotto, 2014; Cruz, Baratgin, Oaksford, & Over, 2015, as regard the latter, in particular). Against this background, Costello and Watts also have claimed that their probabilistic model accounts for major biases, including the conjunction fallacy, while insisting that human judgment is “surprisingly rational,” as the title of their article states. This seems to call for some clarifications as to what Costello and Watts's idea of surprising rationality might or might not imply. Because Costello and Watts's indications seem rather scant, we will briefly address this point before taking issue with whether their model in fact explains the conjunction fallacy.

Let us grant for the moment that Costello and Watts's model satisfactorily explains the conjunction fallacy. If so, then although human reasoning would not arise from heuristic rules, which depart systematically from probabilistic principles, it would still be true that systematically biased judgments ensue. That is, even if “conjunction fallacy responses” are not “systematically influenced” by any factor other than the “systematic distorting influence of noise” (Costello & Watts, 2014, p. 477), they would be systematically biased nonethe-

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