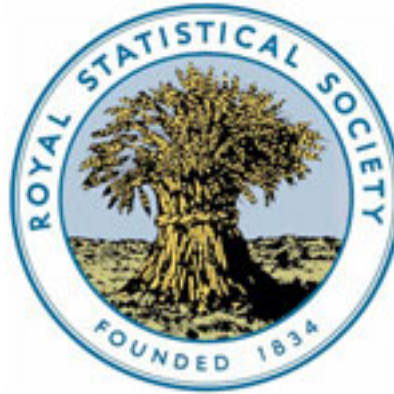


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Le Hasard by Émile Borel

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Journal of the Royal Statistical Society, Vol. 77, No. 8 (Jul., 1914), pp. 866-867

Published by: [Wiley](#) for the [Royal Statistical Society](#)

Stable URL: <http://www.jstor.org/stable/2340931>

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and fertile analogy. One illustration of this, of special appeal to the biometrician, must suffice.

Referring to the postulate that "phenomena obey the laws of chance when small differences in the causes are sufficient to produce great differences in the effects": "The greatest chance is the birth of a great man. It is only by chance that the meeting occurs of two genital cells of different sex that contain precisely, each on its side, the mysterious elements whose mutual reaction is destined to produce genius. It will be readily admitted that these elements must be rare, and that their meeting is still rarer. How little it would have taken to make the spermatozoid which carried them deviate from its course. It would have been enough to deflect it a hundredth part of an inch, and Napoleon would not have been born and the destinies of a continent would have been changed. No example can give a better comprehension of the true character of chance."

E.C.S.

3.—*Le Hasard*. Par Émile Borel. iv + 312 pp., 8vo. Second Edition. Paris: Librairie Félix Alcan, 1914. Price 3 frs. 50 c.

The demand for semi-popular articles and books on the theory of probability would seem to be considerable, and several eminent French mathematicians have endeavoured to satisfy it. Among these M. Borel is not the least distinguished. The work before us is a clear exposition of fundamental ideas, and is divided into three parts. The first deals with some of the simpler problems of chance, including a short study of that vexed question, the probability of causes. In the second, the applications of the theory of probability to sociological, biological, physical and purely mathematical problems are examined; and in the last the value of the methods of probability from the practical, the purely scientific, and the philosophical aspects is discussed.

Naturally one does not expect to find in a work of this kind any mathematical novelties, and, so far as the purely mathematical aspect is concerned, the book hardly contains anything which had not already been well said in M. Borel's *Éléments de la Théorie des Probabilités*. The discussion of the practical value of the laws of chance is, however, a sufficient apology for a new work, being admirably sane and likely to dissipate various popular misconceptions.

The section dealing with the interpretation of majorities, the argument being well illustrated by the analysis of some data collected by Mme. Rousson, is also of value. M. Borel's discussion of statistical biology is confessedly incomplete, and may not appear altogether satisfactory to the English reader. We doubt whether effective agreement with the Gauss-Laplace type of distribution can be regarded as an adequate criterion of racial purity, while the reference to the theory of correlation is too slight to convey a distinct idea to the general reader.

It is unnecessary to inform those familiar with M. Borel's writings that his argument is frequently enlivened by a ray of quiet humour

or good-natured sarcasm. Thus, after quoting Bertrand's trenchant criticism of Condorcet and others' work on the probability of judgments, M. Borel meekly observes, "It would be interesting to inquire whether Condorcet, Laplace, Poisson, Cournot were really as ingenuous as Bertrand seems to think they were." His definition of Baccarat will also bear quoting: "A rudimentary game, the mathematical theory of which can be completely worked out; for that reason, a game entirely devoid of any interest of its own, and merely a rapid way of either losing or gaining money."

It speaks well for the intellectual curiosity of the French-reading public that this work has reached a second edition.

M.G.

4.—*Le Jeu, la Chance et le Hasard*. By Louis Bachelier. 320 pp., 8vo. Paris: Flammarion, 1914. Price 3 fr. 50 c.

This is one of the volumes of the Bibliothèque de Philosophie Scientifique in which appeared, for example, Henri Poincaré's works on *Science and Hypothesis* and *Science and Method*. It is presumably intended to appeal to the general reader rather than the specialist, and the treatment, necessarily elementary, is, when it comes to definite mathematical results as distinct from philosophical discussion, often dogmatic rather than explanatory. The ground covered is extremely wide, notwithstanding the fact that the study of statistics lies outside the author's programme, as well as the applications of statistical methods to biometry. Chance, probability, mathematical and moral expectation, means, the origins of the theory of probability, lotteries, the laws of large numbers, Bernoulli's law, the ruin of gamblers, the illusions of gamblers, new theorems in probabilities, speculation, the probability of future events in the light of past experience, errors of observation, the principle of the mean, frequency curves, target shooting, is a very varied and extensive field to survey in the space available. In the chapter on target shooting (p. 300) a rather serious slip seems to have occurred. The reader is told to mark on the horizontal through the centre of the target the points corresponding to the horizontal probable error (*écart probable*); and similarly on the vertical axis the points corresponding to the vertical probable error. It is then said to be an equal chance for a bullet to hit the target inside or outside the ellipse through these points. If we have not seriously misunderstood the author's instructions, only some 20 per cent. of the bullets will fall within the ellipse so drawn; the "probable ellipse" has semi-axes equal to 1.177 times the standard-deviation, or nearly 1.75 times the probable error.

The best portion of the book, we think, is that dealing with the law of large numbers and Bernoulli's law, while the most novel features lie in the chapters or paragraphs based on the author's large volumes *Calcul des Probabilités* and *Théorie de la Speculation*. The two chapters on the latter subject give, perhaps, just enough to make a reader desirous of forming an acquaintance with the