International Gambling Studies
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rigs20

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Published online: 13 Sep 2013.

To cite this article: Catalin Barboianu , International Gambling Studies (2013): Mathematician's call for interdisciplinary research effort, International Gambling Studies, DOI: 10.1080/14459795.2013.837087

To link to this article: http://dx.doi.org/10.1080/14459795.2013.837087

International Gambling Studies, 2013
http://dx.doi.org/10.1080/14459795.2013.837087

Routledge
Taylor & Francis Group

Mathematician's call for interdisciplinary research effort

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(*Received 18 June 2013; accepted 15 August 2013*)

The article addresses the necessity of increasing the role of mathematics in the psychological intervention in problem gambling, including cognitive therapies. It also calls for interdisciplinary research with the *direct* contribution of mathematics. The current contributions and limitations of the role of mathematics are analysed with an eye toward the professional profiles of the researchers. An enhanced collaboration between these two disciplines is suggested and predicted.

Keywords: gambling; mathematics; responsible gambling; psychology; research design

In the field of problem gambling, the discipline of psychology is predominant in both research and applicability over other disciplines studying this field. This predominance came about naturally since problem gambling has been seen primarily as a problem with pathological aspects and social consequences (Abbott & Clarke, 2007; Bradley, 2003). Thus, disciplines already connected to and collaborating with psychology such as other social and behavioural sciences, medicine (principally psychiatry), neuroscience and chemistry have continued to contribute to problem-gambling research. Once another discipline claims findings applicable in this field, that discipline will be implicitly subordinated to psychology since the ultimate purpose of intervention is to modify human behaviour; such modification is the province of psychology and psychiatry. Mathematics is strongly connected to gambling through the mathematical models underlying any game of chance. Among the branches of mathematics dealing with these models, Probability Theory and Statistics are the most important as these branches provide measures and predictions for random gaming events, both for gamblers and for people studying gambling. Probability Theory provides a quantification of the uncertainty under the measure theory; Statistics deals with the collection, organization, analysis and interpretation of empirical data, such interpretation being justified by probability theory.

Games of chance are developed in their physical, consumer-ready form on the basis of abstract mathematical models. These models are simply the essence of the games themselves, and applications within the governing theories of these models represent the functional premises around which the games operate. For instance, within statistical models, the *house edge* is ensured through precise mathematical calculations involving probability and expected value; if such calculations were not possible, the game would never run (Barboianu, 2009). In the research, treatment and prevention of problem gambling, we cannot separate the gambler from the game s/he plays; thus it follows that an optimal psychological intervention cannot disregard mathematics. Let us call this the gambling-math indispensability principle.

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What has happened thus far? The mathematics of gambling has been a subject of greater interest to gamblers than to psychologists; the plethora of literature on gambling mathematics for the popular audience over the last decade confirms that observation (Turner, Fritz, & Mackenzie, 2003; Williams & Wood, 2007). As regards its interaction with psychology, the role of mathematics (through Probability Theory and Statistics) has been limited to two basic functions: providing numbers (quantities) and adjusting erroneous views related to probability and randomness (Peard, 2008). The quantification function includes the odds as well as statistical indicators attached to games of chance. Empirical studies have been conducted testing hypotheses related to changes in gambling behaviour associated with increased mathematical knowledge of the games; those tests, however, did not yield conclusive results (see Abbott & Volberg, 2000; Gerstein et al., 1999; Gray & Mill, 1990; Hertwig, Barron, Weber, & Erev, 2004; Lambos & Delfabbro, 2007; Pelletier & Ladouceur, 2007; Steenbergh, Whelan, Meyers, May, & Floyd, 2004; Williams & Connolly, 2006). As a result, the *direct* role of mathematics in problem-gambling research, treatment and prevention ended before even beginning. Furthermore, the connection between mathematics and psychology that has developed within the course of such research is not a direct one – mathematical intervention is addressed exclusively to gamblers via an instructional entity (schools, experimental courses, books, other media and the like), and psychology has conducted the empirical studies and interpreted the results only in terms of predicted behaviour after the intervention. In this respect, mathematics has served more as an external resource for psychology than as a research partner. To sum up, the direct contributions of mathematics to psychological intervention in problem gambling have been reduced to *facing the odds* and *correcting erroneous beliefs*. However, some past empirical studies have confirmed that these components of the intervention are not enough. (see Hertwig et al., 2004; Steenbergh et al., 2004; Williams & Connolly, 2006). A quick survey of the literature in this field indicates that no *complete* research has been conducted on the subject of *interpretations* of probability in the gambler's mind.

What can happen next? Following the gambling-math indispensability principle, mathematics can go more deeply into the gambler's mind with the help of psychology (or vice versa, if you prefer), and its contribution can extend further to cognitive therapies. The influence of mathematics can also go beyond Probability Theory & Statistics to incorporate knowledge from adjacent domains such as mathematical modelling, decision theory, theory of representation and even epistemology. Additionally, a basic psychology of mathematics and of mathematical concepts (Godino, 1996; Vergnaud, 1990) can be used in a psychological intervention in problem gambling.

Psychologists do accept that mathematics plays an important role in the gambling phenomenon; however, they have not delved deeply into the mathematics of gambling in search of new elements that could help in their endeavour, and this is perhaps due in part to the nature of their profession. The typical scientific profile of the psychologist is that of a person inclined toward the social, empirical and practical, a team worker in research (Norwich, 2000), who perhaps struggled in school with formal mathematics. By contrast, the mathematician tends to be an individual researcher more inclined toward the abstract and theoretical (Albers & Alexanderson, 2008). Thus far, mathematicians have found nothing to model, apply and provide in the fields of psychological investigation, except for measuring, scaling and predicting through the methods of inferential statistics addressed to empirical studies (Coombs, 1951; Luce, 1995; Mazur, 2006). These methods are external tools and not direct contributions for psychology; therefore, the circumspection is mutual.

Moreover, when trying to disseminate ideas related to both mathematics and problem gambling, mathematicians encounter reluctance from the editorial boards of problem-gambling journals. The reason is that the boards consist mainly of psychologists, and thus some of the journals have difficulty finding appropriate reviewers for such papers.

Mathematics and psychology have been avoiding each other, but in the field of problem gambling their confluence is unavoidable and necessary. The fissure between the two disciplines arises mainly from the contrasting profiles of their researchers and will render difficult any further collaboration. One of the purposes of the current article is to make both factions aware of this difficulty; the other is to call for scientists whose interests fall partially within the other discipline, so as to initiate interdisciplinary research involving mathematics and psychology in the field of problem gambling.

Good examples of the successful adoption of applied mathematics in the last decade – despite the particular profiles of the researchers – include biology (Committee on Mathematical Sciences Research for DOE's Computational Biology, 2005; Friedman, 2010), neuroscience (Ermentrout & Terma, 2010) and some branches of medicine (Artzrouni et al., 2011), such as medical imaging (Epstein, 2008), cardiology (Ottesen, Olufsen, & Larsen, 2004) and, in some cases, oncology (Araujo & McElwain, 2004; Chaplain, 2011).

Notes on contributor

Catalin Barboianu is gaming mathematician, author of eight books on mathematics of gambling. He is the leader of a private research group in applied mathematics and militates for the exposure of the mathematical facts of games of chance to the gamblers.

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