Improving statistical reasoning: representational format and valid intuitions

Peter Sedlmeier (peter.sedlmeier@phil.tu-chemnitz.de)
Department of Psychology, Chemnitz University of Technology
09107 Chemnitz, Germany

In numerous studies, statistical reasoning has been found to be a notoriously difficult topic for lay people and experts alike, and resulting biases in judgments under uncertainty have been regarded as being very resistant to training attempts. Although this still seems to be a widespread view, there have been moderately successful attempts to make people reason according to probability theory. For instance, Nisbett, Krantz, Jepson, and Kunda (1983) hypothesized that it is mainly the salience of three "chance factors" – clarity of the sample space and the sampling process, recognition of the role of chance in producing an event, and cultural prescriptions to think statistically in a particular domain – that determine whether people take sample size into account properly. However, even if these chance factors hold, several kinds of sample-size problems still seem to be very difficult to solve (Sedlmeier, 1998). Why? After a thorough review of the literature on people's use of sample size, Sedlmeier and Gigerenzer (1997) advanced an explanation: People have a valid intuition conforming to the empirical law of large numbers. This intuition is, however, only applicable to tasks that involve judgments about single means or proportions and is usually not invoked in judgments about sampling distributions.

Valid intuitions are not restricted to judgments about the impact of sample size but cover a large variety of probabilistic judgments (Sedlmeier, 1999; in press a). However, the use of these intuitions depends on the way statistical information is processed: When applicable, intuitions work best if the information is given in a format that is close to the naturally occurring format (e.g., frequencies instead of probabilities) or if, after training, participants are able to "translate" numerical information into that format (Sedlmeier, 1999). Valid statistical intuitions, (such as the size-confidence intuition, that is, the intuition that means or proportions from larger samples should be given more confidence than means or proportions from smaller samples) can be explained as a by-product of associative learning (Sedlmeier, 1999; 2002; in press b).

The hypothesis that the representational format makes a decisive difference in learning to reason statistically was explored in several studies that compared the effectiveness of different kinds of computerized tutoring systems. These systems were built either in a way that conformed to our view or in a way that was held to be nearly equivalent but conformed to more traditional ways of teaching probability theory. For tasks involving conditional probabilities, the impact of sample size, and probability revision, the training versions optimized to elicit valid intuitions led to remarkably better results than traditionally built training programs, especially in respect to long-term learning effects (Sedlmeier, 1997; 1999; 2000; Sedlmeier & Gigerenzer, 2001). As a practical side effect of our research, a textbook on probability theory (including a program on CD) resulted, which is currently being used in several German high schools (Sedlmeier & Köhlers, 2001; Wassner, Martignon & Sedlmeier, 2002).

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