Relational problems are not fully solved by a temporal sequence of statistical learning episodes

A. Vinter & P. Perruchet
L.E.A.D., C.N.R.S., University of Bourgogne, 21000 Dijon, France.
vinter@satie.u-bourgogne.fr

Abstract: Clark & Thornton's conception finds an echo in implicit learning research, which shows that subjects may perform adaptively in complex structured situations through the use of simple statistical learning mechanisms. However, the authors fail to draw a distinction between, on the one hand, subjects' representations which emerge from type-1 learning mechanisms, and, on the other, their knowledge of the genuine abstract "redoding function" which defines a type-2 problem.

1. Power of statistical learning mechanisms. Much of the interest of Clark & Thornton's (C&T's) target article lies in the fact that it offers a straightforward demonstration of the power of statistical learning mechanisms for solving problems which seem, prima facie, to be beyond the scope of such mechanisms. Empirical support for this conclusion can be found in the recent literature on implicit learning (Dienes & Berry, in press). In an often-cited study (Lewicki et al. 1988) for example, participants were asked to track as fast as possible a long and continuous series of targets appearing apparently at random locations. Unknown to participants, the series was composed of a systematic alternation of two unpredictable and three predictable trials. The discovery of this structure implies that subjects recode the continuous succession of trials into adjacent blocks of five successive trials. The underlying structure of the series remained completely opaque to participants, even after practice, yet performances were better for the predictable trials than for the unpredictable ones. Perruchet et al. (1990) demonstrated that the surprising adaptive performance of subjects in this situation was a direct consequence of a sensitivity to the frequency of occurrence of certain small chunks of two or three trials generated by the rules structuring the series. One could say that subjects solved a type-2 problem after its reduction to a set of type-1 problems.

The analogy between C&T's position and some aspects of the literature on implicit learning may be taken a step further. Perruchet and Gallego (in press) have proposed a theoretical account of implicit learning which shares striking similarities with C&T's claims about the nature and the function of type-1 learning. In this account, implicit learning is devoted to the formation of the "subjective units" shaping the perception of events and objects. Statistical learning mechanisms result in the chunking of information into discrete units, the nature and size of which are a function of the salience of surface features, as well as of the subject's background knowledge and general processing constraints and abilities (active memory and attention mainly). These subjective units emerge from the association of the primitive features that are processed conjointly in an attentional focus, and determine how the environment is attentionally perceived and processed after experience. With training, these units become increasingly independent of the sensory input and hence form internal representations. In line with C&T's position, this account construes the notion of representation as the endproduct of statistical learning mechanisms, making it possible to deal efficiently with problems involving what are a priori powerful computational abilities.

2. Limits of statistical learning mechanisms. Placing C&T's conception of learning within the context of implicit learning research reveals a major limitation of this conception, however. First note that C&T do not distinguish between the formation of achieved internal representations of the world, which permits behavioral adaptation to a given situation, and subjects' knowledge about the structural features of this situation. Let us illustrate this distinction. Each of us can state the direction of the source from which a sound comes. This ability stems from the detection and analysis of subtle differences in intensity or phase between the auditory streams processed by each ear. Consequently, location detection belongs to the class of relational, type-2 problems. The distinction we refer to is between the formation of achieved representations of sound space and the knowledge of the principle which permits these representations, namely, that detection is possible thanks to the relation between the information provided to each ear (Vinter & Perruchet 1994). Now, as should be clear from this example, it makes no sense to endow laymen with knowledge of this principle. The idea of knowledge makes sense here only from the observer's point of view not from the subject's.

In location detection, the coding of relational information is the direct product of hard-wired mechanisms. Our proposal is that the very same logic holds for the recoding provided by type-1 mechanisms of learning. The sensitivity to frequency statistics, and the representation resulting from this sensitivity, must be carefully distinguished from the subject's knowledge of the relational properties embedded in the task. Let us return to the Lewicki et al. situation. We noted that the better performance of subjects on the predictable trials, which apparently indicated that subjects were sensitive to the underlying structure of the series, relied on the sensitivity to the frequency of certain chunks forming the series. The crucial point is that this sensitivity to the surface frequency features gave the subjects no access at all to the underlying structure, for the very reason that the relevant frequencies, although a byproduct of the rules, do not make it possible to infer the rules. Indeed, the rules were concerned with the trajectory defined by two successive locations, whereas the resulting frequency effects captured by the participants were mostly concerned with perceptually salient units such as back and forth movements involving three successive locations. In this situation, it is clear that there is no justification for inferring relational knowledge from improved performance.

3. The need to introduce higher-level processes. We suggest that the solution provided by statistical learning mechanisms to type-2 problems is only a first step in the full course of human learning. The genuine knowledge of the relation embedded in type-2 problems involves processes that C&T fail to consider. In order to gain knowledge about the mechanisms involved in the detection of sound location for instance, scientists need to proceed by reasoning, hypothesis testing, and logical inference. The fact that they are themselves able to detect, as can everyone else, the location of a sound is of no help. In other words, knowledge of the "recoding function" can only be achieved by using processes fundamentally different from those involved in statistical learning. These high-level processes are needed to infer any abstract relation and to integrate it into a coherent view of the world or even to transfer it to another domain. The formation of abstract knowledge implies the use of processes which rely on the specific power of conscious thought. Overall, C&T's suggestion that there is no other type of learning to be had than type-1 learning, needs revision.