Implicit versus explicit: an ACT-R learning perspective

Commentary on Dienes & Perner:

A theory of implicit and explicit knowledge

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Abstract

Dienes and Perner propose a theory of implicit and explicit knowledge that is not entirely complete. It does not address many of the empirical issues, nor does it explain the difference between implicit and explicit learning. It does, however, provide a possible unified explanation as opposed to the more binary theories like the systems and the processing theories of implicit and explicit memory. Furthermore, it is consistent with a theory in which implicit learning is viewed as the mechanisms of the cognitive architecture, and explicit learning as strategies that exploit these mechanisms.

The distinction between implicit and explicit knowledge, memory and learning is used in many slightly different meanings in the cognitive sciences. Dienes and Perner (D&P) show how these different meanings can be captured by a system in which the natural language meaning of implicit and explicit is used. In a sense, the title of the article, a theory of implicit and explicit knowledge, is misleading. It is rather a theory of how scientists use the terms implicit and explicit knowledge. A real theory of implicit and explicit knowledge should first answer the question whether it is useful to have the distinction at all (cf. Newell 1973). The interesting point that the D&P theory supports, but fails to capitalize, is that the distinction is not so fundamental after all. In that perceptive it is useful to examine theories that stipulate that the difference is fundamental. The systems theory, for example, stipulates implicit and explicit knowledge is stored in separate memory systems (Squire & Knowlton 1995). The processing theory (Roediger 1990), on the other hand, supposes different processes are used to store and retrieve information. The common property of both theories is that they propose fundamentally different mechanisms in the information processing architecture for implicit knowledge on the one hand, and explicit knowledge on the other hand. So why are these distinctions made? They are needed to explain certain empirical phenomena. Most of these phenomena are so-called dissociations, that show that implicit knowledge is much more robust than explicit knowledge. Implicit knowledge persists over a longer time period, while explicit knowledge is forgotten quickly (e.g., Tulving et al. 1982). Amnesiacs have lost their ability to retain explicit knowledge, although their implicit memory is intact (Warrington & Weiskrantz 1970). In-

dividual differences in implicit learning are small, whether they are due to age or intelligence, while individual differences in explicit learning are large (e.g., McGeorge et al. 1997). These empirical results are part of the reason why we can talk about implicit versus explicit knowledge, in stead of just conscious and unconscious knowledge. And it are these data that need to be explained by a theory of implicit and explicit knowledge. Both the systems and the processing theory are not entirely satisfactory: they propose separate mechanisms to explain the distinction. A unified account would be much more preferable.

Unfortunately, the D&P theory offers only some starting points for a unified explanation. In my view, a proper account of implicit and explicit knowledge should start with a theory of implicit and explicit learning, since the explicitness of knowledge, as D&P indicate, depends on the context in which it is acquired, and whether or not this context is retained. A useful approach is to view the distinction using the ACT-R architecture (Anderson & Lebiere 1998). ACT-R is a cognitive theory implemented in a simulation system, that can be used to model performance and learning on individuals tasks. The architecture encompasses several learning mechanisms. For example, the baselevel learning mechanism keeps track of how often certain information in memory is needed, and adjusts certain activation parameters accordingly. The learning mechanisms, however, are all quite primitive: there is no mechanism that performs analogies or other complex forms of reasoning (as opposed to its predecessor, ACT*). In order to perform complex reasoning, the system needs additional knowledge, which has to be applied in a goal-driven fashion. So in order to gain new knowledge by using

analogy, an explicit analogy goal has to posed, and procedural knowledge needs to be supplied to retrieve an example and find the appropriate mappings. The learning mechanisms of the architecture take care of the fact that the results are stored and evaluated for their usefulness. Implicit learning seems to correspond very well with the learning mechanisms in the architecture. These mechanisms are always at work, are not directly related to the current goals of the system. Since they are not tied to the goals of the system, there are not directly available to consciousness. Explicit learning, on the other hand, is tied to goals, and is dependent on procedural knowledge. This means that a certain type of explicit learning is only possible if the proper knowledge is available. This also explains why individual differences in explicit learning are so large. It also implies awareness, since the acquired knowledge is associated with a learning goal. I have shown (Taatgen in preparation; Lebiere et al. 1998), that this way of looking at the distinction enables explanations for several of the implicit learning phenomena. This theory also avoids a binary distinction between implicit and explicit learning: explicit learning is just a clever way of processing information so that the implicit learning mechanisms pick up the right information. In a sense, all learning is implicit learning.

At this point it is useful to compare this account to the D&P theory. According to D&P, information is more explicit as more information about its justification and attitude is available. In the ACT-R account, information is explicit if there is a learning goal associated with it. This learning goal may serve as a source of justification, since it contains information on the successfulness of the goal, and may also point to other contextual information

like attitudes.

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