tuality and temporal context) were explicit in this patient. From the hierarchical nature of the theory, if high-level elements are explicit, low-level elements must be explicit too, and the patient should be unimpaired on indirect tests. Hence, the impaired performance of this patient on indirect tests presents a real puzzle for the theory.

Equally troubling are the predictions that the theory would make with regard to the ability of successful performance on a direct test to predict performance on an indirect test. If the two tests were administered successively, then successful memory of an item on the direct test would suggest that the high-level elements of the representation for that item were made explicit. Because indirect tests can benefit from elements that have either been made explicit or not, the probability that the item will be produced on the indirect test, conditional on its having been remembered on the direct test, is higher than had it not been remembered on the direct test. This prediction has been disconfirmed. Tulving et al. (1982; Hayman & Tulving 1989) found stochastic independence between word recognition (direct test) and a subsequent word-fragment completion test (indirect test).

Finally, according to D&P, what determines bona fide performance on an indirect test is implicit representation of the elements of a fact (or elements of the attitude or self) that constitute part of the proposition. Presumably, the propositional nature of the representation should be insensitive to format of presentation. Yet format of presentation seems to be a critical factor in predicting implicit memory performance. For example, on tests such as perceptual identification (e.g., Jacoby & Dallas 1981) or word-fragment completion (e.g., Tulving et al. 1982), where subjects are required to identify a visually degraded display, indirect memory performance is diminished, or completely eliminated, if the similarity of retrieval cues (e.g., word fragments) to studied items is reduced by crossing the modality of presentation between study and test (e.g., Jacoby & Dallas 1981; for a comprehensive review, see Roediger & McDermott 1993). Moreover, even when study and test presentations are within the same modality, presenting different study and test materials such as words and pictures (e.g., Weldon 1991) or words in different languages (e.g., Kirsner & Dunn 1989) has been shown to reduce performance on indirect tests. It is unclear how a propositional theory can account for these findings.

Implicit and explicit knowledge: One representational medium or many?

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Abstract: In Dienes & Perner's analysis, implicitly represented knowledge differs from explicitly represented knowledge only in the attribution of properties to specific events and to self-awareness of the knower. This commentary questions whether implicit knowledge should be thought of as being represented in the same conceptual vocabulary; rather, it may involve a quite different form of representation.

Implicit knowledge is characteristic of most human cognition (and, as far as one can tell, of *all* animal cognition). If a proper account could be given of levels of implicit representation, it would therefore have tremendous explanatory power and would open up a way to understanding numerous problems in cognitive science.

A proper distinction between explicit and implicit knowledge is important in the study of conceptual knowledge. When interrogated about the contents of their conceptual knowledge, it is well known that people generate variable and idiosyncratic responses (Rosch & Mervis 1975). For example, in one unpublished study, I examined the relation between the relative importance that people attach to criterial properties of a concept and their judgements of the relative typicality of instances of the same concept. Subjects performed two tasks. The first was to rank order a set of properties in terms of how relevant they were to the definition of a category. The second was to rank order a set of category instances in terms of their typicality. The data were analyzed to measure the similarity between individuals on either task. If people have explicit knowledge of the reasons why they consider some instances more typical than others, and if there is any individual variability amongst the population (as could reasonably be expected), then the similarity of a pair of individuals on one task should be related to their similarity on the other task.

When the two sets of similarities were compared, however, the pattern of similarity between individuals in terms of the centrality of attributes showed no correspondence at all with the pattern of similarity between individuals in terms of instance typicality. It appears then that much of our conceptual knowledge is implicit.

If conceptual understanding is implicit, then the critical question will be how the representational language of explicit knowledge is grounded in implicit knowledge. The challenge is to provide a semantics for knowledge representation with the flexibility of the different levels of explicit/implicit awareness. Is the conceptual representational language the same at different levels of the system, and is it only the predication of properties to objects or events and to the self as knower that differentiates the levels? This would appear to be D&P's view. Or should the representation of knowledge using a vocabulary based on natural language be restricted to explicit levels of representation?

Fodor (1998) has argued strongly against the grounding of explicit concept terms (such as bird or bachelor) in a more implicit set of semantic features or roles. To Fodor, the meaning of the word "bird" is just BIRD – a conceptual atom that is grounded through its symbolic relation to the class of birds in the real world. We may learn that certain propositions hold of birds in general (e.g., that birds are creatures), but this set of propositions – whether necessarily true or not – is not constitutive of the meaning of the concept.

In section 2.2., D&P suggest that an atomic, nondecomposable representation may be thought of as having an implicitly represented property structure. For example, whereas "bachelor" can be decomposed into its component features, on any particular occasion it may be used in an explicit representation without being decomposed. A person may be able to claim, "I knew that I was looking for a bachelor, but I had neglected the fact that the person would have to be unmarried." Yet there is clearly a major difference between this type of atomism and the type advocated by Fodor. Fodor's arguments for conceptual atomism suggest that there is no implicit property structure encoded at some deeper or more hidden level – there is just an informational semantic connection to the class of bachelors, and the possibility of learned generalisations that one could make about the class.

The problem becomes more apparent if one asks that information one would wish to include in the implicit conceptual structure of a representation, and how this information might be constrained or determined. D&P suggest that implicit conceptual structure involves "necessary supporting facts." The closest they come to giving a detailed account of these is when they state, "Using 'bachelor,' oneself commits one quite strongly to 'male' and 'unmarried' lest one show oneself ignorant of the meaning of the word bachelor in the language spoken" (sect. 1).

But in using the term, one is also committed to an indefinite number of other propositions such as "not a vegetable" or "composed of cells containing DNA," while in addition one is committed (to a greater or lesser extent) to all the more prototypical aspects of being a bachelor, such as living alone, wariness of marriage, or fondness for solitude. There is no simple logical way of selecting those aspects of a concept's meaning that should be considered as forming the implicit conceptual structure, from, on the one hand, the indefinitely large number of necessary inferences that follow from the concept, and, on the other hand, the many probabilistically related attributes that characterise so much of our conceptual knowledge.

A clear account of the implicit/explicit distinction with respect to conceptual content is needed in cognitive science. In making connections across disparate fields of cognition, Dienes & Perner have drawn attention to the possibility of offering a unifying account of the distinction, which would have far-reaching consequences. It remains to be seen, however, whether it makes sense to think of the implicit representation of knowledge making use of the same language-like representational medium as is found in explicit conceptualisation.

Making implicit explicit: The role of learning

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Abstract: Three forms of implicit knowledge are presented (functional, structural, and procedural). These forms differ in the way they are made explicit and hence in how they are represented by the individual. We suggest that the framework presented by Dienes & Perner does not account for these differences.

Dienes & Perner (D&P) present a framework for conceptualizing the nature of mental representations that attempts to capture the various natural language uses of *implicit* and *explicit* knowledge. Although D&P find several points of agreement between the different uses of *implicit*, we suggest that they do not adequately capture the nature of "fully implicit" knowledge; hence essential, qualitative differences inherent in the different uses of *implicit* are lost in the D&P framework. There are at least three forms of implicit knowledge: structural, functional, and procedural. The differences between them become apparent when one considers what is needed to make them explicit.

One form of implicit knowledge derives from "property-structure" implicitness (sect. 2.2) in which an explicitly represented property (e.g., "bachelor") is a compound of two or more basic properties (e.g., "unmarried" and "male"). Property-structure implicit knowledge is semantically related to explicit knowledge: One cannot use the word "bachelor" correctly without knowing that it means "unmarried" and "male." For knowledge that is structurally implicit to become implicit, an individual need only consciously reflect on the implications of the explicit knowledge. The explicit property (e.g., "bachelor") acts as a heuristic for recalling the implicit properties and so on individual can easily provide the longer version of the heuristic (i.e., "unmarried and male"). A heuristic represents implicit knowledge in a way that makes it the most available to conscious or explicit representation.

Contextual function is another source of implicit knowledge. As an example of this, D&P point out that certain propositions (e.g., "the present king of France is bald,") presuppose other propositions (e.g., that there is a present king of France). The presupposition is therefore implicit in the first proposition. Presuppositions are given as the "prime case" of contextual function implicitness (sect. 1, para. 6). A similar source of implicit knowledge, not addressed by D&P, is *entailment*. Two or more propositions, when related according to a set of semantic rules, can entail certain other propositions. These entailed propositions are implicitly contained in the original propositions and the semantic rules. For example, in Plato's *Meno* (1986), through the process of questioning a slave boy about geometry, Socrates succeeds in eliciting the Pythagorean theorem. This is a sense of "implicit" that is not easily accounted for in D&P's framework. The logical propositions and the rules by which they are related to create the theorem are explicitly known to the slave boy; it is the way in which they are explicated that is new. This is a unique instance of implicitness. In the case of "bachelor," the implicit constituents are made explicit through the efforts of the individual. In the case of entailments, they are not, although they are recognized as being logical explications. Once explicated, entailments are immediately grasped by the individual, although their previous existence was not explicitly represented.

A final example of implicit knowledge is procedural knowledge. Certain information (e.g., a rule, theory, or concept) is contained implicitly in any procedure. For example, children who are able to balance odd-shaped blocks on a beam have a naïve theory of torque implicit in their balancing procedure (Karmiloff-Smith 1992). For this implicit information to become explicit, however, simply telling an individual the implicit information is not enough. Specific concepts may have to be learned so that children will reflect on their procedure and explicate their theory. In a series of studies, Piaget (1976) investigated children's explicit representations of their actions and found that there is a lag between their ability to perform actions and their ability to describe how they perform these actions. For example, children demonstrated great skill in performing tasks that require centrifugal force (e.g., hitting a target with a slingshot); however, the children's representations of how they succeeded on the task and the actual means by which they achieved the result were discrepant. This is a case where implicit knowledge (the procedure) and explicit representations conflict. How do children become aware of this implicit knowledge? Piaget suggests that this is through the process of "reflexive abstraction," which entails developing new conceptual structures that allow the emergence of this reflexivity. Furthermore, the development of these new conceptual structures may depend on extrinsic factors. Homer and Olson (1999), for example, have found evidence that literacy is responsible for children becoming aware of certain linguistic properties of their speech.

In the examples above, we have presented three different forms of implicit knowledge. One of the essential ways in which these forms differ is in how the implicit knowledge can be made explicit. For structurally implicit knowledge, an individual need only engage in conscious reflection to explicate the implicit knowledge. For functionally implicit knowledge, an individual must be told the implicit knowledge (e.g., presupposition or entailment); however, once told, the implicit knowledge is immediately grasped (i.e., explicitly known) by the individual. For procedurally implicit knowledge, individuals must learn new concepts that can be used to reflect on their procedure. The key point is that these different forms of implicit knowledge become explicit in very different ways. This suggests that they are represented by the individual in qualitatively different ways. We suggest that any framework attempting to capture the nature of knowledge representations must account for these differences.