main two terms of the to-be-learned conjunction, from conditioning or quasi-conditioning paradigms of learning, primarily those that have been frequently characterized as formed by an associative "link." Assuming that "learning" refers to the acquisition of new knowledge, in this commentary I show (necessarily briefly) that the notion that human associative learning is neither automatic, nor necessarily unconscious, has a venerable, nearly century-old history, missing from the target article. Furthermore, propositional structures constitute just one part of organization theories (see Mandler 2007, for a more extended history).

The opposition to unconscious, automatic associative processes started in modern times with the work of G. E. Müller (e.g., Müller 1911) and proceeded rapidly with the development of Gestalt theory. Following the work of Wertheimer (1921), Duncker (1926), and Katona (1940), the time was ripe for a full-scale assault on the mechanisms of associative memory. The initial arguments were primarily presented by Asch (1962; 1969) and Asch and Ebenholtz (1962), and generated specific demonstrations of human associative learning by Bower (1970), Bower and Bryant (1991), Mandler and Mandler (1964), Mandler (1968; 1979a; 1979b), and Murdock (1966). In Mandler (1979b), I suggested three possible structures accounting for human associative phenomena: coordination (holistic, unitary organizations), subordination (hierarchical organizations), and pro-ordination (sequential organization). The last is most like the propositional structure proposed in the target article – *A* followed by *B*.

Relevant to the target argument, my colleagues and I have tested human associative learning and demonstrated that holistic structures characterize the storage of verbal associations. Mandler et al. (1981) showed that in verbal human associative learning (sometimes known as paired-associates), "associations" are stored not as "links," but by combining the two terms in a single holistic unit. Tests of free recall, cued-recall, and recognition supported that conclusion.

Propositions about and tests of organizational theory describe the structure of human semantics – the mental organization of meaningful knowledge and experience. Organization defines the structure of memory. It is obvious that propositional structures depend on retrievals from memory, and, albeit without any detailed discussion of memory, Mitchell et al. too assert the centrality of memorial functions, when in section 3.1 (para. 1) they state that the encoding of an associative hypothesis in memory constitutes learning. Organization theory has generally avoided any distinction between learning and memory. The history of the organizational approach discussed the organization of mental contents, which can be seen as "learned" when established and retrieved once the organizational structure is established. Consistent with such an approach, Mitchell et al. also note that subsequent to a bell-food pairing, a bell can retrieve memories of previous pairings. More generally, it may not be initially obvious which of the possible structures applies to a particular learning experiment or paradigm. At present it is not obvious which experimental or experiential situations give rise to one organization or another. The target article seems to claim that all encodings are propositional; in contrast, we have shown that some are holistic and unitary. Specific experimental procedures and probing and testing procedures need to be developed in order to determine which particular structures eventuate from a specific "learning" situation.

Finally, it does not seem obvious that "we have been heading . . . towards a propositional approach to all learning" (sect. 7.1, para. 3). The holistic encoding of word pairs or the hierarchical organization of some lists argues against a single model of underlying structures. A general organizational approach has asserted for some time that learning is indeed "not separate from other cognitive processes" (sect. 8, para. 1). Organization theory has made it possible to see the connectedness of these various functions and processes.

The Proust effect and the evolution of a dual learning system

Helena Matute and Miguel A. Vadillo
Department of Psychology, Deusto University, 48080 Bilbao, Spain.
matute@fice.deusto.es
http://paginaspersonales.deusto.es/matute
mvadillo@fice.deusto.es
http://paginaspersonales.deusto.es/mvadillo

Abstract: Proust's madeleine illustrates the automatic nature of associative learning. Although we agree with Mitchell et al. that no compelling scientific proof for this effect has yet been reported in humans, evolutionary constraints suggest that it should not be discarded: There is no reason by which natural selection should favor individuals who lose a fast and automatic survival tool.

> And soon, mechanically, weary after a dull day with the prospect of a depressing morrow, I raised to my lips a spoonful of the tea in which I had soaked a morsel of the cake. No sooner had the warm liquid, and the crumbs with it, touched my palate than a shudder ran through my whole body, and I stopped, intent upon the extraordinary changes that were taking place . . . at once the vicissitudes of life had become indifferent to me, its disasters innocuous, its brevity illusory.
> — Marcel Proust (1913/1922), *Remembrance of Things Past*

The episode of the madeleine in the Proust work cited above is one of the most famous passages of universal literature of all times. Not only is it beautifully written, but the passage also describes an experience that is so personal and so ubiquitous in human nature that any psychologist, from Freud to Pavlov, would love to explain it. We will refer to it as the "Proust effect." To our knowledge, it is the best possible description of associative learning.

The beauty of the target article by Mitchell et al. is that it tries to understand the Proust effect in its entirety, not just a part of it. As such, the article is ambitious, important, and timely. It makes us rethink all the established assumptions about learning. Contrary to all intuitions, Mitchell et al. (almost) convince us that (a) there must be only one learning process, and (b) this unique process must be propositional in nature.

The standard explanation for associative learning is the link approach. Because the narrator in Proust's novel had associated the madeleines with all the happiness of childhood (even though he was not aware of this fact), then tasting one of those cakes now, after so many years, brought back the enormous happiness and all the good feelings from childhood. Thus, the Proust effect reflects a simple, automatic link that was created during childhood and is now expressed, also without effort or knowledge of the contingencies, in the form of a conditioned response (CR). According to the link proponents, there was no propositional learning here, no consciousness of the contingencies while the association was acquired; not even now that it is expressed. Indeed, it will still take the narrator many pages and a considerable amount of thinking and elaborated reasoning to discover why the madeleine was producing the CR.

But the link approach is not as simple as it seems, and Mitchell et al. are correct in highlighting this point: The link approach presupposes a dual (and complex) system. Automatic links need to be complemented with some more-elaborated, rational, and time-consuming forms of learning. This complex learning is at work, for instance, after the CR has occurred and the narrator begins to consciously think about it and tries to identify its cause. Even the most enthusiastic proponents of low-level mechanisms have to admit that people are obviously capable of other forms of learning and reasoning.

What Mitchell et al. suggest is that, if we all agree that propositional learning is needed, why should we maintain a belief in automatic links? Couldn't we assume just a propositional learning

process that could account for both the automatic-like and the more complex processes? Are there any experiments that can only be explained by the link mechanism? That there are data to support that propositional learning exists is unquestionable, and the authors make an excellent case of it. That many of the results that have traditionally been explained using the link approach can also be explained by the propositional account is also clear in their target article. Moreover, it is well established today that there are very few experiments that can be explained solely by the link approach (Lovibond & Shanks 2002; Shanks & St. John 1994). What Mitchell et al. are showing is that both the dual and the propositional account can explain the majority of the available evidence. Scientific parsimony becomes then the central argument: If a single process can explain it all, why should science maintain two?

But the argument of scientific parsimony should be confronted against that of natural selection. A simple, low-level process is vital for survival because, by definition, it can do all those things the complex process cannot do: it responds quickly, automatically, and without consciousness or effort to the demands of the environment. Even under high pressure, it provides a fast tool for survival. Its loss would be too costly.

As Mitchell et al. note, natural selection has produced a continuum of complexity in the different species. At one end of this continuum, we find very simple species which have just the link system and no cognition. At the other end, we find the human species, which, according to Mitchell et al., has only the propositional system. If so, Mitchell et al. need to explain why humans (and other evolved animals) should have lost their primitive link system while developing the propositional one. There is no clear evolutionary advantage in losing a fast and automatic tool.

Indeed, there is a growing body of evidence suggesting that learning is actually caused by a multiplicity of different mechanisms and that the insistence of traditional learning theory in a unique, general-purpose learning system was simply a mistake (Gallistel 2000; Tooby & Cosmides 1992; 2005). If natural selection has encouraged flexibility and adaptability, having many different forms of learning must have been favored through the course of evolution.

In sum, Mitchell et al. need to explain not only why consciousness becomes so difficult in the Proust effect, but also what survival advantages a species that extinguishes the link system should have. If all the evidence for the automatic mechanism would come from novels and intuitions, Mitchell et al. would be right that science should ignore it. But we have shown good reasons to believe that the automatic mechanism must still be present in humans. Perhaps the problem is that the Proust effect has always been taken for granted and proofs have not been searched in the right places.

Both rules and associations are required to predict human behaviour

I. P. L. McLaren
School of Psychology, University of Exeter, Exeter, EX4 4QG, United Kingdom.
i.p.l.mclaren@exeter.ac.uk

Abstract: I argue that the dual-process account of human learning rejected by Mitchell et al. in the target article is informative and predictive with respect to human behaviour in a way that the authors'

purely propositional account is not. Experiments that reveal different patterns of results under conditions that favour either associative or rule-based performance are the way forward.

In this target article, Mitchell et al. argue for a propositional account of human learning, rather than a dual-process model that allows for propositional and associative (what they call the "link model") processes to operate concurrently. The issue at hand, then, is whether we need to postulate associative processes in addition to propositional ones; the converse argument, whether we need to postulate propositional processes in addition to associative processes, can be left for another time. But let me be quite clear: I am of the view that we need to appeal to both if we are to understand learning in humans.

The approach taken in this commentary is to point out differences in learning and performance under conditions that should favour either propositional or associative learning. Mitchell et al. consider a number of these cases, but perhaps do not do them justice. I take as my first example their review of the Le Pelley et al. (2005a) demonstration of unblocking in humans. In these experiments, it was demonstrated that a design such as $A- > O_1$ followed by $O_2|AB- > O_1$ followed by O_3 revealed that learning to B was greater for outcome 1 (O_1) than in a conventional blocking design where the second phase had the compound followed by O_1 then O_2. This finding was predicted on the basis of Mackintosh's (1975) associative theory of learning, which has received experimental support in animals other than human. To dismiss it by saying that it is possible that in a complex design the human participants had forgotten earlier trials and knew something had changed but were not sure whether it was O_1 or O_2, ignores this background. As an explanation of the phenomenon, it is terrifically weak. We are expected to allow that propositional learning and an automatic memory (that is definitely not associative?) are both imperfect, and so people make mistakes, which just happen to be the ones that associative theories predict.

This does sound rather implausible, and it is, even though the authors reassure us that it can be tested. Their proposal is to make the outcomes more distinctive, thus reducing any confusion between them, and so the effect (unblocking) should go away. In fact, if the outcomes were made that distinct from one another, the same associative theory that predicted the original result would now predict that the effect would go away as well, as the alpha change that leads to unblocking is to some extent reinforcer-specific in this model. This result has also been found in humans in another experiment by Le Pelley and colleagues (Le Pelley et al. 2005b), in which changing outcomes from those that are generally "nice" to those that are generally "nasty" (and vice versa) prevented alpha effects that were generated by manipulating the predictiveness of certain cues during training. So we are left with a "test" of their account that fails to distinguish between it and the very associative theory that motivated the experiment in the first place. Not much of a test!

Mitchell et al. also fail to take into consideration a number of other studies that demonstrate a different pattern of results when learning is dominated by either rule-based (hence propositional) or associative processes. People show a peak shift, like pigeons, when they are tested on a dimension after relatively little experience with it, and when they are unable to verbalise any rule that captures the discrimination (Jones & McLaren 1999; and see Livesey & McLaren, forthcoming). This pattern of responding changes (to a monotonic function across the dimension) after extensive experience with the stimuli and when people can verbalise the correct rule. In the spirit of the target article, I would expect the response to be that this does not demonstrate associative learning, but instead, incorrect rule induction or imperfect application of a rule in some way. If this characterisation of Mitchell et al.'s position is right, then it is impossible to defend against. There will always, with sufficient ingenuity, be some incorrect or imperfect rule that can be appealed to