DISCUSSION (1)

Prior to beginning work on this discussion, read the APA's Ethical Principles of Psychologists and Code of Conduct (Links to an external site.)in its entirety, paying special attention to standards 8 and 10 that cover ethics in research and therapeutic practice. Oftentimes research methods courses discuss the ethics of research and focus on historic examples of unethical research studies. This discussion of ethics will involve a different focus. The Ethical Principles and Code of Conduct (Links to an external site.) presents information on ethical standards and expectations that apply to specific situations, including therapy and research. Explain the differences between the ethical standards for clients being treated by psychologists in counseling sessions and the standards for conducting psychological research with human participants. Consider your future career in the field of psychology and describe the parts of the Ethical Principles and Code of Conduct (Links to an external site.) you expect to relate directly to your future career. Select and provide the number for one ethical requirement that applies specifically to psychological research and briefly summarize the standard. Explain why this requirement may not apply to a therapy situation. Provide a substantive response. Please do not include the question prompt in your initial post.

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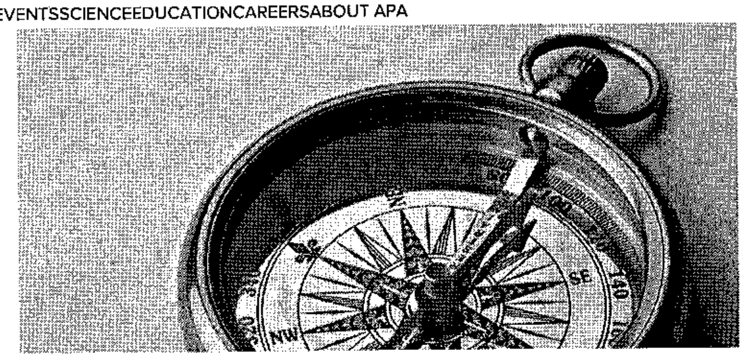

Ethical Principles of Psychologists and Code of Conduct

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- Revision of Ethical Standard 3.04 of the "Ethical Principles of Psychologists and Code of Conduct" (2002, as Amended 2010) (PDF, 26KB)
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Cognitive Psychology   Assignment (1)

For this assignment you will apply the first step of the scientific method by identifying a topic and explaining its importance in the field of psychology. Choose a topic of interest to you in psychology that is relevant to your current or future career, and search the databases in the Ashford University Library for a published peer-reviewed literature review on the topic. Evaluate the literature review and describe whether or not it provides multiple perspectives and or results on the topic, or if the author is including only those studies that prove his or her original hypothesis. Using the literature review as a reference, compare the characteristics of the different research methods that have been used to study this topic. Summarize what is known about the topic based on the evidence presented in the literature review.

The paper

- Must be two to three double-spaced pages in length (not including title and reference pages) and formatted according to APA style as outlined in the Ashford Writing Center (Links to an external site.).
- Must include a separate title page with the following:
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Evolutionary Theory Meets Cognitive Psychology: A More Selective Perspective

LAWRENCE SHAPIRO AND WILLIAM EPSTEIN

Abstract: L. Cosmides and J. Tooby, leaders in the field of evolutionary psychology, have claimed that an evolutionary perspective toward psychology requires both that psychologists conceive of psychological processes as domain specific and that psychologists view all adaptive behavior as the product of cognition. In fact, we argue, an evolutionary perspective commits psychology to neither of these positions. The real value of evolutionary theory for psychology, we contend, lies in the heuristic role it plays in determining the function of psychological mechanisms and in the depth it contributes to explanations of why psychological processes have the properties they do.

> Quite unexpectedly, cognitive psychologists find their field intimately connected to a whole new intellectual landscape that had previously seemed remote, unfamiliar, and all but irrelevant. Yet the proliferating connections tying together the cognitive and evolutionary communities promise to transform both fields, with each supplying necessary principles, methods, and a species of rigor that the other lacks. (Cosmides and Tooby, 1994, p. 85)

Recent years have seen a growing movement to wed evolutionary theory to cognitive psychology, and among the matchmakers pushing for this marriage Cosmides and Tooby have been especially outspoken. We too think the match will be a fruitful one, but we disagree with C&T that the resulting union is likely to transform cognitive psychology in any drastic way. C&T, as well as other workers in what is sometimes called *evolutionary psychology*, are inclined to describe a Darwinized cognitive psychology as a radical departure from traditional cognitive psychology. In particular, C&T believe that an introduction of evolutionary thinking into cognitive psychology will

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transform the field in two ways. The first transformation brings a new way of conceiving of cognitive processes. Traditionally, C&T claim, cognitive psychologists have assumed that cognition is governed by a few general-purpose processing rules, as applicable in one domain as in any other. Consideration of human evolution, however, will show this view to be incorrect; and replacing it will be a modular view of the mind in which cognition consists of numerous kinds of processes, each kind precisely tailored to a specific domain. The second transformation concerns the subject matter of cognitive psychology. The facts of human evolution will reveal, C&T believe, that *all* of human behaviour must be the product of cognitive processes. Accordingly, cognitive psychologists interested in explaining behaviour have much more work to do than they previously thought.

In this paper, we present a more tempered view of the changes evolutionary theory is likely to bring to cognitive psychology. It is our hope that a more selective view of the impact evolutionary theory will have on cognitive psychology will ease the merger of the two fields, providing evolutionary psychology with a future free of unnecessary encumbrances. In particular, we will dispute C&T's claim that an evolutionary perspective will force cognitive psychologists to abandon their search for domain-general processes in favour of domain-specific ones. One cannot deduce domain-specificity from the theory of evolution by natural selection, as C&T sometimes suggest. On our view, questions about the breadth of a domain are at bottom empirical and must be examined on a case by case basis. As we show, psychology today is not 'coming around' to a domain-specific view of mind, as C&T intimate. Rather, psychology is in a state of flux on this issue.

In the second part of the paper, we criticize C&T's claim that evolutionary considerations require cognitive psychologists to accept the view that all behaviour is under the control of cognitive programmes. While this view seems obviously false upon brief reflection, it is worth discussing in order to draw distinctions between kinds of behaviour-producing mechanisms that are often lumped together. We suggest that behaviour can be the product of systems that may appear anywhere along a cognitive continuum, with noncognitive and nonrepresentational mechanisms at one end and mechanisms of the sort C&T describe at the other. While cognitive psychologists ought to continue to investigate processes at the cognitive end of the spectrum, and even some that lie between the two ends of the continuum, there is no reason, we think, to hold cognitive processes responsible for all behaviour.

Finally, we conclude the paper with some remarks about what we take to be the positive significance of evolutionary theory for cognitive psychology. We argue that evolutionary theory contributes both to the methodology and explanatory power of cognitive psychology. For this reason, the wedding of evolutionary theory and cognitive psychology has our warmest blessings. We urge only that the marriage not take place under false pretences.

1. Domain-Specificity and Cognitive Psychology

Perhaps the greatest impact C&T believe evolutionary theory will have on cognitive psychology will be its tendency to steer research away from domain-general cognitive processes and toward domain-specific ones. The term 'domain' receives a variety of interpretations in the writings of evolutionary psychologists.[1] While all might agree that a domain is a body of information, some, like C&T, tend to conceive of domains as consisting of information that has been significant in our evolution. Language, on this view, is a domain insofar as linguistic utterances compose a kind of information to which we have been selected to respond. Information about social relations also constitutes a domain, as does information about predators, food sources, etc. In contrast to this evolutionary taxonomy of domains, some psychologists might extend the meaning of 'domain' to include bodies of information that would have been of no importance to our Pleistocene ancestors. On this second way of conceiving of domains, information about chess might form a domain. However, as we understand the current excitement over domains, the interesting questions focus less on how to characterize a domain and more on the nature of the mechanisms that access and process the information in a domain.

In defending a domain-specific view of cognition, evolutionary psychologists take themselves to be challenging the claim that there are a few rules or strategies that serve in the processing of all kinds of information, i.e. across all domains. 'Traditionally,' C&T claim, 'cognitive psychologists have assumed that the human mind includes only general-purpose rules of reasoning and that these rules are few in number and content-free' (1992, p. 179).[2] Once considerations of our evolution by natural selection are brought to the fore, C&T believe, we will see that cognition is more likely to consist of 'many mental rules that are specialized for reasoning about various evolutionarily important domains, such as cooperation, aggressive threat, parenting, disease avoidance, predator avoidance, object permanence, and object movement' (1992, p. 179). This statement of the goals of traditional cognitive psychology and the contrasting Darwinized view of cognitive psychology with which it is to be replaced is a common one. As another example, Hirschfeld and Gelman (1994, p. 3) claim that:

> According to a long predominant view, human beings are endowed with a general set of reasoning abilities that they bring to bear on any cognitive task, whatever its specific content. Thus, many have argued, a common set of processes apply to all thought, whether it

1 See the papers collected in Barkow, Cosmides, and Tooby, 1992 and Hirschfeld and Gelman, 1994, for confirmation of this point.

2 See also C&T, 1987: 'Many cognitive psychologists assume that the human mind is a general-purpose computer with domain-general, content-independent processes' (p. 285).

> involves solving mathematical problems, learning natural languages, calculating the meaning of kinship terms, or categorizing disease concepts. In contrast to this view, a growing number of researchers have concluded that many cognitive abilities are specialized to handle specific types of information. In short, much of human cognition is domain-specific.

While our main concern in this section is to argue that appreciation of evolutionary theory does not commit the psychologist to a domain-specific view of mind, it is important that the evolutionary psychologist's portrait of traditional cognitive psychology not go uncontested. While it is true that *some* cognitive psychologists, e.g. Newell and Simon (1972), have offered domain-general descriptions of mental processes, these figures can hardly be said to define the cognitive tradition. Indeed, other cognitive scientists, most notably Chomsky (1975, 1980) and Fodor (1983), have been unrelenting advocates of domain-specific approaches in psychology. It is for this reason ironic that evolutionary psychologists bemoan the 'traditional' cognitive psychologist's domain-general view of mind while at the same time applauding the Chomskian programme. If Chomsky is not central to the cognitive tradition, no one is. In contrast to the evolutionary psychologist's depiction of traditional cognitive psychology, we believe that cognitive psychology simply *has* no tradition with respect to domains. Some psychologists have attempted to explain all cognition in terms of a few general-processing rules; others have adopted the view that the mind consists of specially dedicated cognitive modules; still others have sought to combine these approaches.

Moreover, not only is the evolutionary psychologist's portrait of traditional psychology suspicious, but the suggestion that cognitive psychology is moving in a domain-specific direction is inaccurate. In fact, there is among psychologists today no consensus regarding the specificity of processes underlying particular psychological abilities. This is true even of an area of cognition that has long been a stronghold for advocates of domain-specificity: language acquisition. We discuss this case in more detail below. Now, however, it is time to turn to an argument C&T believe challenges the plausibility of domain-general cognition. As we shall see, the argument they invoke suggests instead a reason to believe domain-general processes might have a significant place in our cognitive economy after all.

C&T argue against the possibility of domain-general processes in the following way. Organisms face a variety of adaptive problems, i.e. long-standing problems the solutions to which have required that species evolve in characteristic ways. C&T conceive of adaptive problems as defining domains for which cognitive processes have evolved. The catalogue of adaptive problems includes things such as mate selection, predator avoidance, kin selection, optimal foraging, disease avoidance, etc. Moreover, because success and error are defined relative to a specific problem, cognitive programmes that lead to success in one domain will lead to error in another. In an example C&T discuss, they point out that successful mate selection requires that an organism avoid mating with kin. In contrast, kin selection theory leads us to expect that interactions with kin can be quite beneficial to an organism. So, while avoiding kin counts as a successful strategy in one context, it counts as error in another. C&T conclude, 'Because what counts as the wrong thing to do differs from domain to domain, there must be as many domain-specific cognitive mechanisms as there are domains in which the definitions of successful behavioral outcomes are incommensurate' (1994, p. 92).

This argument may be convincing against the possibility of a single cognitive system that, with a few general rules, could solve any number of complex adaptive problems. However, one need not be committed to such a system to believe that some cognitive processes are domain-general. Indeed, the argument seems to rest upon a confusion that becomes evident in the following parody:

> Tightening screws requires turning them to the right. Loosening screws requires turning them to the left. Because what counts as success or error differs between the two tasks, there must be at least two different kinds of screwdrivers—one for tightening screws and one for loosening them.

The conclusion doesn't follow, because the argument fails to take note of the possibility that a single screwdriver can be employed in two distinct ways: it fails to distinguish the tool from the uses to which it is put. For similar reasons, the argument fails to establish that selection will favour distinct cognitive processes for the solution of every adaptive problem. Cognitive processes can be considered tools and, like the screwdriver, they can be used in ways that make them valuable in the solution of different kinds of adaptive problems.

Put simply, C&T's argument for domain-specificity makes the mistake of identifying cognitive processes with the tasks or goals in which cognitive processes serve. In fact, the adaptive problems they discuss cross-classify cognitive processes. That is, we should expect to see a variety of cognitive processes involved in the solutions to each of the adaptive problems they mention and, as the screwdriver parody suggests, it is quite possible that the same cognitive processes will figure in the solutions of many different kinds of adaptive problems. To assume otherwise is to risk the need to posit distinct cognitive mechanisms for every task an organism is able to perform. Surely, however, this would mark an untenable profligacy in cognitive theorizing. Must there be a mechanism for recognizing snakes and another for recognizing spiders? Are the processes that yield memories of apples distinct from those yielding memories of oranges? It simply does not follow from the fact that different adaptive problems require different kinds of solutions that an organism will have as many pieces of cognitive equipment as there are adaptive problems it must solve.

C&T's example of the conflicting strategies that the problems of mate selection and kin selection impose is relevant here. Avoiding kin proves to be a good strategy for solving the first problem but a bad one for the second. Nevertheless, the solution to either problem requires that the organism distinguish kin from non-kin. Accordingly, a single cognitive process that allows for the recognition of kin might be a useful tool for solving either problem. Rozin and Schull (1988) make a similar point about the mechanisms a rat employs in searching for food. 'Many mechanisms, such as the spatial mapping abilities involved in food search and storage,' they claim, 'also subserve other major functions, such as predator avoidance' (p. 535). Too much specificity may not make evolutionary sense. If a mechanism useful in one domain can be usefully employed in another, it may make evolutionary sense to do so. This is even more obvious when one considers the number of adaptive problems that organisms solve with the aid of visual processes. It is absurd to suppose entire visual systems, including eyes, have to develop every time vision would benefit an organism confronted with some new adaptive problem. Why develop new eyes with which to find kin when one can use old eyes that have served well in the detection of predators? Likewise, why develop a new process for recognizing kin when one has already in place a process that allows avoidance of kin when searching for mates? We should not be surprised if natural selection has recruited extant cognitive capacities for new purposes rather than going to the trouble of developing new capacities every time a novel problem comes along.[3]

Having now argued that domain-general processes have some evolutionary plausibility, we are in a position to consider some recent work in cognitive psychology that attempts to reconceptualize in domain-general terms the process of language acquisition. The summary we offer of this work, we stress, is not intended as an endorsement. Rather, the point to draw from it is that conclusions about domains ought not to spring, like Athena, preformed from someone's head, but must develop incrementally as a result of painstaking empirical investigation.

As is now familiar, Chomsky's analysis (1957, 1959, 1975, 1980) of the challenging demands of first-language acquisition convinced him that an account which relied exclusively on the power of a general learning mechanism could not succeed. While the original target of Chomsky's critique was Skinner's behaviourist treatment of language, the lesson was intended to have broad application. On Chomsky's analysis any empiricist theory stressing a domain-general learning mechanism was preordained to fail. The bar to success is the nature of the language environment the preverbal child encounters. The language environment, according to Chomsky, is too noisy and impoverished to support reliable learning. Given the unimpeachable fact that all but a few young children do acquire their native language and the putative fact of informational impoverishment, there seemed no recourse but to attribute to the child an innate endowment that makes language acquisition possible. For this reason, Chomsky proposed that the child is equipped

[3] Sterelny, 1995, independently develops a similar point.

by evolution with a special language organ containing whatever domain-specific knowledge of the structure of language is necessary for learning a first language.

Chomsky's proposal has been received enthusiastically by linguists and cognitive psychologists who study the psychology of language (see, e.g., Pinker, 1994). However, it has never gone unchallenged (e.g. Bates and MacWhinney, 1982; Maratsos 1982) and, with the advent of connectionism, these challenges are increasingly difficult to dismiss. Connectionist theories of language acquisition (e.g. MacWhinney, Leinbach, Taraban, and McDonald, 1989; McClelland, 1989; Plunkett, 1995, forthcoming) often contest both Chomsky's premise and his conclusion. They contend that Chomsky has underestimated the structure of the young child's language environment and that it is unnecessary to invoke an innate domain-specific mechanism or innate domain-specific knowledge to get first-language learning off the ground. The child's language environment does, they claim, exhibit recurrent regularities. A relatively simple domain-general learning mechanism which is sensitive to the regularities in the language is sufficient to support first-language acquisition.

The dispute has advanced significantly beyond the stage at which contesting intuitions are given rhetorical expression. The connectionists are committed to empirical tests. These take the form of exposing an artificial neural network which embodies a general learning algorithm to a representative segment of the language environment the child encounters. Will the network learn the critical features of the language, e.g. past tense constructions, in the absence of rules (innate knowledge) and supervision? Success would seriously challenge Chomsky's assessment and weaken the appeal of domain-specific modularity in the treatment of cognition. Unsurprisingly, considering the stakes, the connectionist views have not been received uncritically (e.g. Pinker and Prince 1988).

As we said earlier, successful applications of connectionist models are only in the way of existence demonstrations: they show that it is possible to formulate a plausible account of language acquisition which has at its core a domain-general learning algorithm. Admittedly, more is needed to warrant the conclusion that the process of language acquisition does in fact conform to the process embodied in the artificial network. In the interim, should we adopt a sceptical stance on the grounds that the connectionist approach does not respect the alleged preference for modularity as articulated in C&T's argument from the evolutionary perspective? We think that such scepticism grounded in a priori dogma would be misguided. The fate of the connectionist enterprise will be determined by the results of empirical investigation, not by the results of a litmus test set by promoters of the evolutionary perspective.

To summarize this section, the first transformation C&T claim evolutionary theory will force upon cognitive psychology is, we believe, ill-advised. Traditional cognitive psychology is not committed one way or another to domain-generality. Furthermore, the fact that cognition has evolved does not mean that cognitive processes consist in domain-specific mechanisms.

Whether and how much of cognition is domain-specific will be determined in the psychologist's laboratory.

2. *Cognition and Behaviour*

It cannot be denied that we often exercise our cognitive capacities in tasks that have no adaptive value. While we might take pleasure in a game of bridge, or spend the night in the grip of a mystery novel, neither of these activities confers any reproductive advantage upon us. Nonetheless, they are examples of behaviours and, moreover, behaviours that make use of cognitive capacities. Clearly, then, cognition affords behaviour beyond that which adapts an organism to its environment. The burden of this section is to argue for something like the converse of this fact: many behaviours that adapt an organism to its environment will not be the products of cognitive processes, where, standardly, a cognitive process is understood to involve rule-guided transformations of representations. In endorsing this noncognitivist view toward at least some adaptive behaviour, we are again in disagreement with C&T's forecast for a Darwinized cognitive psychology. The claim that all adaptive behaviour is the product of cognitive processes portends, C&T think, a necessary transformation of cognitive psychology:

> As a scientific matter, mechanisms describable at the cognitive level underlie and organize all of human thought and behavior—not just knowledge acquisition—and so cognitive psychology needs to broaden its scope to include them. This changes cognitive psychology into a wide-ranging discipline in which every kind of behavior or psychological phenomenon must eventually be addressed. Indeed, once cognitive psychologists begin to consider what kind of mechanisms would have been capable of generating adaptive behavior under ancestral conditions, the area of inquiry is explosively expanded. (1994, p. 105)

We saw earlier that the tendency toward domain-specificity in cognitive psychology that C&T foresee is at the very best premature. In the present case, we think C&T's prediction of a transformation is again hasty. Before elaborating this point, it is worth discussing in more detail why C&T believe that all adaptive behaviour must have roots in cognition.

Evolutionary psychologists like C&T are understandably impressed with the extraordinary skill organisms exhibit when hunting for food, or selecting a mate, or deciding with whom to cooperate. These tasks present an organism with problems of staggering complexity. When foraging for mussels, for instance, a crab must make decisions that require evaluating a number of tradeoffs: larger mussels contain more food but are more difficult to open; smaller mussels are more common but less nutritious; increased searching time yields more mussels but makes one more vulnerable to predation (Elner and Hughes, 1978). Which mussels ought a crab to choose and how long ought it to spend searching in a given mussel patch if it is to forage most efficiently? Complexities of other sorts present themselves when trying to decide how much help one should offer kin at cost to one's self. As Hamilton showed, selection will favour helping behaviour when cost to self is less than the benefit conferred upon the kin member multiplied by the coefficient of relatedness the kin member bears to self (Hamilton, 1964). Like the foraging example, the decision to cooperate seems to require complex calculations if fitness is to be maximized.

In short, every organism, it appears, must be able to solve problems of remarkable difficulty in order to compete successfully with other organisms or meet the challenges an unforgiving environment imposes. That organisms do seem capable of making the right decisions often enough shows, C&T claim, that they are 'guided by cognitive programs that can solve certain information-processing problems that are very specific' (1994, p. 97). Continuing their example of kin selection, C&T contend that:

> To confer benefits on kin in accordance with the evolvability constraints of kin selection theory, the organism must have cognitive programs that allow it to extract certain specific information from its environment: Who are its relatives? Which kin are close and which distant? What are the costs and benefits of an action to itself? To its kin? The organism's behavior will be random with respect to the constraints of kin selection theory unless (1) it has some means of extracting information relevant to these questions from its environment, and (2) it has well-defined decision rules that use this information in ways that instantiate the theory's constraints. (1994, p. 97)

This view that adaptive behaviour requires both information about the environment and decision rules for its processing is one that C&T emphasize time and again. Discussing kin selection elsewhere, for instance, they claim that a 'species may lack the ability to confer benefits on kin, but if it has such an ability, then it has it by virtue of cognitive programs that produce behavior that respects this constraint' (1987, p. 287). And, in general, they suppose, '*Adaptive behavior is predicated on adaptive thought*: an animal must process information from its environment in ways that lead to fit behaviors while excluding unfit behaviors' (1987, p. 283, their italics).

It is one thing, however, to note the complexity of a given problem; another to infer from this anything about the nature of a given solution. Certainly the complexity of adaptive problems does not entail, in the logical sense, that their solutions must utilize cognitive processes. Why should we expect that cognition is the only route to successful solutions of difficult problems? In defence of this expectation, we might reconstruct from C&T (1987) an argument that does indeed go beyond a mere appeal to the complexity of the adaptive problems organisms face. The argument pivots upon the claim that adaptive behaviour is best described at a functional level of explanation—a level of explanation that is somehow connected with a cognitive level of explanation:

> *When applied to behavior, natural selection theory is more closely allied with the cognitive level of explanation than with any other level of proximate causation. This is because the cognitive level seeks to specify a psychological mechanism's function, and natural selection theory is a theory of function.* (1987, p. 284, their italics)

This argument, however, is too quick. It is not clear why the second claim is offered as justification for the first, and so why we might expect all behaviour to depend upon cognitive processes. A brief discussion of what is meant by *levels of explanation* suffices to show that C&T's argument provides no reason to regard cognitive processes as the most likely causes of adaptive behaviour.

This claim that objects or events lend themselves to distinct levels of explanation is one that is familiar in both philosophy and psychology. In philosophy the idea of multiple levels of explanation is often tied to the notion of multiple realizability. Jerry Fodor (1974) has articulated this connection quite clearly. The heart, for instance, exists as a physiological kind at the level of explanation that characterizes its role in the circulatory system of an organism. When classifying something as a heart, it is the functional properties of the heart that are important. The material stuff in which these functional properties are realized can, for purposes of understanding circulation, be ignored. It is for this reason that functional kinds are in principle (if not in fact) multiply realizable: functional kinds have identity conditions distinct from those of their realizing materials. Significantly, multiple realizability has provided the philosopher with a succinct way of making the point about levels of explanation. We have reason to believe that there are various levels of explanation because we have reason to believe that a single kind from the perspective of one science, e.g. physiology, can be constituted in kinds that, from the perspective of another science, e.g. chemistry, are quite heterogeneous.[4] Whenever a level of explanation individuates its kinds by

[4] In psychology, discussion of levels of explanation is especially prominent in the work of David Marr. Famously, Marr urged that we approach the study of vision from three distinct levels. At the computational level the investigator theorizes about the function of vision as well as the tasks various modules in the visual system must perform in order to contribute to this function. However, the computational level remains silent about the specific algorithms and representations the visual system employs to perform its function. It is at the representational level of the theory of vision that answers to these questions are sought. Finally, the theorist operating at the implementational level seeks to discover the physiological mechanisms that instantiate the algorithms and functions described by the other levels. Note that Marr's discussion of levels of explanation is directed toward an end that differs from that which Fodor had in sight. For Marr, the distinction between levels is supposed to aid in the investigation of some psychological phenomenon. While the levels of explanation are distinct, they are distinguished for the sake of understanding vision, and work that goes on at one level is intended to help facilitate work at the other levels. Fodor's reason for discussing levels, in contrast, is to

reference to functions, it seems plausible that its kinds may be multiply realizable in kinds that other levels of explanation specify.

Returning now to C&T's point about adaptive behaviour and cognition, we see that the connection they see between the two cannot be sustained by appeal to levels of explanation. C&T are correct that the cognitive level of explanation, i.e. the level of explanation that contains the categories and concepts necessary to identify cognitive phenomena, attributes functions to psychological mechanisms. Moreover, we can agree that at more proximate levels of explanation these cognitive phenomena become unrecognizable *qua* cognitive. In terms we introduced above, cognitive processes can be multiply realized in kinds that are heterogeneous from the perspective of the realizing sciences. Finally, we can agree with C&T that the theory of natural selection makes use of functional language when categorizing the behaviour of organisms. However, C&T go wrong in believing that this collection of observations implies that the cognitive level of explanation is the only level at which to describe the causes and functions of adaptive behaviour. For, while it is true that the cognitive level of explanation attributes functions to cognitive mechanisms, it is not the only level of explanation that attributes functions to its kinds. Physiologists, as we have just seen, certainly attribute functions to physiological kinds. Hence, simply because functional talk appears at the cognitive level does not make it any more or less suited to explaining adapted behaviour than any other explanatory level that ascribes functions to its kinds. Indeed, the argument quoted above can be restated in such a way as to make physiology, rather than cognition, the cause of all adapted behaviour:

> *When applied to behavior, natural selection theory is more closely allied with the physiological level of explanation than with any other level of proximate causation. This is because the physiological level seeks to specify a behavioral mechanism's function, and natural selection theory is a theory of function.*[5]

We conclude that C&T's argument for the connection between cognition and adaptive behaviour does not hold up.

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criticize a reductionist view of science. Reduction is blocked, Fodor thinks, because the kinds of 'higher' sciences will be met by a heterogeneity of kinds at 'lower' levels. Despite these differences, however, Fodor's observation about multiple-realizability also serves well in an explication of Marr's levels. There are conceivably numerous physiological kinds, from the perspective of the implementation level, that can realize what at the representational level is a single kind of algorithm; likewise, there are conceivably numerous algorithmic kinds, from the perspective of the representational level, that can realize what at the computational level is a single kind of function.

[5] We have replaced the term 'psychological mechanism' in C&T's original argument with 'behavioural mechanism'. Doing so avoids reducing their argument to triviality, on the assumption that a psychological mechanism is by definition something that is best explained at the cognitive level.

So far our discussion of C&T's claim that all adaptive behaviour must be the consequence of cognitive processes has been at a fairly abstract level. We have argued that neither simple appeals to the complexity of adaptive problems organisms must solve, nor the fact that the cognitive level of explanation ascribes functions to behavioural mechanisms, provides reason to believe that behaviour and cognition must be tied together in the way C&T believe. It's time now to make our case against C&T more concrete. In the following, we describe a variety of complex and adaptive behaviours. Important in the present context is the fact that these behaviours can be explained without reference to robustly cognitive processes of the sort that C&T believe underlie all complex and adaptive behaviour. As an alternative to this view, we hold that the processes producing adaptive behaviour lie along a cognitive continuum. At one end of this continuum are processes that are best described in wholly mechanistic terms and it is only at the other end that we find full-blown cognitive processes like those C&T describe. Between these two end points are processes that might usefully be described as involving the pick-up of information or the detection of stimulus invariants. Perhaps worth distinguishing from these intermediate processes are others that, while still not cognitive, utilize representational states. Distinctions between these intermediate processes are often difficult to articulate with great clarity, but we must anticipate such difficulty when examining processes that lie along a continuum. When natural divisions are fuzzy, we should expect our perception of these divisions to be blurry. With this concession in mind, we turn now to examples of behaviours whose origins seem to us quite distinct from the sort C&T require for the production of complex and adaptive behaviour.

It's well known that many organisms contain mechanisms that tune their behaviour to daily cycles. It is clear that these circadian rhythms are adaptive: without them trees might bud too early, bears might emerge from hibernation too soon, bats might leave their caves too late to forage efficiently, etc. Clearly many organisms need to know when one day ends and the next begins. This 'need to know', however, should not be taken too literally. Organisms can track time without knowing anything about time. Time-keeping does not have to be a cognitive process, in the sense of a process that performs calculations or inferences upon representations of the environment. So, while some organisms may keep track of time by representing the angle of the sun above the horizon and calculating accordingly, other noncognitive and nonrepresentational solutions can suffice as well.

Consider, for example, the mechanism by which the fruit fly controls its daily rhythms. Such regulation is important for the fruit fly for, among other things, it dictates the proper time at which the fly is to emerge from its pupa. Here is the latest theory of how the fruit fly's internal clock works (Barinaga, 1995). In the nuclei of fruit-fly cells are two genes, called *per* (for *period*) and *tim* (for *timeless*). During the day *per* and *tim* produce proteins, PER and TIM, that accumulate in the cytoplasm of the cell. As the concentration of PER and TIM in the cytoplasm increases, they begin to bind to each other, forming dimers. Once in the form of dimers, the PER and TIM proteins are capable of re-entering the nucleus and, upon doing so, their presence shuts down the protein synthesis activities of the *per* and *tim* genes. Protein levels in the cytoplasm drop, and the cycle begins once again.

The point to notice about this description of the fruit fly's internal clock is that it is neither cognitive nor representational. Attributions of inferential capacities, or representational states, do not belong in this account of time-keeping, for they would only obscure a phenomenon that already has a clear explanation at the level of molecular biology. Without promising further insights about the workings of the fruit fly's internal clock, the introduction of cognitive or representational talk in its explanation is unwarranted. Here, then, is an example of adaptive behaviour that is produced by a noncognitive and nonrepresentational mechanism.

Furthermore, because the explanation of the fruit fly's internal clock is noncognitive and nonrepresentational, it is not an explanation that cognitive psychologists have any business trying to make. Without attempting to define precisely the kinds of *explananda* that fall within the confines of cognitive psychology, we would venture as a plausible characterization of these *explananda* that they must involve representational states. This means that cognitive psychologists will attempt to offer explanations of some causes of adaptive behaviour while not of others. Indeed, understanding the internal clocks of *some* organisms *might* require the use of concepts like representation and inference. In such a case, the workforce needed to understand circadian rhythms will be divided. Cognitive psychologists will explain the mechanisms behind rhythmic behaviour in some organisms, but explanations of the same kind of behaviour in other organisms might fall to molecular biologists. Exactly how many of an organism's (including a human being's) adaptive behaviours are the products of noncognitive and nonrepresentational mechanisms is, we suggest, an empirical question; but we may have to accept that noncognitive and nonrepresentational mechanisms might be in charge of many adaptive behaviours.

The study of perceptual processes affords yet another class of examples that are not cognitive in the sense that C&T suppose. Now it must be recognized that there is a venerable and widely endorsed tradition in the theoretical treatment of visual perception which considers the process underlying perception to be inferential in nature (e.g. Helmholtz, 1867; Ittelson, 1962; Gregory, 1970; Rock, 1983; Shepard, 1990). According to this traditional view, the perceptual process is a process of unconscious inductive inference that differs from ordinary inference only in being inaccessible to conscious expression and control. On this view, the perceptual process is a cognitive process in every important sense. Familiarity with this tradition may have encouraged C&T to look to the attainments of the visual system to support their thoroughgoing cognitivism. But their unreserved enthusiasm for cognitive just-so stories can be shared only by ignoring two highly visible dissenting trends in contemporary perceptual theory. Gibson (1979) and Marr

(1982) disagree about much but they agree in rejecting the cognitivist point of view.[6]

In Gibson's theory of direct perception, the perceptual process entails neither representations nor cognitive operations, but only the pick-up of stimulus invariants. Consider the adaptively significant class of behaviours constituting visually guided interceptive action. We have selected this class because it seems plausible that the ability to intercept moving objects and the ability to avoid interception by moving objects must have been an important ability for our Pleistocene ancestors. From a cognitive perspective, these competencies might be attributed to a three-step cognitive/perceptual computational routine: first independent representations of velocity and distance are computed; then these representations are entered into an algorithm which derives the point of interception. On this account, the solution is the product of unconscious cognitive operations over representations. In fact, the contemporary account of interceptive behaviour is very different. Evidence is growing (Babler and Dannemiller, 1993; McBreath, Shaffer and Kaisser 1995; Tresilian, 1995) that interceptive action is governed by a noncognitive, nonrepresentational process that is sensitive to a variable of spatiotemporal optical structures that specify the point of interception and that direct the action of the motivated actor. On this neo-Gibsonian account, perceiving the point of interception is not the product of inferential reasoning; the point of interception is picked out by the optical variable with which that environmental variable is lawfully related. Moreover, it is not supposed that the actor first computes the point of interception and then computes a compliant action. The information in optical structures simultaneously specifies both the point of interception and the effective action. It is too early to pass conclusive judgment on these efforts. But they offer the prospect of a satisfyingly simpler account of this class of behaviours. Given the problems associated with the psychology of rules and representations, any respite in the form of noncognitive processes is welcome.

Marr differs significantly from Gibson in proposing that the process of perception is a process of representational transformation. In this respect, Marr's theory is like the more traditional cognitive theory of perception. But for Marr the operations that execute the transformations are noncognitive. The algorithms that make explicit the structure in the raw sensory input and the algorithms that transform these representations of early vision into viewer-centered representations and finally into object-centred representations are not cognitive operations. The algorithms exploit regularities of

[6] C&T often hold up Marr as an example of how cognitive psychology will be done once the proper evolutionary perspective is in place. This use of Marr is doubly troubling: in the first place, Marr himself rarely makes any explicit mention of evolutionary theory (see section 3). Hence, it is unclear why C&T think the introduction of evolutionary theory should make a difference to cognitive psychology. Second, as we observe here, Marr departs from the standard inference-from-knowledge view of cognition that C&T presuppose.

the environment but the regularities are not represented or used as premises in the algorithm. The regularities, the 'constraints', are in the environment and not in the head. Moreover, the algorithms, having evolved in an environment that instantiates certain regularities, will reflect these regularities in their design, but it should not be supposed that these constraints make up a body of knowledge for use in the construction of inferences about the world. The fact that the writings of the computationalists exhibit occasional lapses into the language of cognitive activity, e.g., inferring 3-D shape from 2-D silhouettes, image interpretation, that the visual system exploits assumptions, should not be misconstrued as a tacit commitment to cognitivism. The language of cognition is here only a manner of speaking.

An example will help to distinguish the computational approach from the richly cognitive accounts of psychology C&T describe. When a human observer examines a 3-D object that rotates or oscillates along one of its axes, the retinal projection of the object will undergo transformations. Comparable transformations will result when an observer circumambulates a stationary 3-D object. Despite the plasticity of the retinal input, the observer will perceive a rigid 3-D object in good agreement with the object under observation. In fact, access to continuous projective transformations is a better guarantor of useful perception of 3-D structure than access to any static view. These observations have been replicated and refined in experiments that ask for descriptions of computer-generated displays that simulate the projective transformations normally produced by movement in 3-D space. The human visual system displays a robust capacity to 'recover' 3-D structure from (2-D) optical motion configurations.

What is the process that underlies this adaptively significant and robust perceptual competence? A cognitive/constructivist account of the sort C&T would endorse has been proposed (Rock, 1983, pp. 196–200; Rock and Smith, 1981) but it has not secured wide support. The favoured answer takes the general form prescribed by the computational approach (Marr, 1982, ch. 3; Ullman, 1979, 1984). There are two principal steps in the development of the computational answer. The first is to identify realistic constraints on the environment that when satisfied will underwrite a lawful relationship between optical motion and 3-D structure. This is an exercise of intuition and mathematical analysis. Ullman has proposed that rigidity or maximal rigidity is a constraint that can do this work. The second step is to devise a computational algorithm that exploits this constraint, i.e. that seeks to maximize rigidity of the perceptual representation, in computing a durable solution for the problem posed by the optical motion. The success of the approach is assessed in two ways: (a) by running the algorithm and evaluating the correspondence between the algorithmic solution and the virtual object; and (b) by psychophysical experiments that assess the sensitivity of the human observer to the variables that are important to the success of the algorithm. Nowhere in this enterprise is there explicit recourse to cognitive operations over mental contents. The process is considered to be an autonomous self-organizing process which runs its course independently of top-down influences.

Is Ullman's computer model more than an existence demonstration? Is it in fact an account of recovery of structure from motion by the human visual system? Probably not. For one thing, experiments have shown that when the constraints Ullman posits are violated, the 3-D solutions human observers produce are hardly effected (Todd, 1995). While it appears that Ullman's specific implementation of the computational approach is likely to be incorrect, the general style of explanation remains the preferred one.

To conclude this section, we submit that much of our adaptive behaviour, much of the behaviour that selection installed in our ancestors, is the product of mechanisms that fall somewhere between the two extremes of the cognitive continuum we described above. We should not allow the intricacy of some adaptive behaviours to bewitch us. From modest devices can spring marvellous things. Determining exactly how much of our repertoire of adaptive behaviour is cognitive in the sense C&T assume requires further reflection upon the divisions that constitute what we have called the cognitive continuum, as well as empirical investigations that will both inform and benefit from such reflection. Until this kind of work is done it is impetuous to insist that evolutionary psychology will force the cognitive psychologist to re-evaluate radically the kinds of behaviour that require her attention.

3. *The Place of Evolutionary Theory in Cognitive Psychology*

In the two previous sections we have argued that the transformations C&T herald in cognitive psychology resulting from attention to human evolution are unlikely to occur. Yet, despite these doubts about the changes in cognitive psychology that evolutionary theory is likely to produce, we nevertheless believe there is a place for evolutionary theory in cognitive psychology and, in fact, regard evolutionary theory as making important contributions to the study of cognition. In this final section we will discuss two reasons cognitive psychology should attend to the fact of human evolution. The first is methodological. Explanations of cognitive mechanisms begin with hypotheses about the functions of these mechanisms, and evolutionary theory provides a helpful, though not essential, means by which to formulate these hypotheses. A second reason to scrutinize the evolutionary history of cognition is for the sake of explanatory completeness. Some questions about cognitive mechanisms concern the nature of their behaviour: why do they exhibit the characteristics that they do? Insofar as this is a question that needs an answer, evolutionary theory will be indispensable to cognitive psychology. Below we elaborate upon these two points.

3.1 The Heuristic Role of Evolutionary Theory

Philosophical analyses of function (e.g. Millikan, 1984; Wright, 1973) emphasize the need to distinguish the functional effects of a mechanism from its incidental effects. In a well-worn example, pumping blood is a functional effect of a heart, but throbbing noises are incidental effects. The heart both pumps blood and makes throbbing noises, but it is only the former effect that the heart has been designed by selection to produce. A physiologist interested in discovering the purpose of the heart—the reason the heart has been selected—should focus her attention upon those properties of the heart important for pumping and not noise-making. Moreover, until the physiologist has a clear conception of what the heart is *supposed* to be doing, she cannot begin to investigate *how* it goes about doing what it is supposed to do.

This distinction between functional and incidental effects is as crucial in psychology as it is in physiology. Before a psychologist can begin to study how, for example, perception occurs, she must first make conjectures about what perception is for, about what inputs and outputs are *appropriate* to perception; and it is for this reason that the perceptual psychologist can benefit from consideration of our evolutionary history. Functional effects simply are those effects that selection has favoured: they are the effects that have adapted an organism to its environment.[7] Hence, evolutionary theory provides the psychologist with a valuable guide to the function of cognitive mechanisms.

This use of evolutionary theory in an investigation of a cognitive capacity is quite clear in the work of J. J. Gibson.[8] Gibson wonders 'If vision was gradually evolved, as we know it was, the question is, why? What benefits are conferred by seeing? What purposes does it serve?' (1966, p. 155). In an effort to answer these questions, Gibson devotes a chapter of his 1966 book to a study of the evolution of the human eye as well as a survey of nonhuman animal vision. He concludes that 'vision is useful for (1) detecting the layout of the surrounding, (2) detecting changes, and (3) detecting and controlling locomotion' (p. 156). With this statement of the purposes of vision in hand, Gibson is in a position to reject previous claims about the inputs to the visual process (the stimulus for vision, Gibson believes, is not sensation or even the retinal image, but is ambient light (p. 155)) and articulate a new conception of the output of the visual system (something like successful action). Of course, one may disagree with the details of the theory of perception Gibson eventually develops, while retaining appreciation for his application of evolutionary theory to questions about the goals of perception.

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7 Among philosophers, this interpretation of functions has met with controversy; however this is not the place to delve into this debate. For alternative interpretations, see Cummins, 1975, and Walsh, 1996.

8 Gibson, of course, would deny that perception is a cognitive capacity. If cognitive capacities must be cognitive in the sense of performing inferences upon representations, we would agree with Gibson. However, we believe that perception is usefully considered cognitive if we understand cognition to involve at least the pick-up of information or the production of representations.

Among contemporary psychologists, Marr has been most explicit in recognizing the need to focus psychological investigation upon the functional rather than incidental effects of cognitive mechanisms. This is apparent in Marr's emphasis upon the computational level of his theory of vision, the level at which questions like 'What is the purpose of vision?' and 'What is vision for?' are asked. Moreover, the success of Marr's programme recommends the use of a computational level of theorizing in the study of any cognitive capacity, and it is for this reason that evolutionary theory is likely to make a valuable methodological contribution to cognitive psychology. Insofar as the questions asked at the computational level are the very questions we might expect evolutionary theory to answer, appeals to evolutionary theory will be of obvious benefit to the cognitive psychologist.

We have so far been cautious in stating the methodological significance of evolutionary theory for cognitive psychology. If, as we might concede, knowledge about the function or purpose of a cognitive mechanism is a prerequisite to its further investigation, is this caution necessary? Can we not simply declare that cognitive psychology needs evolutionary theory, for without it it becomes impossible to determine what a cognitive mechanism is supposed to do? In fact, such a declaration would be ill advised: much successful research in cognitive psychology has been done in an evolutionary vacuum. Accordingly, we continue to recommend evolutionary theory as a methodological *heuristic* only. Evolutionary theory, in our view, helps the psychologist to formulate descriptions of a cognitive mechanism's function, but it is not necessary in order to do so.

In defence of this 'heuristic-only' view of evolutionary theory, it pays to reflect upon William Harvey's discovery of the function of the heart (see Enç, 1979, for a very brief analysis of this event). Harvey published his *Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus* in 1628, long before anything was known about evolution by natural selection. Nevertheless, his description of the function of the heart was accurate; and Harvey's achievement was made possible 'by concentrating on two mechanical questions: (a) what is the role of the valves in the veins, and (b) what happens to the large quantities of blood which enter the heart?' (Enç, 1979, p. 346). Harvey's discovery of the heart's function is best viewed as an instance of abduction, or inference to the best explanation. Given observations about the presence of valves in veins and the large quantities of blood entering the heart, what function assignment to the heart, Harvey must have asked, would lead us to expect these things? That Harvey was able to put the pieces together in a successful way is a testament to his genius; but it is equally a proof that evolutionary theory is not necessary for correct identification of functions.

Indeed, despite Marr's insistence that questions about function and purpose must take precedence over questions about algorithms and implementation (e.g. 1982, p. 27), evolutionary theory appears to play no explicit role in the development of his computational theory of vision. In the section of his book in which he discusses the purpose of vision (pp. 32–6), Marr gives credit to Elizabeth Warrington's work on aphasics for his formulation of early vision's function: 'Elizabeth Warrington had put her finger on what was somehow the quintessential fact of human vision—that it tells about shape and space and spatial arrangement. Here lay a way to formulate its purpose—building a description of the shapes and positions of things from images' (p. 36). Like Harvey, Marr's speculations about function rest on evidence uninformed by evolutionary theory. Perhaps, had Marr thought more deeply about the evolution of the visual system (he had, after all, read his Gibson), he would have arrived at a statement of the purpose of vision earlier. Perhaps Warrington's work would have served only to reinforce his evolutionarily inspired conjectures. Whatever the case *might* have been, the point remains that computational theories of cognitive capacities—theories that require precise characterizations of a cognitive mechanism's function—can and do proceed without the aid of evolutionary theory.

3.2 *The Explanatory Role of Evolutionary Theory*

In contrast to the merely heuristic role evolutionary theory plays in the methodology of cognitive psychology, its role is essential when demanding a complete explanation of cognitive capacity. Cosmides's work on the Wason selection task provides a clear example of the contribution evolutionary theory can make to a complete explanation of some cognitive capacity.[9] In this task subjects are asked to judge when a rule of conditional form, i.e. *if p then q*, applies. As it turns out, subjects' performance shows dramatic content effects. For instance, given four cards on whose surfaces are printed:

E K 4 7

the rule 'If a card has a vowel on one side then it has an even number on the other side', and the instruction to turn over all and only those cards that will verify the rule, most subjects will correctly turn over the card with the vowel but will incorrectly neglect to turn over the card with the odd number. On the other hand, Johnson Laird (1983, p. 31) reports that when the cards read:

Manchester Sheffield Car Train

and the rule is 'Every time I go to Manchester I travel by train', then more than 60% of subjects understand that verification of the rule requires that they turn over the card that reads 'car'.

The content sensitivity of performance on the selection task has been replicated in a tremendous number of laboratories using a bewildering variety of contents. There is no disputing that subjects' abilities to apply correctly a conditional generalization depend upon the content of the generalization. An obvious question to ask is 'What accounts for the content sensitivity of performance?' Is there some common theme running through the cases in

9 Cosmides is not the only psychologist who has contributed to the work described below, although we shall continue to mention only her. For references to other studies upon which Cosmides draws, see C&T, 1992.

which subjects are good at applying the conditional? As C&T observe, 'the literature on the Wason selection task was full of reports of a wide variety of content effects, and there was no satisfying theory or empirical generalization that could account for these content effects' (1992, p. 183). It is for the sake of a more satisfying theory that it makes sense to consider whether performance on the Wason selection task has been shaped by natural selection.[10]

When asking why a given trait exhibits the characteristics that it does, at least two kinds of answers are possible (Mayr, 1961; Tinbergen, 1963). For example, why does a bicycle have a cable leading from the brakes to the handle bar? One answer is that such a connection allows the bicyclist to slow down the bicycle. The bicycle has been designed in this way so that the bicyclist can conveniently and effectively bring the bicycle to a stop when required to do so. Another answer is simply that the mechanic who put the bicycle together attached a cable from the brakes to the handle bar. The cable is there because it was placed there. Similarly, we can offer two kinds of answers to questions about why kinds of natural devices have the characteristics they do. Why does the epiglottis cover the windpipe? It does so in order to prevent one from inhaling food. Selection has favoured those organisms in the past who possessed epiglottises and that is why organisms today have epiglottises. On the other hand, epiglottises appear in a given population because the gene pool in this population contains instructions for the synthesis of epiglottises. We all have epiglottises because we all have genes that code for them.

As the discussion of the epiglottis suggests, appeals to natural selection contribute to our understanding of a trait. The theory of natural selection answers questions about what are sometimes called the ultimate (as opposed to proximate) factors that influence the characteristics of a trait—factors such as survival value (Krebs and Davies, 1987, p. 6). Insofar as questions about the survival value of the epiglottis are worth pursuing, the theory of evolution by natural selection is going to be ineliminable.

The distinction between ultimate and proximate explanations is as necessary when asking about the characteristics of psychological mechanisms as it is when investigating physiological mechanisms. The curious behaviour of subjects on the Wason selection task, for instance, suggests that questions about the ultimate causes of this behaviour might be illuminating. Why do subjects find evaluation of a conditional generalization easy in some contexts

[10] Note, however, the independence of this point from the dispute over the domain-specificity of cognitive capacities. That is, the following two claims are quite consistent: (a) facts about human selection can inform our understanding of cognition; and (b) cognitive abilities are largely domain-specific or largely domain-general. Indeed, while Cosmides believes performance on the Wason selection task requires appeal to domain-specific process, others, e.g. Oaksford and Chater, 1994 and 1995, explain the same performance in terms of a domain-general process. Certainly, however, a domain-general explanation of performance on the Wason selection task does not drive one to deny that selection has had a hand in shaping human reasoning abilities.

and difficult in others? Until Cosmides thought to look to evolution for an answer to this question, research in this area was largely undirected. Psychologists approached the selection task with a 'let's see what happens if' attitude. The finding that behaviour was content sensitive was well established, but there was no clear sense about what kinds of contents would make a difference to subjects' performance.

Examination of subjects' performance suggested to Cosmides that subjects' evaluation of conditional rules was best when these rules expressed a social contract. More specifically, when the rule is of the form 'If you take the benefit, then you pay the cost (or satisfy a requirement)', then subjects are quite good at detecting violations of the rule. So, for instance, Cosmides reports 75% correct responses on a Wason selection task for the following rule: 'If a person is drinking beer, then he must be over 20 years old' (C&T, 1992, p. 182). The cards shown the subjects read:

drinking beer drinking coke 25 years old 16 years old

A subject told that he or she is employed as a bouncer and must enforce the drinking-age rule has little trouble recognizing the need to check beer drinkers and to check those who are under-age. There is 'obviously' no need to examine individuals who are neither drinking beer nor clearly older than the drinking age. Subjects do equally well when asked to enforce rules like 'If you give me your watch, I'll give you $20'. In general, Cosmides and Tooby claim, 'human reasoning is well designed for detecting violations of conditional rules when these can be interpreted as cheating on a social contract' (1992, p. 205).

For present purposes, Cosmides's work on the Wason selection task provides a beautiful example of the kind of explanatory contribution the theory of evolution can offer cognitive psychology. Cosmides's hypothesis that our competence with conditional rules evolved as an adaptation to detect cheaters on social contracts unifies previous work that had revealed content sensitive performance on the Wason selection task. We now have testable answers to questions about why subjects perform well with some contents and poorly with others. Moreover, Cosmides's conjecture allows psychologists to predict how a subject will perform in selection tasks with novel conditional rules. In short, a more complete understanding of human reasoning is possible once one has discovered the ultimate factors that have shaped our ability to evaluate conditional rules.

We believe the lesson to be learned from Cosmides's appeal to human evolutionary history has general applicability for cognitive psychology. It's one thing to understand how the visual system perceives colour, for instance. Yet, until we know *why* the visual system sees colour, and *why* it sees those colours that it does, we cannot claim to understand the visual system completely. Likewise, understanding language involves more than understanding how we acquire language and how we judge grammatical correctness. Why, we must also ask, did language evolve in the first place? Why do human languages have the syntactic structure that they do? Furthermore, why are some concepts easier to grasp than others? What accounts for certain contextual effects on recall? For what sorts of problems are we more likely to generate mental images? Answering these questions, we believe, requires that we investigate our evolutionary past and discover the kinds of selection pressures that moulded our cognitive development.

4. Conclusion

Will evolutionary theory transform cognitive psychology? On the one hand, if this entails a drastic reorientation from a domain-general view of the mind to a domain-specific one, then such a transformation is unlikely. As we noted, cognitive psychology is not currently (nor traditionally) committed to a domain-general view of mind, and so even were evolutionary theory to entail domain-specificity, this would not produce a transformation in the way cognitive psychologists conceive of domains. But, more significantly, facts about domains cannot be deduced from the theory of natural selection. The breadth of a domain is a matter for empirical investigation, and it is for this reason that cognitive psychologists must continue to explore domain-general approaches to cognition despite the fact that the human mind is the product of evolution. On the other hand, if an affiliation with evolutionary theory requires that cognitive psychology treat all behaviour as the product of cognitive processes, then it is an affiliation cognitive psychologists should resist. Behaviours can have a variety of causes, not all of which require for their explanation the adornments of cognitive theory. However, if the marriage of evolutionary theory to cognitive psychology calls only for cognitive psychologists to be more self-conscious in their employment of teleological reasoning and to consider the ultimate factors that have influenced the nature of our cognitive capacities, then it has our blessing. As we have said, we strongly support the use of evolutionary theory in cognitive psychology: it is a valuable methodological tool and provides elements that must appear in a complete explanation of a cognitive capacity.

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