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Original Article

Distinguishing Byproducts from Non-Adaptive Effects of Algorithmic Adaptations

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Abstract: I evaluate the use of the byproduct concept in psychology, particularly the adaptation–byproduct distinction that is commonly invoked in discussions of psychological phenomena. This distinction can be problematic when investigating algorithmic mechanisms and their effects, because although all byproducts may be functionless concomitants of adaptations, not all incidental effects of algorithmic adaptations are byproducts (although they have sometimes been labeled as such). I call attention to Sperber's (1994) distinction between *proper domains* and *actual domains* of algorithmic mechanisms. Extending Sperber's distinction, I propose the terms *adaptive effects* and *non-adaptive effects*, which more accurately capture the phenomena of interest to psychologists and prevent fruitless adaptation-versus-byproduct debates.

Keywords: algorithmic adaptation, byproduct, actual domain, proper domain, adaptive effect, non-adaptive effect.

Introduction

The adaptation concept has been immensely useful in psychology. Theories and hypotheses derived from adaptationist thinking have produced an abundance of discoveries that have filled several recent edited volumes (e.g., Buss, 2005; Dunbar and Barrett, 2007; Schaller, Simpson, and Kenrick, 2006). The byproduct concept, despite being the focus of substantial discussion and exposition (e.g., Andrews, Gangestad, and Matthews, 2002; Buss, Haselton, Shackelford, Bleske, and Wakefield, 1998; Klein, Cosmides, Tooby, and Chance, 2002), has been far less useful, at least with respect to empirical yield. Moreover, as I show below, the concept has sometimes been applied in a manner inconsistent with its definition. In this article, I evaluate the use of the byproduct concept in psychology—particularly the associated idea that commonly investigated psychological phenomena can be categorized as either adaptations or byproducts. I argue that the adaptation–byproduct distinction often fails to capture the distinction of interest to psychologists, and I advocate the use of another distinction based on Sperber (1994).

Discussion

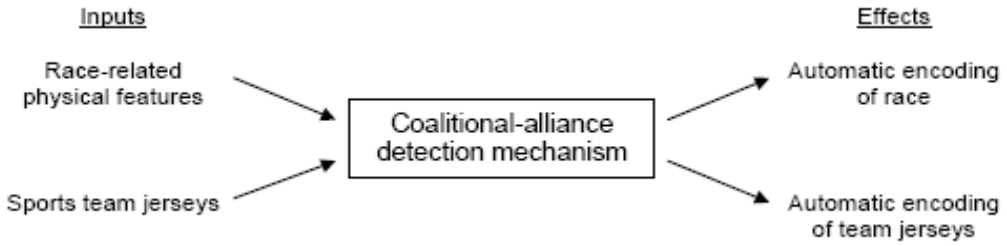
What is wrong with the adaptation–byproduct distinction? First, what is a byproduct? According to established definition, a byproduct is a trait that evolved "not because it was selectively advantageous, but because it was inextricably linked (either through pleiotropy or linkage disequilibrium) to another trait that was reproductively advantageous" (Andrews et al., 2002, p. 491; for a similar definition, see Buss et al., 1998). A commonly invoked analogy for byproducts is architectural spandrels, which are spaces that are necessarily left between designed features of buildings (Buss et al., 1998; Gould, 1997). There are several examples of biological byproducts that clearly conform to this definition, such as the whiteness of bone and the belly button—these features evolved, are functionless, and are inextricably linked to an adaptation (i.e., white bones are necessary effects of selecting for bone made of calcium).

A number of evolutionary psychologists have applied the adaptation–byproduct distinction by asking questions of the form "Is X an adaptation, or is it a byproduct of an adaptation?" where X represents phenomena such as *automatic encoding of race* or *rape* (e.g., Kurzban, Tooby, and Cosmides, 2001; Thornhill and Palmer, 2000). According to Kurzban et al., humans possess adaptations for tracking coalitional alliances, which are sensitive to a variety of information suggesting group membership. In modern contexts consisting of racially diverse individuals, race-related physical features may (incorrectly) be perceived as cues for coalitional alliances, resulting in the automatic encoding of race. Kurzban et al. went on to show that automatic encoding of race can be eliminated by modifying contextual circumstances. Therefore, they concluded, the tendency to automatically encode race is a byproduct, not an adaptation.

That conclusion, however, depends on a looser, more colloquial use of the term 'byproduct.' Although encoding race may indeed be an incidental effect of an adaptation for tracking coalitional alliances, it is not an evolved feature and is demonstrably not inextricably linked to this adaptation—it is just one possible effect in one possible social milieu. The confusion arises because (1) the term byproduct has been used in a different manner and (2) effects of functional algorithms have been conflated with the algorithmic mechanisms themselves. Unlike structural traits—such as bones and umbilical cords—behavioral 'traits' that many psychologists tend to investigate are information-processing algorithms that take in specific stimuli as input and produce specific psychological or behavioral responses as output.

As shown in Figure 1, a psychological adaptation designed to detect coalitional alliances consists of a functional algorithmic component that detects cues that potentially signal coalitional alliances and translates those cues into quick categorization of the social world. In different social contexts, this algorithmic mechanism may detect a range of coalition-connoting cues (some diagnostic, others not) and produce a response (some functional, others not). The functional component of this adaptation is the algorithmic mechanism (depicted in the box in Figure 1). Thus, one can claim to have identified a byproduct of this adaptation only when one has identified some evolved feature that is inextricably linked to this algorithmic mechanism. The various effects of this algorithmic adaptation—whether they are adaptive effects or incidental effects—are not properly the focus of the adaptation-versus-byproduct debate, because they logically cannot be either. Therefore, asking whether encoding race is an adaptation or a byproduct is misleading.

Figure 1. A schematic diagram of coalitional-alliance detection adaptation, which detects a range of stimuli (some diagnostic, others not) and translates them into specific responses (some functional, others not), a pattern that is characteristic of many algorithmic adaptations.



As another example, Thornhill and Palmer (2000) asked whether rape is an adaptation or a byproduct of other adaptations—specifically, men's desire for sex and tendency to use violence in pursuit of a goal. The authors were undecided, but for the moment, suppose that rape is not an adaptation, but is an incidental effect of these other adaptations; that is, given some environmental conditions, these adaptations sometimes produce effects that lead to rape. Then, rape would represent just one possible effect of these adaptations in a given circumstance. And as it would not represent an evolved feature that is inextricably linked to those adaptations, it should not be labeled a byproduct. Indeed, given the multiplicity of psychological mechanisms that may underlie and contribute to rape, the adaptation-versus-byproduct dichotomy may have been too simplistic to begin with (Pinker, 2002).

If in fact phenomena such as automatic encoding of race and rape are neither adaptations nor byproducts, what are they? Sperber (1994) offered a distinction that is less known than the adaptation–byproduct distinction, but is perhaps more useful for psychologists. He noted that algorithmic mechanisms (those that detect specific stimuli and produce specific responses) can be said to have *proper domains* and *actual domains*. The coalition-alliance detecting mechanism evolved in response to various indicators of coalitional alliances—for example, "patterns of coordinated action, cooperation, and competition" (Kurzban et al., 2001, p. 15387); these cues constitute the proper domain of this adaptive mechanism. However, once in place, this mechanism may potentially respond to a wider range of cues, such as team sports jerseys and race-related physical features, regardless of whether these cues existed ancestrally or are diagnostic of coalitional alliances; these cues constitute the actual domain of this adaptive mechanism.

Extending Sperber's (1994) distinction, I propose a distinction between *adaptive effects* (e.g., responding to ancestrally existing "proper" cues) and *non-adaptive effects* (e.g., responding to evolutionarily novel "actual" cues). Then, automatic encoding of race can be characterized as a non-adaptive effect of the coalition-alliance detecting adaptation. The distinction isn't perfect, because one could argue that some evolutionarily novel, 'non-proper' cues—such as sports team jerseys—are actually diagnostic of coalitional alliances and produce what appear to be 'adaptive' effects. Nevertheless, this distinction prevents misuse of the byproduct concept and forces one to be more explicit about adaptive components of algorithmic mechanisms and their effects. This is beneficial, because a clear separation of algorithmic adaptations from their effects can prevent awkward

conclusions such as that a coalition-alliance detecting adaptation, in the case of encoding race has transformed into a byproduct (of course, the underlying adaptation has remained unchanged and no real byproduct has been identified).

An important point for psychologists (especially those interested in algorithmic stimulus–response mechanisms) is this: Not all psychological phenomena qualify for the adaptation-versus-byproduct debate. The adaptation–byproduct distinction does not neatly "carve nature at its joints" when investigating the nature and consequences of adaptive algorithmic mechanisms. Several psychological phenomena—the tendency to overeat, the tendency to stigmatize unusual-looking people, the tendency to react prosocially toward facially similar (but unrelated) others, and the tendency to find unrelated housemates sexually aversive—can be understood as incidental effects of algorithmic adaptations (e.g., DeBruine, 2005; Park, Faulkner, and Schaller, 2003; Pinel, Assanand, and Lehman, 2000; Shepher, 1971). But asking whether these phenomena are adaptations or byproducts would have missed the point, as they are neither; they are all effects of normally operating algorithmic adaptations.

Conclusions

In sum, when applying evolutionary reasoning to algorithmic psychological processes, one must first separate the adaptive components (e.g., coalition-alliance detecting mechanisms) from their effects (e.g., automatic encoding of race). Then, one should attempt to identify the design features of the mechanism (including the identification of the proper domain of the mechanism), which will then lead to hypotheses about how the mechanism may operate in novel circumstances, producing various adaptive and non-adaptive effects.

Does this mean that the byproduct concept is useless in the study of algorithmic adaptations? That remains an empirical issue. It's possible that there are true byproducts of algorithmic adaptations yet to be identified. In the meantime, we should be mindful of our terminology so that we can recognize a real byproduct when we see one.

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