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Cognition in harsh and unpredictable environments

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In environments that are harsh and unpredictable, people are typically more vigilant, act more impulsively, and discount the future more. In this paper, we argue that these behaviors reflect a present-orientation produced by biological adaptations, despite potential harm to health and wellbeing. We review recent studies showing that people in stressful environments have a stronger preference for immediate over delayed rewards, have children at a younger age, and develop enhanced cognition for dealing with threat and rapidly changing conditions, compared with people from supportive environments. Moreover, people from supportive environments, when exposed to harsh-unpredictable environmental cues, shift toward a present-orientation. These findings underscore the benefits of integrating evolutionary and developmental psychology.

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'*The future's uncertain, and the end is always near*'

(The Doors, 1970, Roadhouse Blues)

Introduction

Although evolutionary theory is becoming increasingly integrated into the psychological sciences, challenges remain. One is the persistent but false belief that evolved traits are present at birth and not learned, unchanging during ontogeny, and universal in the species [1]. If this belief were true, it would imply that psychological variation shaped by experience — within and between individuals — falls outside of the scope of evolutionary psychology. In fact, all traits result from development, and development always results from physiological mechanisms (e.g. gene regulatory systems) that are products of evolution [2•].

Two questions are essential to integrating evolution and development into psychological research: How does natural selection shape development, and how does development construct adaptive phenotypes? The answers to these questions depend on the trait and require a case-by-case analysis [3]. Natural selection, however, typically results in developmental mechanisms that use individual experience to tailor phenotypes to local conditions and the individual's current state [4–8]. Developmental inputs play multiple roles in shaping such phenotypes. They provide the raw materials required for tissues to grow; they may expose individuals to toxins and other causes of molecular damage; and, they provide information about an individual's situation [2•].

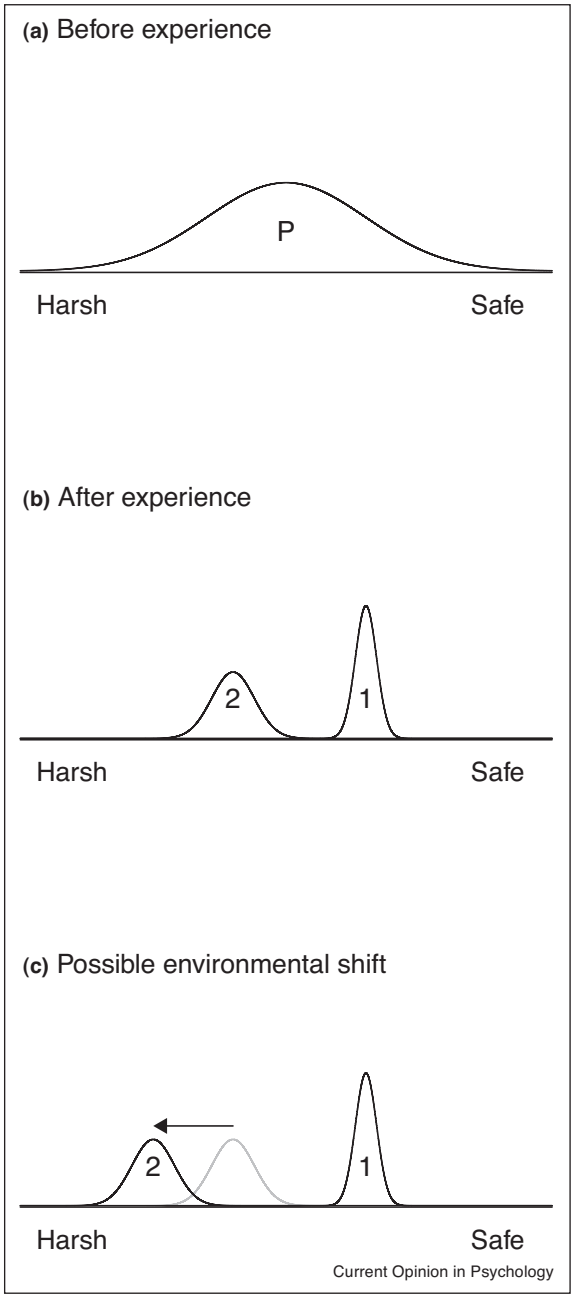
Experience conveys information

Developing organisms learn about the world and adapt accordingly, allocating resources (e.g. energy) among growth, maintenance, and reproduction [4–6]. Experience provides information — a reduction in unpredictability — about the current environmental state (Figure 1a,b). For example, frequently witnessing violence indicates a dangerous world. And, if environmental states are auto-correlated across time, experience can teach us about future conditions as well [9,10]: A dangerous world today implies a dangerous world tomorrow.

Two environmental dimensions, *harshness* and *unpredictability*, are fundamental to individual development [11]. Harshness refers to the rates of mortality and morbidity caused by factors an individual cannot control (e.g. high rates of infectious disease). The shorter one's expected reproductive life span is, the greater the benefits of accelerating maturation and reproducing early, even if it compromises bodily maintenance [12,13]. There are different notions of unpredictability [11,14], which are compatible: first, for a given mean level of harshness, the range of possible outcomes (Figure 1b); second, variation in the mean level of harshness across time and space (Figure 1c). Both harshness and unpredictability can affect adaptive developmental trajectories.

Some people experience environments that are both harsh and unpredictable, such that mortality and morbidity are high, threats appear without warning, and opportunities are fleeting. In such conditions, present-orientation may be adaptive [13,15–20,21••,22,23]. This orientation can

Figure 1



Experience and unpredictability. The horizontal axis depicts the outcome dimension. The height of the curve at any point corresponds to the likelihood of that outcome occurring. The curve in **(a)** represents the range of possible outcomes before experience. All naive individuals share this range of expectations; 'P' denotes the 'population'. In **(b)**, we see the expectations of two individuals diverge after experience (see [52]). Individual 1 expects safer and more predictable (narrower curve with a higher mean) outcomes than individual 2. In **(c)**, we revisit these individuals at a later time. Individual 1 has not changed her expectations. Individual 2, however, has experienced an environmental shift (e.g. a change in family composition); he now lives in a harsher environment.

psychologically manifest in: first, vigilance used to detect threats and opportunities; second, impulsive reactions (little deliberation) in order to respond quickly; and third, steep future discounting to motivate the capture of immediate benefits, as future rewards are less likely to be cashed in. When we argue that present-orientation may be 'adaptive' in certain contexts, we are referring to biological fitness, not health or wellbeing [7], as we explain below.

Empirical research

'*I say fuck tomorrow. It's all about today. Might not be a tomorrow. Might get shot. Might get hit by a bus. So get it now. Now, now, now. Next week might as well be next century. Fuck next week. Fuck tomorrow' (offender named Blue Eyes, age 23 [quoted in 23, p. 1116])*

A common view in psychology is that 'there may be no such thing as 'too much' self-control' [(24, p. 2639)], as by definition, self-control helps us to achieve 'valued, longer term goals in the face of conflicting impulses to seek immediate gratification' [(25, p. 32)]. High self-control predicts numerous 'desirable' outcomes, including better health, higher education, and more wealth [24–26]. Accordingly, psychologists often describe a here-and-now preference as shortsightedness, or failure to delay gratification, implying dysfunction [27]. Such descriptions may be valid from a (mental) health perspective, which focuses on wellbeing. However, natural selection maximizes fitness, not (mental) health and wellbeing.

We and others [13,15–20,21••,22,23] argue that a present-orientation reflects a biological *adaptation* to harsh-unpredictable environments. By 'adaptation', we mean that the orientation would have increased reproductive success in ancestral environments; there is no necessary commitment to the idea that the orientation does so under current conditions. However, it is still of interest to know whether the fitness costs of a here-and-now preference (e.g. worse health) are counteracted by fitness benefits (e.g. more sexual partners). Some evidence points in this direction. For example, violent offenders typically act more impulsively, increasing their risk for sexually transmitted diseases, physical injury, and early death [(23,27–29; but see 30)]. On the benefit side, however, delinquents may have more sexual partners [31,32•] and also more children [32•].

Exposure to harsh and unpredictable conditions predicts current time preference in diverse populations. For instance, American university women who recollect more early life stress are more present-oriented and have their first sexual intercourse at a younger age [13]. In a mixed-sex sample, North Americans' past experiences of close bereavement — the number of people a person knew who