

Individual Differences: Variation By Design

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Abstract: Stanovich & West appear to overlook the adaptivity of variation. Behavioral variability, both between and within individuals, is an absolute necessity for phylogenetic and ontological adaptation. As with all heritable characteristics, inter-individual behavioral variation is the foundation for natural selection. Similarly, intra-individual variation allows a broad exploration of potential solutions. Variation increases the likelihood that more optimal behaviors are available for selection. Four examples of the adaptivity of variation are discussed: a) Genetic variation as it pertains to behavior and natural selection; b) behavioral and cognitive aspects of mate selection which may facilitate genetic diversity; c) variation as a strategy for optimizing learning through greater exploration; and d) behavioral variation coupled with communication as a means to propagate individually discovered behavioral success.

Variation is often misconstrued to be non-adaptive because it insures that many individuals will be less than optimally suited to the environment. For example, Karl Pearson (1897) speculated that cognitive performance should be homogenous due to a disadvantage for those individuals who deviate substantially from some optimum. While strong selection pressures may exert a proximal constraint on variability, environmental change exerts a universally opposing selection pressure for variation (e.g. Slatkin, 1974).

“These individual differences are highly important for us, as they afford materials for natural selection to accumulate” (Darwin, 1859/1959, p. 123). Indeed, mechanisms for enhancing variation constitute the principle adaptation which made virtually all subsequent adaptations possible: The capacity to produce a unique combinations of genes in each individual and at each generation (viz. sexual reproduction) is the point of divergence between the narrow range of cloning species (e.g. amoebae) and all other variety of life. Reproductive behavior itself may have a strong influence on genetic diversity: One line of evidence for this claim is that female learning varies over the ovarian cycle in ways that tend to maximize the genetic diversity of offspring: During proestrus, changes observed in hippocampal connectivity may underlie novel mate selection while the hippocampal state during diestrus may better serve foraging. The combination of a good memory for a former mating partner coupled with a tendency toward promiscuity during proestrus may be one of the most powerful mechanisms for insuring genetic variability (see Desmond & Levy, 1997). Another line of evidence supporting this claim is that twin studies show that mate preference has a negligible heritability component (Lykken, & Tellegen, 1993) especially compared to other preferences (job, religion, political affiliation, etc.). High variability allows species to occupy novel and unpredictable environments and to survive local and global ecological changes (e.g. Cooper & Kaplan, 1982). Genetic continuation is clearly more important than the optimal function of any individual within that species (e.g., Yoshimura & Clark, 1991). Thus, the phylogenetic adaptiveness of variation completely circumscribes considerations of local optimizations.

The volatile environment that favored phylogenetic variation also favored adaptations that allow organisms to learn and thereby to survive and proliferate under a much broader range of conditions. While inter-individual variation provides the basis for natural selection, intra-individual variation provides a basis for behavior selection (e.g., Skinner, 1981) by increasing the likelihood that more possible problem solving strategies are explored. Several examples illustrate the utility of behavioral variation:

The well-documented phenomenon of “probability matching” (Estes & Straughan, 1954) is a clear example where response variation is ostensibly sub-optimal, but provides a basis for response selection. That is, if the likelihood of reward is divided unevenly between alternatives, optimal reward would be obtained by always selecting the highest-reward alternative; however, both animals and humans systematically sample the lower-reward alternatives, thus diminishing their expected reward. This is a

senseless choice unless it is remembered that information has value as well (Dinsimoor, 1985). In natural environments, the probability of finding food in particular patches is not stable, so that consistent responses (optimizing consumption) result in ignorance of changes in relative probability densities and possibly starvation as the existing repertoire of patches is exhausted. Interestingly, sated animals tend to engage in more exploration, while deprived animals tend to maximize reward (McDowell & Dallery, 1999).

The exploratory value of variation is further supported by experiments showing that the extent of initial variation predicts the likelihood that the problem is later solved. For example, in a number conservation task, five year old children who engaged in a wider range of initial strategies were more likely to later converge on the correct solution (Siegler, 1995). Similarly, initially high variations in neural network activity (c.f. simulated annealing) improve performance by increasing the portion of phase space that is sampled (e.g. Sohal, & Hasselmo, 1998). Ontologically, the advantage of wide exploration is greatest for juveniles because fewer possibilities have previously been explored. Indeed, Wenger and McKinzie (1996) review numerous findings showing that intra-individual behavioral variation is inversely correlated with age and experience.

Among animals capable of learning from one another, variations in individual performance provide a broader palate for behavior selection by observation. For instance, honeybees explore widely and then communicate successes to their hives (e.g., Seeley, 1994). Similarly, primates have been widely observed to communicate effective tool use and foraging strategies to juveniles (for a review see Galef, 1998). A wide assortment of behaviors with varying degrees of success, coupled with propagation by either observational sharing or communication can improve the success of an entire clan.

Variation is central to any concept of behavioral or phylogenetic optimization. It is then surprising that the target article reviewed evidence that evolutionary considerations may indicate a shift in the construal of optimal performance, but did not account for variation itself as an evolutionary consideration. While we agree with Stanovich & West that individual variation cannot be accommodated within the perspective of perfect rational competence, we disagree that this constitutes a shortcoming. Adaptivity, both within and between lifetimes, requires a degree variability that is not correlated with the adaptive pressures or task demands of the immediate environment.

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