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**The Asymmetric Behavioral Homeostasis Hypothesis:
Unidirectional Flexibility of Fundamental Motivational Processes**

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Abstract

Natural selection has produced not only fixed adaptive traits in response to enduring environments, but also contingencies capable of yielding variable outcomes in variable environments. A well-known example is phenotypic plasticity, which entails alternative developmental outcomes in different environments. Here, we focus on more immediate and transitory behavioral plasticity (underpinned by motivational processes), and we suggest that the physiological concept of homeostasis offers a coherent perspective for studying human motivations and associated behavioral processes. We further propose the *asymmetric behavioral homeostasis hypothesis*, which conceptualizes many motivational processes as one-sided homeostatic mechanisms and which predicts that motivational responses that are amplified by certain cues will not be reversed simply by reversing the input cues. An important implication is that many evolutionarily adaptive—albeit subjectively and socially deleterious—responses to fitness threats (e.g., fears, aversions) are more easily inflamed than dampened. We review literature bearing on this hypothesis and discuss implications for psychology.

Keywords: motivation; homeostasis; feedback control; negativity bias

The Asymmetric Behavioral Homeostasis Hypothesis:

Unidirectional Flexibility of Fundamental Motivational Processes

Biological evolution is about adapting to environments. At the simplest level, organisms possessing heritable traits that confer a reproductive advantage (e.g., superior visual acuity) out-reproduce those possessing inferior variants, resulting in the propagation of evolved *adaptations* over generations (G. C. Williams, 1966). Adaptability can also be programmed into individual organisms (Gluckman, Beedle, & Hanson, 2009; Penke, 2009). When environments are predictably variable across generations, the capacity for *phenotypic plasticity* can evolve, allowing organisms to adaptively alter their traits in response to alternative environments (e.g., for clownfish, sex is not prenatally determined but is contingent on the social environment; Buston, 2003). As a result, genetic clones can end up with vastly different phenotypes, at least for a period, each better adapted to its own particular environment (Pigliucci, 2001). Operating at an even briefer timescale of environmental variability and adaptability is the capacity for *homeostasis*, the ability of organisms to maintain adaptive states (e.g., body temperature) by responding quickly—via endocrine and neural responses—to disturbances, enabling adaptability with greater temporal precision (Widmaier, Raff, & Strang, 2008).¹ In this article, we argue that the concept of *behavioral homeostasis* offers a coherent perspective for the study of human motivations and associated processes.

The concept of evolved adaptations is familiar to most psychologists, largely through the efforts of evolutionary psychologists (Barkow, Cosmides, & Tooby 1992; Buss, 2005). Phenotypic plasticity is also familiar to many—whenever researchers investigate effects of external events on long-term outcomes (e.g., learning), they are often investigating phenotypic plasticity. In recent decades, evolutionarily informed research on phenotypic plasticity in humans has proliferated, generating a rich body of work (e.g., Belsky, Steinberg,

& Draper, 1991; Bjorklund & Pellegrini, 2000; Del Giudice, 2009). The concept of homeostasis is, on the other hand, foreign to most psychologists, apart from those specializing in biological psychology. This is understandable, since the most familiar examples of homeostasis include thermoregulation, fluid balance, blood glucose regulation, and other physiological processes that fall outside the scope of most areas of psychology. However, motivational processes—which are central in psychology—share a key underlying mechanism with homeostasis: negative-feedback control.² Indeed, it could be argued that psychologists have been investigating *behavioral homeostasis* for a long time. Whenever researchers investigate effects of experimental manipulations on functional psychological and behavioral outcomes, they may be investigating components of behavioral homeostasis—behavioral mechanisms designed to maintain adaptive states.

We have three main objectives: (a) delineate the concept of behavioral homeostasis; (b) offer a theoretical perspective from which we derive the general hypothesis that *behavioral homeostatic responses are often asymmetric*, being under stricter control in one direction (and looser control in the other); and (c) review evidence from the psychological literature pertaining to this hypothesis. We aim to demonstrate that the concept of homeostasis and the hypothesis of asymmetric behavioral homeostasis offer a synthesis of known psychological phenomena, as well as a more biologically principled means by which functional hypotheses can be generated and psychological theories advanced.

Negative-Feedback Control, Homeostasis, and Psychology

The thermostat has served as a textbook example of the negative-feedback loop (see Carver & Scheier, 1998; Marken, 2009). Negative-feedback control systems are not just feats of human engineering; they are very common in nature, and they constitute the main mechanism underlying homeostasis. For organisms to function optimally, many variables must be kept in an adaptively steady state. For example, our bodies work best with a certain

amount of water (*reference value*). When we are deprived of water (*disturbance*), a regulatory mechanism engenders functional responses, including the experience of thirst (*output*). These output responses lead to drinking behavior. The actual fluid level (*controlled variable*) is then fed back and compared against the reference value, and as the discrepancy between the two decreases, the functional output responses become attenuated. Such homeostatic mechanisms underlie many of our familiar bodily responses to environmental events: After a period of fasting, we feel hungry; when we enter a sauna, we perspire; when we run, our hearts race. In each of these (simplified) examples, the bodily response is the output that is triggered by a disturbance in order to keep an important variable—energy and nutrition levels, body temperature, blood oxygen level—within an adaptive range. In psychology, negative-feedback control has been invoked in descriptions of human motivations and perceptions (Bargh, Gollwitzer, & Oettingen, 2010; Czikó, 2000). From an evolutionary perspective, human motivations have been described as systems that regulate “internal regulatory variables,” a concept which includes but extends beyond homeostatically controlled variables (Tooby, Cosmides, Sell, Lieberman, & Sznycer, 2008). The notion of feedback control has also been incorporated into cognitive models of increasingly abstract goals hierarchically layered upon lower-order goals (Carver & Scheier, 1990, 1998; Powers, 1973).

Notably, no previous treatment has considered the possibility of directional asymmetries in responses to disturbances. All previous discussions invoking the thermostat-like negative-feedback control have assumed that upward and downward deviations in the controlled variable (e.g., temperature) lead to equivalent output responses—that deviations in both directions are under equally strict control. Below, we explain why this may rarely be the case in behavioral homeostasis.

Directional Asymmetry in Homeostatic Control

When we consider thermostat-regulated systems in the real world, directional asymmetry is actually quite common. Dwellings in colder regions (e.g., Northern Europe) tend to be equipped with heating systems, but not cooling systems. The thermostat works by turning on the heat when the room temperature falls below the desired temperature; if the room temperature happens to exceed the desired temperature, the system does nothing and only natural cooling can occur. Given the rarity of intolerably hot days in these regions, the inhabitants appear willing to endure a few uncomfortably hot days if it saves them the costs associated with maintaining a cooling system as well. On the flipside, dwellings in hotter regions (e.g., the Middle East) tend to be equipped with cooling systems, but not heating systems.³ In either case, equivalent warming and cooling disturbances do not engender equivalent opposing output responses in the temperature-regulation system. The thermostat model, typically conveyed with symmetrical bidirectional responses, has thus been obscuring a key qualifying feature of feedback-control mechanisms in the real world.

Crucially, these considerations apply to homeostasis as well. First, physiological disturbances can occur in two directions (e.g., blood glucose level that becomes too high or too low), and functional responses can theoretically occur in two directions to oppose those disturbances (e.g., the release of hormones that regulate blood glucose levels). Second, like separate heating and cooling systems, bidirectional homeostatic responses are likely to require two distinct (albeit integrated) systems (e.g., there are distinct endocrine mechanisms for decreasing and increasing blood glucose levels). Third, physiological costs associated with upward and downward deviations can differ substantially (e.g., hypoglycemia [abnormally low blood glucose] poses a more immediate threat to survival than does hyperglycemia [excessive blood glucose]; Pocock, Richards, & Richards, 2013). Finally, if the costs of upward and downward deviations are asymmetric, and if the organic costs associated with maintaining a perfectly designed bidirectional system are greater than the

costs of tolerating the less costly deviation, the homeostatic system may be designed to be asymmetric, with one component relatively underdeveloped or readily overwhelmed by its counterpart (e.g., the human body tends to tolerate hyperglycemia more than hypoglycemia).

In short, where the two deviations are associated with asymmetric costs, natural selection may produce an asymmetric homeostatic system with looser control over the less costly deviation—a system that is largely or entirely unidirectional. We propose that many behavioral homeostatic processes conceptually resemble temperature-regulation systems with just a heating (or just a cooling) system. Thus, even when symmetrical disturbances (upward and downward deviations) are introduced, the output responses may not be symmetrical. We refer to this as the *asymmetric behavioral homeostasis hypothesis*.⁴

Theoretical Background and Empirical Implications

To give due credit, the present asymmetry hypothesis has precursors in previous theory and research. Most notably, Kahneman and Tversky (1984) described asymmetries in how humans perceive benefits and costs. According to their *prospect theory*, humans' subjective valuation of costs (losses) and benefits (gains) is usually asymmetric, as described by a steeper curve for losses than gains in the S-shaped value function. That is, people exhibit loss aversion, where a loss of X units is more aversive than a gain of X units is appetitive. Applying this concept more broadly, other researchers have noted the existence of a broader positive–negative asymmetry across psychological phenomena, with the negative tending to overpower the positive (e.g., Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Peeters & Czapinski, 1990). Baumeister et al. (2001) invoked evolutionary reasons for this fundamental asymmetry: “Organisms that were better attuned to bad things would have been more likely to survive threats and, consequently, would have increased probability of passing along their genes” (p. 325). In a similar vein, Rozin and Royzman (2001) noted that negative events tend to overpower positive ones, focusing especially on biologically grounded phenomena (e.g.,

negative contamination, learning). Like Baumeister et al., Rozin and Royzman appealed to evolution to supply the ultimate explanation for the negativity bias. Finally, Nesse (2005) and Haselton and Nettle (2006) offered analyses, also explicitly evolutionary, focusing on functional biases in signal detection situations; their perspectives offer explanations for (functionally) erroneous responses in ambiguous situations; their key lesson for the present discussion is that it is better to err on the side of caution (see also Eiser & Fazio, 2008). While the present perspective conceptually overlaps with these previous approaches, it makes a key theoretical advance. None of these previous approaches pertain specifically to feedback-regulated motivations underlying goal-directed behavior. Thus, none of them implies the specific hypothesis that equal and opposite inputs to motivational systems will often lead to asymmetric outputs.

The asymmetric behavioral homeostasis hypothesis implies more strictly regulated homeostatic responses to more costly deviations, which will generally be those signaling impending losses and threats (as opposed to deviations signaling gains and opportunities). Psychologically, stricter regulation means more urgent motives and behaviors. For many adaptive processes, what is often critical is maintaining a *sufficient level* of a variable, for example, consuming enough food and water to survive, or maintaining a safe buffer (e.g., physical distance) against threat. This is because, for a number of variables such as energy and fluid levels, the costs of substantial deviation downwards from the adaptive level (deprivation) often exceed the costs of commensurate deviation upwards from the optimal level (overconsumption). This may explain why humans have evolved to experience intense hunger and thirst, but have not evolved equally urgent motivational states following overconsumption of food and water. The body does deal with excess food and water via waste elimination, but there are no motivational states comparable to hunger and thirst that

drive deviation-reducing behavior toward a goal (the feeling of overfullness is not a commensurate counterpart to the feeling of hunger).

Similarly, survival often depends on being *sufficiently distant* from threats, which may explain why threat-related emotions are more ubiquitous and powerful than safety-related emotions (Baumeister et al., 2001). As a specific example, if there is a safe distance that one must maintain from a venomous snake—say, 2 meters—deviation in which that distance is reduced is more costly than an equivalent deviation in the opposite direction. Thus, a change that reduces this distance is expected to impel behavior (perhaps via increased fear) that restores the 2-meter buffer, but a change that increases the distance is not expected to impel behavior (via decreased fear or via some other motivational state) that reins in the distance back to 2 meters. To the extent that fear is involved in regulating the 2 meter buffer against snakes, a reduction in the distance (e.g., to 1 meter) is expected to increase fear (demonstrating homeostatic control), but an equivalent increase in the distance (e.g., to 3 meters) is not expected to lead to a commensurate decrease in fear (demonstrating less strict homeostatic control).

Asymmetric Behavioral Homeostasis and Experimental Psychology

Many psychological theories and findings may be interpreted through the lens of asymmetric behavioral homeostasis. Indeed, any theory or model that specifies *a need to maintain a sufficient level of X* (or maintain a sufficiently *low* level of X, in the case of harmful stimuli such as toxins) lends itself to being couched in terms of asymmetric behavioral homeostasis. Testing the asymmetry hypothesis is analogous to testing whether a thermostat-regulated home is equipped with both heating and cooling systems (rather than just one of them). Thus, with regard to motivation, a rigorous test of the asymmetry hypothesis would require manipulations introducing symmetrical bidirectional disturbances—which, in principle, could both increase and decrease the motivational state

from the baseline. Not surprisingly, however, tests of motivational hypotheses have focused on trying to stimulate the motivational states above the baseline, rather than on trying to depress them below the baseline; thus, the latter tests are nearly absent in the literature. And even if the latter type of studies had been conducted widely, they are less likely to have yielded measurable effects on motivational states—if the asymmetry hypothesis is valid. It's difficult to ascertain the extent to which such tests have been conducted (as null findings are less likely to have been published). In any case, if abundant research shows that motivational states can be amplified but little research shows that motivational states can be dampened, this would be telling.

Below, we review the relevant literature by discussing specific theories/models and associated findings. The coverage is not intended to be exhaustive, but illustrative. The review is organized around three fundamental needs and motives (see Table 1) associated with survival and reproduction (cf. Kenrick, Griskevicius, Neuberg, & Schaller, 2010; Nesse, 2005).

Maintaining a Buffer against Pathogens

The well-being of organisms is constantly threatened by pathogens, and organisms have responded to this evolutionary pressure, as evidenced by the vertebrate immune system. Recently, a psychological defense system has been described as well. Referred to as the *behavioral immune system*, it appears that animals possess a set of behavioral mechanisms (undergirded by perceptual, cognitive, and motivational mechanisms) that facilitate behavioral avoidance of pathogens (Curtis, Aunger, & Rabie, 2004; Oaten, Stevenson, & Case, 2009; Schaller & Park, 2011). Because humans are group-living, and because many diseases are transmitted between individuals, humans are likely to have evolved psychological mechanisms that facilitate identification and avoidance of disease carriers. These mechanisms—encompassing contamination cognitions, disgust, negative attitudes—

appear to contribute to avoidance and exclusion of individuals perceived to harbor pathogens, such as people with morphological abnormalities and members of culturally foreign outgroups (Kurzban & Leary, 2001; Schaller & Neuberg, 2012).

It can be argued that the behavioral immune system acts to maintain a buffer between organisms and apparent sources of pathogens. Thus, when a disturbance reduces that buffer, output responses that serve to restore the buffer may become activated. A common research strategy has involved making predictions about functional output responses in specific situations and then testing whether the output response increases above the baseline when a disease-vulnerability disturbance (e.g., visual reminder of contagious diseases) is introduced. Studies have generated ample evidence for such an effect (Ackerman et al., 2009; Faulkner, Schaller, Park & Duncan, 2004; Miller & Maner, 2012; Mortensen, Becker, Ackerman, Neuberg, & Kenrick, 2010; Navarrete & Fessler, 2006; Park, Faulkner, & Schaller, 2003; Park, Schaller, & Crandall, 2007; Reid et al., 2012). Disturbances that impinge on the pathogen buffer activate buffer-restoring responses.

If heightened subjective vulnerability amplifies buffer-restoring output responses, one might expect heightened subjective *invulnerability* to dampen the same output responses. Indeed, invoking such a hypothesis, Schaller, Park, and Faulkner (2003) suggested that disease-based prejudice might just as easily be decreased: “Interventions designed to reduce individuals’ real or imagined risk of contracting infectious diseases may therefore help to reduce this particular prejudice” (p. 133). By contrast, the asymmetry hypothesis suggests that because deviation toward an inflated buffer (e.g., feeling especially invulnerable to disease) is simply not as consequential as deviation toward an insufficient buffer (e.g., feeling especially vulnerable to disease), an invulnerability disturbance is not expected to be strictly regulated—that is, heightened invulnerability may lead to few or no output responses. Therefore, experiments testing whether a disease-invulnerability manipulation can reduce

responses such as negative attitudes (compared to a baseline control condition) are hypothesized to yield weaker or negligible effects.

To our knowledge, only one set of published studies has come close to testing the effects of a disease-invulnerability disturbance on output responses. Huang, Sedlovskaya, Ackerman, and Bargh (2011) tested whether “experiences with two forms of disease protection (vaccination and hand washing) are capable of attenuating the relationship between concerns about disease and prejudice against out-groups” (p. 1551). They conducted Study 1 during the 2009 H1N1 pandemic, recruiting both individuals who had and had not been vaccinated. These participants were randomly assigned to either a disease-threat condition or a no-threat control condition. The dependent variable was a measure of attitudes toward immigrants. Huang et al. had predicted that, following a disease-threat manipulation, people who had received vaccination would express less prejudice than those who had not. Comparison of vaccinated and unvaccinated participants in the disease-threat condition did reveal the predicted difference. Importantly, their data also permit a test of whether disease invulnerability actually *reduces prejudice compared to the baseline*. For this test, the relevant comparison is that between vaccinated and unvaccinated participants in the control condition—this comparison can address whether an inflated buffer directly leads to a reduction in the relevant output response. Their results showed no significant difference between these two groups (if anything, there was a trend indicating greater prejudice among those vaccinated). Thus, although vaccination appeared to inhibit prejudice under disease threat, it did not straightforwardly reduce prejudice. Huang et al. conducted two additional studies. Study 2 did not have a baseline control condition, which does not permit the key comparison. In Study 3, protection was manipulated via random assignment to a hand-cleaning versus control condition. The most relevant result for the present discussion was the lack of a main effect of the hand-cleaning manipulation—that is, the disease invulnerability

manipulation did not reduce prejudice when compared against the baseline. The bottom line from Haung et al.'s research is that a disease-involvement disturbance (receiving vaccination, cleaning hands) does not actually reverse the output response (prejudice is not reduced compared to the baseline). But it can inhibit what would otherwise have been a prejudicial response, suggesting that protective interventions can potentially cancel out transient effects of disease salience.

In sum, the behavioral immune system is expected to prioritize the maintenance of a safe buffer against sources of pathogens, operating in a manner consistent with asymmetric behavioral homeostasis. When the buffer is reduced, the system is expected to activate disease-avoidance output responses (cognitions, emotions, motives) that serve to restore the buffer (i.e., there is strict homeostatic control). Under conditions of an inflated buffer, the asymmetry hypothesis predicts fewer and weaker output responses (i.e., there is little homeostatic control). The available data are consistent with the asymmetry hypothesis, although further research is needed.

Maintaining a Buffer against Dangerous People and Animals

Another recurrent evolutionary problem for humans (and prehuman species) has been the possibility of physical harm at the hands and claws of predatory people and animals. Given the immediacy of this sort of threat, it is not surprising that it has shaped some of the most urgent motivational states and behaviors (commonly referred to as “fight or flight response”), involving dedicated brain circuits (LeDoux, 2000) and specific perceptual, cognitive, and motivational mechanisms (Barrett, 2005). Fear appears to be the key emotion, and research has identified learning biases that facilitate quick acquisition of associations between danger-relevant animals and fear responses (Barrett & Broesch, 2012; Öhman and Mineka, 2001). In humans, such learning biases have been found to extend to social targets as

well (Navarrete et al., 2009, 2012). Here, we focus on the threat of interpersonal violence, particularly threat posed by members of coalitional outgroups (Schaller & Neuberg, 2012).

From the behavioral homeostasis perspective, it can be argued that these danger-avoidance mechanisms serve to maintain a buffer against potentially dangerous people. Thus, when a disturbance reduces that buffer, output responses that serve to restore the buffer are expected to be observed. The output responses comprise a wide range of psychological responses, including fear, danger-relevant cognitions, and increased negative attitudes toward danger-relevant social targets. The asymmetry hypothesis predicts that while a disturbance that reduces the buffer will trigger an output response that restores the buffer, a disturbance that makes people feel especially safe will have little effect.

As an important aside, one might argue that it would be more adaptive to strive for maximization of safety rather than an “optimal set point.” However, there is a problem with such a maximization motivation. A motivation system that strives for maximum safety would be an open-ended system, with no environmental stimuli that could deactivate the motivation—the motivation would be insatiable (Szechtman & Woody, 2004). An individual motivated to achieve maximum safety (e.g., distance from predators) would thus be unable to engage in many adaptive behaviors such as eating, sleeping, and mating. Indeed, this kind of situation may describe obsessive–compulsive disorder. Researchers in this area have argued that humans possess a security-motivation mechanism that involves negative-feedback processes (i.e., engaging in precautionary or safety behaviors typically triggers an emotional response that reduces security motivations) and that obsessive–compulsive disorder may be the result of a failure in negative-feedback control (Szechtman & Woody, 2004).⁵

Consistent with the unidirectional homeostatic control predicted for costly deviations, across a number of studies, danger-connoting cues (e.g., ambient darkness, fear-inducing movie clip, news about terrorism) have been found to exert vigilance-amplifying effects that

may be understood as buffer-restoring output responses—specifically, stronger tendencies to ascribe anger to the faces of neutrally expressive outgroup members (Maner et al., 2005), functional shifts in perceptions and cognitions with respect to outgroups associated with danger-connoting characteristics (Becker et al., 2010; Schaller & Abeyesinghe, 2006; Schaller, Park, & Mueller, 2003), increased prejudicial attitudes toward outgroups (Das, Bushman, Bezemer, Kerkhof, & Vermeulen, 2009), and quickened avoidance responses to outgroup targets (Miller, Zielaskowski, Maner, & Plant, 2012). More broadly, various theoretical approaches to discriminate sociality have highlighted the impact of perceived threats, including the threat of direct physical harm (Cottrell & Neuberg, 2005; Schaller & Neuberg, 2012). Essentially, research has found that a wide range of evolutionarily functional (albeit socially deleterious) responses can be amplified via the introduction of danger-connoting cues. These responses may result in the restoration of the danger-avoidance buffer, evidenced by preparatory cognitive shifts or actual behavioral avoidance.

An assumption of symmetrical responses predicts that the vigilance-related psychological responses may be reversed by interventions designed to make people feel especially invulnerable to danger. On the other hand, the asymmetry hypothesis predicts weaker or negligible psychological responses to a danger-invulnerability disturbance. We identified one experiment bearing on this issue (although we should note that the specific motive under investigation had to do with acquiring and maintaining resources, not physical safety). Rodeheffer, Hill, and Lord (2012, Study 2) investigated ingroup/outgroup categorization of ambiguous faces under a particular type of threat. Specifically, White participants categorized biracial faces as White or Black, following a resource-scarcity prime or a resource-abundance prime; there was also a neutral control condition. To the extent that the exclusion of potential outgroup members from the ingroup serves a protective function, one may expect threats to the ingroup to heighten the tendency to be exclusive, resulting in

more of the ambiguous faces being categorized as Black. This is exactly what Rodeheffer et al. found—the resource-scarcity prime led to heightened exclusivity (“seeing” more of the faces as Black). With regard to the asymmetry hypothesis, the key question is whether the resource-abundance prime led participants to be extra inclusive compared to the baseline, resulting in more of the ambiguous faces being categorized as White. The results showed no difference between the resource-abundance prime and the control conditions. The authors did not explain this null effect, but it’s fully consistent with asymmetric behavioral homeostasis.

In sum, mechanisms for avoiding dangerous people (and animals) are expected to prioritize maintaining a buffer against threatening targets. When the buffer is breached, the mechanisms are expected to activate danger-avoidance output responses (cognitions, emotions, motives) that serve to restore the buffer (i.e., there is homeostatic control)—and several studies have shown such effects. The little existing evidence is consistent with the asymmetry hypothesis.

Maintaining Social Relationships and Relational Value

Humans are said to be “ultrasocial,” a species characterized by “obligatory group living,” meaning that individual humans typically could not have survived alone (Richerson & Boyd, 1998; West-Eberhard, 1979). Baumeister and Leary (1995) argued that humans possess a fundamental *need to belong*. In many respects, their analysis falls nicely in line with the present perspective. There is a controlled variable to be maintained (i.e., relationships), and when a disturbance is introduced (e.g., rejection, isolation) it leads to an output response (e.g., seeking affiliation). In addition, Baumeister and Leary invoked the concept of *satiating*—the idea that people’s motivation to form social bonds will subside as they approach a *sufficient* level. And they articulated the implication that an excess of social affiliation is likely to be less impactful than insufficient social affiliation (specifically, that the pursuit of new relationships will have diminishing returns). Thus, although they did not

employ the terms homeostasis, feedback, or asymmetry, their perspective is fully compatible with asymmetric behavioral homeostasis.

Satisfaction of the need to belong likely hinges on a subjective sense of having a sufficient number of supportive and lasting relationships. Is there an approximate quantity of relationships that humans tend to maintain? Although Baumeister and Leary (1995) did not provide specific figures (indicating only that people need “a few” close relationships), others have suggested that human social aggregations reveal hierarchical organization (Caporael, 1997; Dunbar 1998) within which there is a relatively small group of individuals with whom one maintains especially close bonds, referred to as the “sympathy group.” Researchers have attempted to estimate the size of the sympathy group (e.g., by asking people to list the names of people whose death they would find devastating), and they have come up with figures in the region of 10–15, plus or minus a handful (e.g., Buys & Larson, 1979; Dunbar & Spoor, 1995). Not surprisingly, the sympathy group comprises close family and friends, and it is these few close bonds that are expected to be regulated by behavioral homeostasis.

Research has found that people are highly sensitive to cues of rejection and isolation across many social contexts (K. D. Williams, 2007). For instance, experiments have shown that minor instances of rejection by strangers kindle people’s desires to affiliate with new sources of potential affiliation (Maner, DeWall, Baumeister, & Schaller, 2007), albeit with greater interpersonal wariness (Twenge, Baumeister, DeWall, Ciarocco, & Bartels, 2007). Given that the experience of rejection and isolation throughout human evolutionary history is likely to have portended a serious setback, this sort of hypersensitivity is not surprising. Highly telling is the discovery that the “pain” of social rejection exhibits neurophysiological overlaps with the experience of physical pain (Eisenberger, Lieberman, & Williams, 2003; MacDonald & Leary, 2005).

Perhaps the most widely studied psychological phenomenon associated with social rejection is self-esteem (the extent to which people value themselves). According to Leary's (1999) *sociometer theory*, the evolutionary importance of maintaining interpersonal relationships may have led to ancestral humans developing "a mechanism for monitoring the degree to which other people valued and accepted them" (p. 33), and self-esteem may serve that monitoring function. Information suggesting threats to relationships or rejection by others may act as a disturbance that leads to the experience of low self-esteem and concomitant motives to restore one's sense of relational value (Leary, 2005).

According to the asymmetry hypothesis, experiencing extra relationship security or being socially accepted when already sated is not as functionally consequential as experiencing threats to relationships or being rejected. Accordingly, the output responses for attaining and maintaining relationships (yearning, loneliness, and affiliation motives) are expected to be easier to amplify than to dampen. Likewise, to the extent that reduced self-esteem (i.e., the warning signal from the sociometer) motivates functional behavior, decreases in self-esteem (engendered by rejection) should be easier to trigger and typically larger in magnitude, compared to increases in self-esteem (engendered by acceptance). For most of the output responses, there exist no data bearing on the asymmetry hypothesis (all of the studies we have come across have used one-sided manipulations). Also, many tests of sociometer theory omitted a baseline control (e.g., Bourgeois & Leary, 2001; Leary, Cottrell, & Phillips, 2001; Leary et al., 2003), without which the asymmetry hypothesis cannot be evaluated. Other studies included "neutral" conditions (e.g., participants received approval scores around the middle of a Likert-type scale) along with approval and disapproval conditions (e.g., Buckley, Winkel, & Leary, 2004; Leary, Haupt, Strausser, & Chokel, 1998). However, one cannot assume that such neutral conditions are psychologically equivalent to baseline controls, because the "neutral" feedback (e.g., being given an approval score around

5 on a 1–9 scale) may actually be experienced as mild disapproval.⁶ Thus, the results from such studies are difficult to interpret with respect to the asymmetry hypothesis.⁷ We identified one study with a true baseline control (Leary, Tambor, Terdal, & Downs, 1995, Study 4). In this study, participants first completed a pretest measure of self-esteem and in a later experimental session were assigned to an inclusion, exclusion, or no feedback control conditions. They then completed the same measure of self-esteem. Leary et al. (1995) reported two analyses. One analysis examined only the posttest self-esteem scores across the three conditions, and it showed that self-esteem scores in the inclusion condition were higher than in the other two conditions, and self-esteem scores in the exclusion and control conditions were similar, which contradicts the asymmetry hypothesis. A second analysis compared difference scores (posttest – pretest self-esteem scores) across the three conditions. This is arguably a more informative test, as it controls for random variations in pretest self-esteem scores and thus allows a more rigorous examination of how the manipulation shifted individuals' self-esteem scores from their baselines. This analysis showed significant posttest reductions in self-esteem scores following exclusion, but no statistically significant changes in the inclusion and control conditions. Leary et al. (1995) concluded, “Thus, rejection significantly lowered self-feelings, but acceptance did not significantly raise them” (p. 526)—consistent with the asymmetry hypothesis.

In sum, humans possess a set of psychological mechanisms that prioritize the maintenance of a sufficient level of social affiliation. When relationships are under threat, the mechanisms are expected to activate functional output responses that serve to reinforce or repair relationships (e.g., desires to forge new bonds). A large number of studies have demonstrated such effects. The asymmetry hypothesis implies that extra relationship security, social acceptance, or trust/face building should not have commensurate dampening effects on those output responses. At least one experimental finding suggests that the warning signal

component of the sociometer is easier to amplify (via exclusion) than to dampen (via inclusion).

Interim Summary

For several fundamental motivational processes, behavioral homeostasis offers a useful means of identifying the key underlying mechanisms. Furthermore, the asymmetry hypothesis predicts that behavioral homeostatic mechanisms should generally be designed to maintain above-threshold levels of a variable, with the result that downward deviations are responded to more robustly. The few unequivocal tests of the asymmetry hypothesis have shown that upward deviations (e.g., disease invulnerability, social acceptance) have no effects on the outcome variables compared to the baseline. We would expect future studies to show similar patterns. Indeed, it's possible that many null effects sit in file drawers. As many psychologists have experienced, null effects are notoriously difficult to interpret. The present perspective offers a theoretically grounded reason to expect null effects in specific situations.

Additional Issues and Directions for Further Research

To be sure, psychologists have been making strides without invoking the concept of homeostasis. So our perspective must be sufficiently justified: It must not only provide a cogent account of observed phenomena, but also inspire novel questions and further research. Below, we identify additional issues for further consideration.

Homeostasis or Maximization?

As noted previously, a possible counterargument to the present perspective is that humans do not attempt to maintain *sufficient* levels of the variables discussed above (distance from threat, social relationships), but instead are driven to *maximize* these variables, as it is only beneficial to have more safety and more (or better) relationships. We noted above why motives that are geared toward maximization (and thus insatiable) may be dysfunctional. Here, we further elaborate on this issue.

It is an evolutionary truism that animals will tend to maximize benefits *within existing constraints*. Importantly, these constraints are what make the systems behave in a homeostatic manner. For instance, a motivational system that strives for “infinite” safety would be insatiable (as mentioned above, a situation that may describe obsessive–compulsive disorder; Szechtman & Woody, 2004). As animals must simultaneously manage multiple (often competing) goals, a threat-avoidance motive that is perpetually activated will inevitably impose fitness costs by hindering other important goals (such as foraging and mating). Therefore, it is improbable that animals have evolved drives to maximize distances from threats; rather, they have evolved to be functionally flexible, attending to threats only when they begin to impinge on the buffer and must become prioritized. The mechanisms described above can thus be said to exhibit the key characteristics of asymmetric behavioral homeostasis—the existence of a reference value, strict control over downward deviations, and loose (or no) control over upward deviations.

Of course, whether a particular motivational process involves homeostatic control or maximization is ultimately an empirical issue, and future research may reveal that some motivational systems are better explained by maximization (or minimization). For example, motivations for social status (Kenrick et al., 2010) may be insatiable, as social status is inherently relative and every increase in status may confer incremental benefits. There are various empirical approaches to this issue. Behavioral observations in either natural or controlled environments might reveal whether animals (including humans) tend to continue gathering (and hoarding) a particular resource or buffer (food, safety, etc.). If the relevant motivational system is homeostatic, one expects to observe satiation—the animal will stop gathering the resource at some point (maximization would be indicated by a continued gathering and hoarding of the resource). Furthermore, one might experimentally manipulate a resource the animal has in the more costly direction (e.g., reduce safety) and measure

subsequent compensatory behavior. In such an experiment, homeostatic control would be indicated by efforts to restore the level of the resource to approximately pre-manipulation levels, whereas maximization would be indicated by efforts to maximally increase the resource. In addition, research on individual differences might yield data consistent with homeostatic control. For example, when multiple individuals can obtain resources at similar costs, individual differences in gathering resources would be consistent with homeostatic control and individual differences in set points (see discussion below on individual differences and person \times situation interactions).

Asymmetry and Its Long-Term Implications

Even highly adaptive physiological and psychological responses entail costs, so natural selection is expected to have shaped homeostatic responses to be only as strict as necessary. This is why hyperglycemia occurs more frequently than does hypoglycemia; the latter is more strictly controlled and the former more tolerated (Pocock et al., 2013). There may be interesting longer-term effects of greater tolerance of the less costly deviation. Sometimes, the less costly deviation may, over a longer duration, have cumulative negative effects. For instance, chronic hyperglycemia (the defining characteristic of diabetes mellitus) does have negative physiological effects (e.g., Brownlee, 2001). In the realm of behavioral homeostasis, repeated deviations in the less costly direction may have the effect of altering the baseline (the reference value), at least under some circumstances. For instance, while recurrent input indicating invulnerability to disease may not precipitate immediate changes in motivational responses, it may gradually alter expectations about diseases in the environment and possibly expand the buffer that one attempts to maintain. An increased buffer means greater reactivity to a wider range of potential disturbances. This would amount to a long-term change in an individual-difference disposition (e.g., greater pathogen disgust sensitivity) or a longer-term shift in societal standards (e.g., increasingly stringent hygiene norms).

Individual Differences and Person \times Situation Interactions

The concept of homeostasis may help clarify person \times situation interaction effects, which psychologists often rely on to buttress causal arguments. Specifically, to test the hypothesis that X has an effect on Y, many researchers will not only experimentally manipulate X (high X condition versus low/no X condition), but also measure individual differences in a dispositional variable corresponding to X, and they will look for interaction effects between the two. An example would be investigating the interactive effect of “state” and “trait” anxiety. This practice may increase the odds of uncovering a noteworthy effect, because even if the main effect of manipulated-X (e.g., state anxiety) is negligible, there may be an interaction effect involving measured-X (e.g., trait anxiety). Interestingly, the literature reveals two types of ordinal interaction effects, both of which have been used to justify causal conclusions: (a) manipulated-X has no effect on individuals low in measured-X but has an effect on individuals high in measured-X (e.g., manipulating state anxiety shows an effect on the DV only among participants high in trait anxiety); and (b) manipulated-X has no effect on individuals high in measured-X but has an effect on individuals low in measured-X (e.g., manipulating state anxiety shows an effect on the DV only among participants low in trait anxiety; for examples of studies showing such interactions, see Bushman & Baumeister, 1998; Maner, Gailliot, Rouby, & Miller, 2007; Maner, Miller, Moss, Leo, & Plant, 2012). The first type appears to show that certain individual-difference effects remain dormant unless “triggered” by a provocative situation, with the result that the impact of individual differences becomes visible only in the experimental (high X) condition. The second type appears to show overpowering effects of “strong situations”—individual-difference effects manifest under typical circumstances (low/no X condition), but not in the experimental (high X) condition (for a discussion of the *strong situation hypothesis*, see Cooper & Withey, 2009).

Can the two types of interaction effects be reconciled? Maner et al. (2012) suggested that some functional motives may not be generally active such that dispositional differences become apparent only under sufficient environmental stimulation (corresponding to the first type described above), but that other functional motives may be chronically active such that dispositional differences exert effects in everyday situations but not under stronger situations (corresponding to the second type described above). Marshall and Brown (2006) proposed the *traits as situational sensitivities model* to account for these two types of interaction effects under a single framework. This model proposes that individuals high on a dispositional variable have a lower threshold for reacting to situational stimulation, resulting in the commonly observed patterns in which high-trait individuals are especially reactive in the weak-to-moderate situations range, and low-trait individuals are especially reactive in the moderate-to-strong situations range (for clarification, see Marshall & Brown's [2006] Figure 1).

While Marshall and Brown's (2006) model represents an important advance in understanding these patterns of person \times situation interaction effects, the asymmetric behavioral homeostasis perspective offers a more direct window into the underlying psychological processes. Consider the following thought experiment. Imagine two individuals with metabolic heating systems (but no cooling systems), and their internal "thermostats" are set at 24°C and 22°C. If the ambient temperature happens to hover around 22°C, the first individual (set at 24°C) will experience larger and more frequent downward deviations, resulting in a more intense and persistent operation of the heating system. In fact, variation in temperature set points occurs in human thermoregulation, most notably during febrile responses, with the result that a person whose body is attempting to maintain a higher temperature will generally feel colder and exhibit more intense output responses to maintain the higher body temperature (Maier & Watkins, 1998). If this difference in set points is

chronic, then we might speak of individual differences—dispositional differences in “cold sensitivity.” Many individual differences can thus be understood as differences in homeostatic reference values. When a system is attempting to keep up to a higher reference value, it will exhibit output responses more intensely and frequently.

Suppose we refer to these two individuals as “high cold sensitive” (set point at 24°C) and “low cold sensitive” (set point at 22°C), respectively. How does this “disposition” interact with external situations? Suppose that, under experimental conditions, these individuals are introduced to ambient temperatures of 25°C, 23°C, and 21°C, and that the activity of their metabolic heating system is measured as the DV. Figure 1 depicts the hypothetical results (note its close resemblance to Marshall and Brown’s [2006] Figure 1). In the 25°C condition, both individuals will experience upward temperature deviations and thus exhibit little or no activity. In the 23°C condition, the low-cold-sensitive individual will continue to experience mostly an upward deviation and thus exhibit little activity; however, the high-cold-sensitive individual will now experience downward deviations and thus exhibit greater activity. In the 21°C condition, both individuals will experience downward deviations and thus exhibit heightened activity. This thought experiment clarifies why we might observe the pattern of person \times situation interaction as described by Marshall and Brown (2006). “Weak” situations might be those in which individuals of all dispositions do not experience a homeostatic disturbance, “moderate” situations might be those in which individuals maintaining higher reference values are more likely to experience a homeostatic disturbance, and “strong” situations might be those in which individuals of all dispositions experience a homeostatic disturbance. For instance, some individuals may maintain larger danger- or disease-avoidance buffers than others, resulting in more intense and frequent responses; such individuals may be said to be high in trait anxiety or disgust sensitivity.

Ballistic Processes

While many adaptive responses may hinge on negative-feedback control, there are some apparently adaptive behaviors showing little sign of feedback control (Schaller, 2003; see also Baumeister, Vohs, DeWall, & Zhang, 2007). Rather, these processes operate in a manner that might be better described as reflexive, or “ballistic,” meaning that a quick response is launched in the correct direction (analogous to a ball being thrown toward a target, after which there is no control over its movement). This sort of process gains in speed what it loses in accuracy, and it likely coexists with feedback-controlled processes. Darwin (1872) provided a vivid example of a response that is best described as ballistic:

I put my face close to the thick glass-plate in front of a puff-adder in the Zoological Gardens, with the firm determination of not starting back if the snake struck at me; but, as soon as the blow was struck, my resolution went for nothing, and I jumped a yard or two backwards with astonishing rapidity. My will and reason were powerless against the imagination of a danger which had never been experienced. (p. 38)

While it may resemble behavioral homeostatic mechanisms, this sort of instantaneous and cognitively impenetrable response does not appear to be characterized by a process involving feedback and discrepancy reduction. Nevertheless, the functional asymmetry applies here as well. There is a safe distance that must be maintained, and so a sudden reduction in the distance is more inciting than a sudden increase in the distance (had the snake made a sudden movement away from Darwin, he would not have attempted to jump forward to reduce the widened gap). Darwin’s passage also hints at the idea that these mechanisms can be evolutionarily prepared toward achieving specific outcomes (i.e., he did not have to learn to jump away from a venomous snake).

Apart from clear-cut cases, the distinction between homeostatic and ballistic processes can be difficult to discern; indeed, many of the behavioral “homeostatic” responses discussed above may be better described as ballistic. Importantly, however, there may be

multiple layers of feedback control, so that a particular behavioral outcome that appears ballistic—and not necessarily feedback controlled toward a genuine goal—at one level may be feedback controlled at a higher level. Darwin's ballistic jumping behavior (which itself is not feedback controlled) can be seen as a lower-order behavioral capacity that serves the higher-order goal of avoiding potential dangers (which is feedback controlled). Generally, we would expect adaptive behaviors to be the result of interlocked combinations of ballistic and feedback-controlled processes.

Conclusion

Psychologists have long been interested in examining effects of experimental manipulations on immediate psychological and behavioral outcomes, developing a wide array of theories and models to account for these effects. The fact that many existing models of psychological processes—especially those pertaining to motivation—align well with the behavioral homeostasis perspective suggests that the behavioral sciences may be more commensurate with the biological sciences than sometimes assumed. Both physiological and behavioral homeostatic processes may exhibit a functional asymmetry. An important implication for motivational processes, thus far largely unacknowledged, is that simply reversing the input cues will not reverse the output responses. This explains why many motivation-related responses (not only basic emotions but also more downstream outcomes such as heightened prejudices) are easy to dial up but difficult to dial down. How (and how much) human psychological processes are characterized by asymmetrical homeostatic control remains to be more thoroughly elucidated. The present perspective supplies another bridge between psychology and physiology, and it highlights the important role that experimental psychology plays in mapping the various evolutionary paths to adaptability.

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Footnotes

¹Of course, phenotypic plasticity and homeostasis are not alternatives to evolved adaptations but are specific instances of them. We are merely highlighting the contrast between adaptations that are relatively fixed within individuals and those that permit ontogenetic and transitory adaptability.

²This usage of the term “negative feedback” should not be confused with the more colloquial usage frequently seen in psychology, where the term means something roughly equivalent to “criticism” (information that draws attention to one’s flaws and weaknesses).

³There are more sophisticated temperature-regulation systems that appear to be “all-in-one,” with the capacity to both heat and cool; however, beneath the surface, these contraptions basically consist of two separate feedback systems packaged together, and they will inevitably cost more to manufacture and maintain. In fact, people living in climatic regions characterized by both hot and cold extremes (e.g., East Asia) often have two entirely separate temperature-regulation systems in their dwellings, if they can afford them.

⁴Carver and Scheier (1998) discussed how feedback systems may be characterized by “sloppy” versus “tight” control (p. 15), but they did not go into the issue of asymmetry.

⁵We revisit the issue of maximization versus homeostasis below.

⁶This conjecture is based on the finding that people’s self-esteem scores tend to lie well above the midpoint of numerical scales (Baumeister, Tice, & Hutton, 1989; though there is cross-cultural variation, Schmitt & Allik, 2005). It may thus be the case that people expect some level of approval by default (at least among populations characterized by above-neutral self-esteem), and downward deviations from that baseline (including feedback constituting the “neutral” conditions in experiments) may actually be perceived as cues of disapproval.

⁷In fact, Leary (2005) used data based on varying levels of feedback (Leary et al., 1998) to draw inferences regarding how self-esteem responds to rejection/neutral/acceptance experiences. Leary's (2005) Figure 1 shows that the self-esteem gain from acceptance is larger than the self-esteem loss from rejection, which contradicts the present asymmetry hypothesis. However, then specific inference depends on at which point on the x-axis one places the "baseline." As noted above, the psychological baseline is probably not equivalent to neutral feedback but closer to the right end of the axis, which would tend toward the opposite conclusion that the self-esteem loss from rejection is larger.

Table 1

Hypothetical Domains of Asymmetric Behavioral Homeostasis

Controlled variable	Disturbance	Output
Buffer against pathogens	Heightened threat posed by pathogens	Disgust, aversion, physical distancing
Buffer against dangerous people and animals	Heightened threat posed by people and animals	Fear, attributions of danger, escape
Social relationships and relational value	Heightened threat of loss of relationships	Low self-esteem, reconnection motives

Figure Caption

Figure 1. Hypothetical results of an experiment in which individuals with different temperature set points (“high cold sensitive” and “low cold sensitive”) are placed under three ambient temperature conditions. The y-axis shows the activity level of their metabolic heating systems in hypothetical units. When the ambient temperature is 25°C, neither individual activates their heating system; when the ambient temperature is 23°C, only the high cold sensitive individual activates their heating system; when the ambient temperature is 21°C, both individuals activate their heating systems.

