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CHAPTER TWO

Motivating Personality: Approach, Avoidance, and Their Conflict

Philip J. Corr*,[1] and Dino Krupić[§]
*City, University of London, London, United Kingdom
[§]Josip Juraj Strossmayer University of Osijek, Osijek, Croatia
[1]Corresponding author: E-mail: Philip.corr.1@city.ac.uk

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Abstract

Evolution has bound closely together motivation and personality. Much of personality psychology today is based on the (increasingly neuro) science of fundamental systems of motivation. This is most clearly seen in the family of approach–avoidance theories that describe the major brain-behavioral systems that mediate reactions to stimuli appraised by the animal (including human beings) as falling into appetitive (attractor) and aversive (repulsor) classes. Here "motivation" may be seen as an immediate *state* process, which is affected by transient internal factors such as drive (e.g., hunger) and external situational constraints and affordances. In contrast, personality may be seen as the corresponding longer-term *trait* of typical motivation. In the causal cascade, it is emphasized that *goal* representations are at the heart of true *latent* motivation, while *states* are the *observed* expression of such motivation modified by a host of internal and external factors. Over a century's worth of experimental research leads us to suppose the existence of two major negative-defensive "avoidance" systems, one related to pure avoidance and escape of aversive stimuli, and the other to behavioral inhibition evoked by the detection of goal conflict. A third major, positive-incentive, motivation system is related to exploratory approach, reward sensitivity/reactivity, goal-drive persistence, and impulsivity. These systems of motivation and personality are discussed in terms of Reinforcement Sensitivity Theory (RST), which proposes three systems corresponding, respectively, to these basic forms of motivation: Fight-Flight-Freeze System, Behavioral Inhibition System, and Behavioral Approach System. The conceptual foundations of RST are outlined, and the neuropsychological systems delineated, which includes discussion of automatic-controlled processes, as well as the exotica of consciousness. Psychometric measurement systems are then presented and examples of the applications of RST are provided. Finally, the problems for future research are sketched to guide the RST-inspired student of motivation and personality.

1. INTRODUCTION

Personality and motivation are closely related epistemological concepts, and advances especially in the neurosciences are revealing that they are often indistinguishable theoretical and operational constructs. The psychological literature has tended to keep apart these two fields, but they share too much in common to allow the opinion to prevail that they should be studied in isolation. The perspective we adopt views personality as the long-term instantiation of motivation. If this contention is valid, we should be able to learn much about the nature of personality *traits* from studying shorter-term motivation *states*. Many theories of personality have motivation at their core, and our article provides a timely summary of one major approach based in fundamental approach-avoidance behaviors.

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Theories of personality attempt to describe systematic differences between people in affect, cognition, and behavior, both across situations and over time. As motivation theory attempts to explain the underlying dynamics of these consistencies, as well as how behavior responds to the pulls and pushes of the "situation" (immediate) and "environment" (longer-term), it gets very close to addressing the causal roots of personality. Basic biological models of approach and avoidance may seem a far cry from the type of constructs specified by, for example, self-determination theory (Deci & Ryan, 2008), regulatory focus theory (Higgins, 2000), and the like. But, as we argue below, such higher-level constructs are not incompatible with lower-level biologically based ones; indeed, assuming they have independent scientific validity, in unified psychological science they must be assumed to be compatible, contained in some form of integrative *biosocial* theory (e.g., Eysenck, 1967).

It is trite, but true, to say that the motives for any behavior are multifaceted. Consider the task facing the author of an article such as the one you are now reading. The author may have different motives. On the positive side of the equation are the intellectual stimulation and creativity and achievement motivation (positive reinforcement). On the negative side of the equation are the avoidance of missed deadlines, escaping from procrastination, and editor disapproval (negative reinforcement). The *real* causes, which would be idiographic, perhaps can never be known and only inferred. It is for this reason that, we believe, it is preferable to focus on the structural and functional properties of motivation at the most general level of approach and avoidance: nomothetic systems that are common to all people irrespective of the specific stimuli to which they are attracted or repulsed. In this way, there are limited degrees of freedom. One can approach, avoid, or engage in indecisive, vacillating, behavior. Something else of relevance in this regard is that people construct their own positive and negative goals and reinforcement, yet we can be confident that they are instantiated in the cognitive and behavioral (approach-avoidance) machinery common to all.

The major aim of this article is to explore the nature of basic systems of motivation, dealing with here-and-now *state* approach and avoidance and their longer-term representation in personality *traits*. Although there is much more to personality traits than these basic motivational pulls and pushes, it may be safely supposed that driving all major personality traits, including those in the Big-5, are such systems of motivation (Corr, DeYoung, & McNaughton, 2013).

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The article is structured to start with basic conceptual issues. Then, the theoretical bases of reinforcement sensitivity theory (RST) are outlined, and this is followed by delineation of RST systems and discussion of the various ways these systems have been measured in humans by standard personality questionnaire. We consider also the nature of automatic and controlled processes, and even the exotica of consciousness. We give some examples of the applications of the approach we summarize and end with some of the problems that still need addressing.

Much of what follows encapsulates our intellectual journey. Although we are a long way from the final destination, assuming one could be identified and defined, our journey has been made possible by the seminal work of thinkers and experimentalists over, at least, the last one hundred years, with the ground-breaking work of Ivan Pavlov providing the route map to guide us (Corr & Perkins, 2006). More recently, the contributions of Jeffrey Gray and, then, Neil McNaughton, have been seminal in advancing our understanding of basic systems of motivation, emotion, learning, and, thence, personality. Of course, their work would not have been possible without the foundations having being laid by such visionary psychologists as Hull (1943, 1951), Mowrer (1960), Miller (1959), Konorski (1967), Schneirla (1959), and most importantly in the area of personality, Hans Eysenck (1944, 1947, 1957, 1967, 1997). Along the way there have been many other psychologists who made incremental contributions, the sum value of which has been substantial; it would be invidious to name only a few of them.

2. BASIC ISSUES

Many of the issues at the core of modern-day approach-avoidance theories have origins in older notions in philosophy and its applications (e.g., jurisprudence). For example, the famous moral philosopher, Jeremy Bentham (1781, *Introduction to the Principles of Morals and Legislation*), wrote about the "sovereign masters, pain and pleasure."

It is readily apparent that, in one form or another, Bentham's "masters"—the true sovereign of behavior—exert their influence throughout society. If we prefer, we can go back to the early philosophers of Ancient Greece (e.g., Epicures of Samos 341–270 BC, and Aristotle 384–322 BC) to see the concern with the masters of pleasure and pain. Whatever our preference, we would be very hard pressed to find a society where behavior is governed by the dominant pursuit of pain and the

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avoidance of pleasure. Everyday life is regulated by striving for the good things (e.g., safety, food, drink, and fulfilling social, personal, and occupational pursuits), as well as the avoidance of bad things (e.g., dangerous animals, rotting food, and criticism from other people).

Despite the obvious importance of these masters, when we turn to science for an understanding of motivation we are often provided with nebulous and tautological concepts. For this reason, motivation has not been accorded its deserved status especially in cognitive psychology; although, in many applied areas where its effects are writ large, it is accorded pride of place in explanations of behavior (although, again, often in a circularity of reasoning manner). Added to this problem is another: the phenomenological experience of the individual, which has unique (idiographic) properties and the common (nomothetic) underlying processes. Putting to one side the suspicion that still surrounds consideration of subjective experience, there is no conflict between these two perspectives. As we show below, levels of neurobehavioral control are central to motivation, and respect for different levels of analysis are required in a thoroughgoing scientific treatment that must include the mysteries of conscious awareness (for discussion of these issues, see Corr, Fajkowska, Eysenck, & Wytykowska, 2015). More tractable are the *functions* of such awareness.

The student (and professor) of the psychology of motivation faces the problem of deciding where best to start, and, although temptation often gets the better of us, it is usually never just by description of phenomena and most certainly not by premature naming of phenomena that tends to put the proverbial cart (conceptual definition) before the horse (scientific data-constrained explanation). As the ugly head of tautology is all-too-ready to be raised, it is important for our understanding of the scientific nature of motivation to consider underlying psychological dynamics: *Causal* explanation. In this pursuit, as in other areas of science, sometimes it is best to creep-up on phenomena in a more tangential fashion especially when they are nebulous (e.g., in the case of consciousness; Gray, 2004).

With these caveats in mind, and cognizant of the fact that the literature can resemble little more than a perfusion and confusion of theoretical and operational claims, few would doubt the fundamental importance of motivation in all aspects of human behavior. At a broad conceptual level, motivation may be applied to an internal state, reflecting competing forces (e.g., drives, goals, and external constraints). At the very lowest level, such forces are basic (e.g., avoidance of hunger and cold), whilst, at the highest level, they may be abstract (creativity and beauty). Seen in this light, we

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may expect a large number of interrelated processes, both biological and social, to contribute to this internal state, but this poses a problem. We need to isolate and characterize the separate components of motivation whilst at the same time keeping in mind the integration of the components to enable the product of motivational forces to influence adaptively moment-by-moment behavior. There must be regulation, feedback, and learning; it is no wonder cybernetic metaphors and theories have been popular (e.g., Carver & Scheier, 2000). And given the complexity of these processes, we may well suspect a high level of central state organization (Miller, 1959) with control mechanisms to enable some form of hierarchical behavior control (Gray & Smith, 1969; McNaughton & Corr, 2009).

In the research literature, motivation science takes several forms. One of the foci in this article concerns fundamental systems of approach, avoidance, and their conflict, based around the RST of personality. This RST approach derives from the work of Jeffrey Gray (1970, 1972a, 1972b, 1975, 1982), which culminated in his final work in 2000 (Gray & McNaughton, 2000). Although colleagues have since been tinkering with the details of this theory (e.g., Corr & McNaughton, 2012) as regards the basic systems, arguably, little of substance has changed. However, as RST is built on nonhuman animal work, much progress has been made applying it to human motivation and personality. For example, the development of theoretically faithful questionnaire measures has been rife with difficulties and debate (for a summary, see Corr, 2016), although good progress has now been made (e.g., Corr & Cooper, 2016).

At this point, it is worth noting that the material herein is applicable to the wider family of approach-avoidance theories, although each has its own epistemological and theoretical quirks. These related approaches include Cloninger (Cloninger, 1986), Depue (Depue & Collins, 1999), Davidson (Davidson, Ekman, Saron, Senulis, & Friesen, 1990), and Carver (Carver & White, 1994). For a review of influential theories in personality neuroscience, see DeYoung and Gray (2009).

2.1 Approach/Avoidance Motivation

In various ways the foundational work starting with Pavlov had a major influence on the present-day agreement that there exist only a small number of state systems that mediate reactions to different classes of reinforcing stimuli (serving as "attractors" and "repulsors" of various kinds; see below), which generate emotion and shape approach-avoidance behavior. According to this view, what we commonly term "motivation" reflects the internal

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process that lies *between* (a) the evaluation of stimuli, that go on to form classes of attractors/repulsors and (b) their influence on behavior (and feelings, cognitions, etc.). In this sense, motivation cannot be defined solely in terms of either reactions to *stimuli* or the form taken by *responses*, as these can be very misleading of this central state (see below). This statement undermines the scientific pretensions of behaviorism, as does any approach that does not recognize the importance of goal representations that lay at the heart of motivation.

Added to this theoretical position is the relevance of context and situational factors. Some environments afford certain forms of behavior, others do not. For example, simple avoidance of a threatening stimulus may be possible in one environment (e.g., in a park with many aggressive-looking barking dogs), but not in another environment (e.g., being approached at night by an aggressive individual in a confined space), which may call forth a different form of defensive reaction (e.g., fleeing or fighting). Context, too, is important. For example, in most people an aggressive boss would elicit a different reaction than an aggressive stranger, and very often we have to inhibit automatic, prepotent reactions (e.g., fleeing from the sound of the dentist's drill, or getting flustered when giving an oral presentation in front of people). Therefore, the rather clinical sounding terms "approach" and "avoidance" need to be seen in the light of the affordances and constraints of the situation and context, and the broader "environment." This is especially important when *assigning* interpretation and meaning to motivated behaviors. We cannot simply "read-off" functions from them without considering the specific context in which they are elicited, observed, and measured (Corr, 2009).

Another reason why focus on explicit (experimenter-defined) reinforcement or overt behavior will not do when trying to provide a truly scientific account of motivation is that "context," "situation," and the "environment" are, often, themselves part-and-parcel of the motivation they are assumed to influence. This point was made by Eysenck (1998, p. 42), when he stated:

> *"Children, as they grow up, increasingly choose their environment; this choice itself is driven by genetic factors. And they interpret their environment in terms of their genetic contributions. Our environment is structured by ourselves, on the basis of genetic drives."*

Given these lines of argument, it would appear that we have no other psychological tools available to understand and predict behavior other than central states of motivation and it is to them that we must turn.

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2.2 The Nature of Goal Representation

Discussion of motivation in terms of central states, in the manner defined above, takes us to the important role played by "goal representations." This discussion is important because talk of "central states" has the potential to be nebulous, elusive, and circular in reasoning, as is the very notion of "motivation" in the wider psychological literature.

As noted by McNaughton, DeYoung, and Corr (2016), an animal's behavior is "motivated," and this motivation is encapsulated in the concept of the "goal." It is crucially important to note that, as used throughout this article, overt behaviors are mere tools to satisfy these internal goal states, which can be desires of an emotive type but also emotion-free cognitions (e.g., the animal's position in space). Despite the noun, "goal" in this sense, *is not* defined by its end-point state; it is a far more abstract notion, but one that does submit to clear definition. As McNaughton et al. (2016, p. 26) noted: "The nature of this internal representation needs some explanation and should be kept completely separate from the 'goals' that people often attribute to behaviors in terms of external functional or evolutionary explanations." In the simplest form of animal behavior, a goal can be merely the detection of an external gradient (e.g., intensity of odor) and whilst still a goal (i.e., to follow the odor) the behavior is motivated by little more than the affordance of the environment. In terms of simple defense, avoidance behavior can be gradient-sensitive, allowing the animal to move away from light (e.g., rats in a light open field). Where light signals danger, simple detection of light strength permits the animal to avoid and to escape to a place of dark safety. These simple forms of motivation are "taxes" (pronounced *tack-seize*). These are very stimulus-specific and do not involve any form of complex goal representation. However, as discussed below, reinforcement may be seen as providing another form of taxes, but this time instead of the organism being sensitive to a gradient of simple stimuli, the human being is sensitive to a gradient of reinforcement.

When discussing basic approach-avoidance, situational and environmental affordances need to be considered. This is especially true when we move from stimulus-specific and rigid forms of behavior. Goals become more abstract and behaviors more flexible. In this latter sense, behaviors become an increasingly poor index of goal representation motivation, and it is a cardinal scientific mistake to assume *isomorphism* between specific goals and specific behaviors (although, for sure, the two are not always independent).

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Before we move on to discuss specific RST systems, some mention is needed of the opposition of goals, which we see formally in approach-avoidance conflict. But this is also seen in more abstract goal representations. The formal situation is seen in the classic Neil Miller conflict situation, where the animal approaches a source of food where shock will also be delivered. Here goal gradients are important. Avoidance (punishment) gradients are steeper than approach (reward) gradients. We see this, too, in the form of loss aversion, where it is said that losses loom larger than gains (typically by a factor of 2), which means that, at short defensive distance (i.e., danger immediate), avoidance/escape dominates, but with less immediate, or distant, threat, tentative approach behavior dominates. Humans similarly behave; for example, approach to a sexual partner where there is prospect of rejection. Such conflict induces hesitation, indecision, and caution.

In the sense in which "goal" is used in this article, personality may be conceptualized as the long-term crystallization of major classes of goals, which then interact with the environment, situation, and context to determine the behavior observed. In the case of human beings, but also seen in other animals (e.g., the domestic dog), goals have a hierarchical structure with basic goals of avoidance of, escape from, threat and the approach to appetitive stimuli requiring satisfaction before higher-order and less urgent/immediate goals (e.g., exploratory curiosity). In discussion of these matters, it would seem desirable to distinguish between two dimensions of motivation: (1) goal representations that can be in states of deactivation or activation and (2) the strength of activated goal states.

Taking a personality perspective may well allow us to reduce all of the apparent complexity, and inherent ambiguity, of motivation to several broad classes, with fairly well-described neuroscience systems. From this tangential perspective, we may see that each of our many personality traits reflects the operations of a set of brain systems that has evolved to respond to a different class of functional requirements (Denissen & Penke, 2008; McNaughton, 1989; Nettle, 2006; Pickering & Gray, 1999). As we discuss below, the most important classes of motivational stimuli can be grouped into "attractors" and "repulsors" (positive and negative goals) that have evolved to promote survival and reproduction (Carver & Scheier, 2000; DeYoung, 2010a). Without a tendency to approach beneficial stimuli (e.g., food, drink, and sexual mates) and to avoid aversive stimuli (e.g., predators and poisons) a species would not survive. We would not be here to write and read this article, and our motivation to do these things are, themselves, shaped by these primitive motivational factors.

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2.3 Reinforcement as Taxes

The power of reinforcement lies in its facility to motivate behavior. The grand Skinnerian paradigm of positive and negative reinforcement attests to the importance of innate and conditioned reactions to the presentation of different forms of stimuli that have acquired by one means or another (e.g., innate, conditioned, and appraised) the status of "attractors" and "repulsors." Indeed, the power of reinforcement psychology may be seen to lay in its ability to provide a low-level, taxes-like, account of even higher-level stimuli, for example money, which has the appealing feature of fungibility (it can be traded for most things), and, thus, in this way has a conversion rate of psychological salience.

Taxes are reactions to a very simple stimulus, for example, light intensity: an animal may move in the direction of increasing darkness. In this sense, taxes are not goal directed. Goal direction requires an internal representation of the desired endpoint, which may entail *not* moving along a specific gradient. In contrast, with taxes proper the final point at which the animal comes to a stop is the point at which behavior self-terminates. Evolution has ensured that this is the best place for the animal; no internal representations are needed to achieve this end. When we observe an animal such as a worm get to a location, it may appear they have a "goal" but its behavior is entirely automatic.

Things seem quite different in the case of human motivation, and this may detract from a deeper form of motivated behavior that has a taxes at its base. How do we find out what is desirable or not in life? We learn, and this comes from feedback from the environment: this is reinforcement. Therefore, although reinforcement as taxes can be used as a simile, it is apparent that they share much in common. In particular, the notion of reinforcement as taxes provides theoretical heft to the "reinforcement" component of RST.

In addition to the effects of reinforcement, Corr (2008) has called attention to the importance of "sub-goal scaffolding." Although the primary function of the positive-incentive system is to move the animal up the temporospatial gradient, from a start state, towards the final biological reinforcer, this primary function is supported by a number of subprocesses: (1) identifying the biological reinforcer; (2) planning behavior; and (3) executing the plan (i.e., "problem solving") at each stage of the temporospatial gradient. In anticipation of the discussion of the questionnaire measure of these processes, there is an obvious difference between the "reward

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interest," goal planning, and "drive-persistence," which characterize the early stages of approach, and the behavioral and emotional excitement as the animal reaches the final biological reinforcer ("reward responsivity" and "impulsivity"). Emotion in the former case may be termed "anticipatory pleasure" (or "hope"); in the latter case something akin to an "excitement attack" of high pleasure/joy.

Goals, expectations, etc. are important when considering the effects of reinforcement. Human beings are attuned to the causal cascade of reward and punishment. Corr (2008) speculates that the fulfilment of subgoals is likely to entail periodic bursts of emotional excitement to maintain motivation across time/space where positive reinforcement is not immediately available. This process has been labeled "temporal bridging" (Corr, 2008) to emphasize the need to maintain approach behavior across time gaps during which approach is not immediately reinforced. In this regard it is interesting to note that *Drive* (Carver & White, 1994) and *Drive-Goal Persistence* (Corr & Cooper, 2016) are frequently used concepts. Reinforcement as taxes, subgoal scaffolding, and temporal bridging, can take us so far in understanding the mechanics of motivated behavior, but as discussed below, subprocesses that oppose each other need a mechanism to resolve the conflict.

In this article, we argue that as all behavior is automatic at the point of execution, reinforcement serves a taxes function. It is only when this function fails to work, that is, when the gradient of reinforcement is not as expected, that controlled processes take over to recalibrate the attentional, cognitive behavioral machinery that is in the service of goal representation. We turn to this specific matter in Section 6.

2.4 Drives

Given the discussion so far, it is proper to ask for an explanation of a "goal" and its "internal representation." For a hungry dog, a place where food is usually delivered would be an example of a "place" goal. A favorite coffee shop likewise for a human being and, irrespective of whether there is an initial desire for coffee, the conditioned stimulus of the sight of the shop, or the mere thought of it triggered by other conditioned stimuli (e.g., route to work) is sufficient to activate goal representations that then recruit behavioral tools to satisfy the central state. But if the dog's eating place is moved, then the goal will be to locate the new eating place, not to go to the usual eating place and wait futilely for food to materialize; much the same would be seen in the case of the human whose favorite coffee shop is closed for the

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day. But none of this matters if the dog just had a hearty meal (or the human his/her morning dose of double espresso): *drive* is a necessary condition for the *activation* of a goal representation. Despite basic satisfaction of such primary drives, higher-order goal representations may lead to the same behavior that reflects a different goal representation motivational state. The dog may well be sated, but this will not usually stop it begging for even tastier morsels from its master's plate, and the coffee-sated human might well be induced to have another espresso if this behavior satisfies another, higher-level, goal representation (e.g., social affiliation upon meeting a friend). Standard forms of classical and instrumental conditioning should be expected to strengthen these behaviors. It should come as no surprise that coffee shops emphasis the socially facilitative nature of the consumption of their psychoactive compound. The US TV program, *Frasier*, made this a centerpiece of the show.

Another critical point to note, and one that subverts the scientific primacy of overt behavior, is that, as in the case of human motivation, a dog that can no longer use his usual behavioral means of approaching its food bowl (e.g., by losing its legs) would nevertheless use behavioral (novel) tools to reach it (e.g., rolling; see Towe & Luschei, 1981, pp. vii—viii). Similarly, if the car breaks down, then the bus may provide a novel and effective behavioral means to get to the coffee shop. None of this requires much in the way of trial-and-error learning; it reflects control of behavior by an internal representation of salient goals, attached to a tool-box of behaviors that enable the satisfaction of the motivated central state.

2.5 Motivational State: *E Pluribus unum*

Thus, far, we have a number of conditions for what we are calling "motivation": goals (including their structural relations), drive ("desire"), conditioning, and memory (which contains representations of past occurrences of drive conditioned to specific stimuli; e.g., a dog's eating place or a person's favorite coffee shop). To the commercial advertiser, marketing executive, or brand manager, this is nothing new. Their aim is to inculcate goal presentations, often linked to a cognitively and emotionally accessible narrative, that are then activated by proximal stimuli (e.g., sight of coffee-related stimuli). Indeed, as argued by Corr and Morsella (2015), if a goal representation can be established in the first place, then a means is engineered by which it becomes activated regularly (e.g., "coffee break" or merely the time of day). This conscious representation has the power to activate automatic-reflexive programs that then strengthen the motivation by initiating desire

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(e.g., "I feel like a coffee"), reinforcement processes ("I need a coffee to wake up"), cognitive ("I will try that new coffee shop"), and behavioral ("I will walk to the coffee shop"). Therefore, in the first instance, there may be no primary drive for coffee without the invocation of consciously mediated stimuli, which are conditioned by prior association. After sufficient training, there is no longer any need for emotion, learning, or even goal representation as behavior becomes habitual (for a discussion of central states of emotion and motivation, see McNaughton & Corr, 2009). This is a very effective commercial strategy, especially as it seems to the consumer the most natural thing in the world, and does not require "a second thought."

As we can see, once we start to talk of "goals" and their "internal representation," we start to encounter a number of psychological processes. In common parlance, what we think of as "motivation" is the end-point of a complex psychological chain of events. It is probably partly for this reason that the concept of motivation has always been a rather confused and confusing topic. Sir Francis Bacon warned us, we should not infer causes from their effects, but this often happens in the motivation literature. The perspective afforded by approach-avoidance theories deftly side-steps this inferential trap and allows us to better "build-up" the components of the causal cascade underlying motivated behavior.

A "goal," as we are using it in this article, has cognitive and motivational qualities. Cognitive features allow detection of places and times, and include interpretations, meanings, and so on, of configuration of stimuli (i.e., a "situation"). But bear in mind Eysenck's (1998) caveat about the self-selected and constructed nature of situations. Motivational features refer to the animal's current need to acquire a specific stimulus or outcome (e.g., juicy bone, double espresso, or pat on the head, literally, from master or, figuratively, friend). We believe that most forms of human behavior of a complex nature are formed by these simpler forms of goal presentation. Certainly the morning hunt for the double espresso "hit" requires little more than Fido's search for his food bowl, and as Pavlov did with such success, Fido has much to teach us about our, apparently more exalted, motivated behavior.

Talk of "central states" and "goal representations," and so on, which are by their nature unseen, latent, and not directly measured, poses a problem: the ever-present worry of the "ghost in the machine" (Ryle, 1949). This led to the behaviorist's stark solution that threw out the baby with the dirty bathwater. Notions of *intra*psychic states of motivation, emotion, and so on, still to this day, challenge mechanistic approaches that prefer to

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emphasize behavior and cognitive processes to the neglect of internal psychological drivers, which give the mind its sense of "agency," and sense of self, which are so *vital* to conscious awareness and human experience. However, the much feared resurrection of the *vitalist* ghost is unnecessary; yet, there is a residue superstition that has not been entirely exorcised and remains lurking in such notions as "traits," "motivations," and the like. If this is the case, then there are "ghosts" in all machines, including every mobile phone that is rarely beyond arm's reach (it seems to be able to read our minds with its cunning predictive text facility!).

3. REINFORCEMENT SENSITIVITY THEORY

Now that the intellectual spade work has been done to clear much of the conceptual overgrowth in the motivation field to expose its links with personality, we can move on to discussing approach-avoidance behavior and specifically RST. RST has provided us with a powerful theoretical framework with deep roots in behavioral psychology and neuroscience; it is also in receipt of a wealth of empirical data to support its main claims. Importantly, it allows us to go from low-level animal behavior to human personality in a scientifically satisfying way, although often the basic neuroscience runs ahead of our capacity to relate it to personality traits and processes. We do not see it as a comprehensive theory of motivation and personality; rather, we view it as a way to tackle motivation and personality factors/processes with the use of rigorous theorizing and constraining empirical findings. We believe that both aspects are required to advance knowledge.

RST originated in the description of major systems of approach and avoidance behavior, and it quickly became apparent that a third system was needed to regulate these two, often, opposing systems, or more accurately, to modify the incompatible influences of competing motivational goals (Gray & Smith, 1969). As noted above, much of the impetus for RST came from the early work of Konorski (1967), Mowrer (1960), and Schneirla (1959). Although names now long forgotten to most students, in their heyday they were highly influential in challenging and, finally, dethroning the preeminent Hullian theory of behavior, which was based on a single general factor of drive reduction underlying reinforcement-based behavior (Hull, 1952; any behavior that reduced drive, which was seen as an aversive factor, was reinforced). The challenge to this once dominant

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Hullian theory came in the form of empirical observations revealing the importance of separate "reward" and "punishment" processes (for reasons stated below, RST now prefers to speak of "attractors" and "repulsors"). This work, which was almost exclusively based on nonhuman experimental animal data, slowly migrated into personality psychology largely through the work of behavioral neuroscientist Jeffrey Gray. Along with the suggestion of the neuropsychological nature of personality traits, RST came with the pleasing corollary of being able to account for emotion, a purely fictional cause of behavior in the grand Skinnerian tradition (Skinner, 1953).

Hidden in these debates was the central state of motivation; but much of this literature assumed the black box approach consisting in reinforced behavior with motivation often seen as a superfluous explanatory concept. Focus on stimuli and responses could quite easily side-step any mention of "goals," especially when the typical animal experimental set-up ensured that, to the extent that goals existed at all, they were isomorphic with—to use the correct Russian translation—"conditional" behavior. The hungry rat may be said to have a "goal" to obtain food, but its behavior was more parsimoniously explained by the associations of (un)conditioned reactions to (un)conditioned stimuli. However, the theoretical problem of goals and motivation was never quite absent, especially in the work of Tolman (1948) who emphasized a more cognitive approach to learning and reinforcement. As already discussed, but worthy of repetition, behavioral repertoire may best be seen as a toolbox, which meets the needs of goals. As a consequence of these developments, we can now talk of goals in mice and men without too much scientific embarrassment, although some shyness of expression would surely accompany its philosophical discourse!

All of this is now standard fare in *personality neuroscience* (DeYoung & Gray, 2009), which derives its impetus from this broad literature in which RST is one of the more prominent theories. It attempts to describe individual differences in cognition, affect, and behavior in terms of cognitive, affective, and social neuroscience. It adopts the general framework of goals and motivation—behavior has to be *about* and *for* something. Personality neuroscience assumes that, in large measure, individual differences, as expressed in personality traits (e.g., extraversion and neuroticism), reflect long-term stabilities in the operation of state systems responsible for basic here-and-now appetitive (or attractor) and aversive (or repulsor) goals, which lead to corresponding approach and avoidance behaviors (see Corr, 2013). On top of this substructure sits the superstructure of abstract goals and motivations we talk about in everyday life.

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Approach-avoidance theories inform motivation research by highlighting that there are a limited number of degrees of freedom of behavioral reactions; that is, how internal states of motivation interact with, impact upon, and are shaped by, the external world. Whether we are concerned with a simple stimulus or something more complex, behavior can take one of three forms: (1) avoidance, (2) approach, or (3) decision-behavior equivocation (defined and discussed below). The claim is that, at the surface level, although behavior may be elaborate and, indeed, ornate with socially sanctioned conventions, this product can be decomposed into these three behavioral degrees of freedom. One way to think of these outcomes is to consider the operation of three types of cones in the retina, which are maximally sensitive to different wavelengths of light, but which lead to rich color experience. As with visual processing research, RST aims to uncover the fundamental processes that give rise to the expression of complex behavior. As may be anticipated, it has a heavy emphasis on functional and evolutionary considerations.

3.1 RST and Motivation

In RST's original (prior 2000) incarnation, "rewarding" *stimuli* were seen as motivating approach behavior *towards* some desired goal state, and "punishing" *stimuli* motivating avoidance/escape behavior *away* from some goal state (Gray, 1975). In typical animal learning experimental set-ups this characterization goes a long way to accounting for the varieties of behavioral reactions to different classes of stimuli. However, in the case of human beings—but also the rat in an appropriate experimental setting—important are expectation and perception. Over the last 20 years, RST has evolved to place more weight on the *evaluation* of stimuli, which is the first step to something being categorized as "rewarding" or "punishing." In a major clarification of RST, Corr and McNaughton (2012) substituted the less ambiguous terms, "attractors" and "repulsors"; it is important to note that valenced goals can be quite different from externally and objectively defined "rewarding" and "punishing" stimuli (i.e., "rewarding" stimuli can lead to negative *frustative nonreward* and "punishing" stimuli can lead to positive relieving *nonpunishment*). Indeed, what the experimenter choses to call a stimulus is much less important than how it is perceived by the subject, and, as we should expect, the domesticated dog may evaluate a hitherto attractive dry biscuit as of little appeal when placed aside a juicy bone. The point we wish to make is that it is not the stimulus per se that matters, but evaluative reactions to it that depend on drive,

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context, memory, and conditioning. In addition, and of considerable importance in the case of human personality, there are significant individual differences in how "rewarding" or "punishing" stimuli are perceived. As the old saying tell us, one (wo)man's meat may be another's poison.

These clarifications have helped to define more closely the central state of motivation. It can no longer be defined as simple reactions to objectively defined stimuli, nor in terms of overt behavior. Instead, motivation is an inferred *psychological* state, defined neither in terms of psychophysics nor behavior. Far from being mysterious, motivation comprises the theoretical concepts that are needed to account for even the simplest animal behavior.

With the wisdom of hindsight, we can see that original RST placed too much conceptual weight on what the experimenter defined as "rewarding" and "punishing." With a rat in a Skinner box, this is easy to manipulate (the absence of food produces a hunger drive, and foot shock can be none other than punishing, and the animal behaves as should be expected); but with human beings things are more complicated, if not conceptually (which, of course, they are), then operationally (i.e., how we go about arranging unambiguously rewarding and punishing contexts).

3.2 Repulsors, Attractors, and Their Interactions

RST contends that *motivated* behavior needs to be understood in relation to five processes: (1) two input systems, for the valuation of stimuli/events (gain and loss) that define them as attractors/repulsors and (2) three output systems that regulate actual behavior (approach, avoidance, and conflict). In between these two sets of processes lies the internal state of "motivation," which is defined in terms of "goals" (activated by drive, e.g., hunger, and environmental affordance, e.g., availability of food). Overt reactions provide nothing more than tools of interaction with the external world. Behaviorists allowed themselves to be led astray, by the availability and salience of behavior as the sole source of data. It is worth reiterating. When specific behavior is neatly shaped to reinforcement, there appears to be no problem. But the simple thwarting of a specific behavior will lead the animal to use other behavioral tools to satisfy the activating goal (e.g., to reach food). In the human case, this is perhaps too obvious to mention; as discussed above, context is all, and specific forms of behavior are the servant, not the masters, of motivation.

The central state of motivation encapsulates not only the evaluation of stimuli, but also their appraisal and meaning in terms of, for example, the self (Sedikides & Spencer, 2014). In this sense, motivation is neither directly

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elicited by stimuli nor defined by overt actions. In fact, in relation to overt actions, different behaviors may be seen under different environmental constraints to achieve the same goal (e.g., avoiding danger may be achieved by freezing, fleeing, or fighting, on the surface, very different behaviors but all aimed at satisfying the central state of motivation, spatial and temporal removal from the source of danger).

In terms of how these central states of motivation interact and influence overt behavior, several complexities must be faced. RST tells us that, on a moment-to-moment state level, attractors and repulsors (their appraisal is defined by "goals") produce approach and avoidance motivational tendencies, respectively, but, in doing this, they subtract from each other to produce the behavior seen or measured. Indeed, this interplay will affect the *in the moment* state of motivation, whilst leaving the, incompatible, goals themselves intact (they may resurface later when the situation or context permits). As with the distinction between personality states and traits, positive and negative traits are, over time, orthogonal, but, here-and-now, they are subtractive (I cannot be happy and sad at *exactly* the same moment in time). At any one moment, motivation is the product of different, and often competing, motivation goal states, and any viable theory needs to account for this fact.

The explanatory power of RST shows how these different motivation goal-states are regulated and how behavior processes are organized to serve them in an adaptive fashion.

4. DELINEATION OF RST SYSTEMS

To better understand the causal cascade of processes of stimulus appraisal to approach-avoidance behavior, in this section we present RST systems specifically in terms of central states of motivation and their representation into three broad *classes* of behavior. These are defined in *functional* terms and, in accordance with the above theoretical discussion, not in terms of specific overt reactions. First, to summarize the principal postulates of RST: (1) differences in brain structures underpin individual differences in sensitivity to perceived gain and loss (valuation of stimuli); (2) these valuations lead to stimuli being categorized as "attractor" or "repulsor" (and, if of no motivational significance, neither); (3) attractors and repulsors are the proximal inputs to the system of goals (at the highest level to avoid danger and approach innately rewarding stimuli), but it should be noted

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that goals affect the appraisal of stimuli in the first place; (4) the proximal strength of goals are determined by drive, conditioning, context, and environmental affordance; and (5) depending on the relationship between goal states, once activated by attractors/repulsors (i.e., strength and conflict potential), there is activation of the three neuropsychological systems of approach, avoidance, and conflict resolution that comprise the bulk of RST.

Consideration of this causal cascade allows us to get to the conceptual heart of the central state of motivation. Attractors/repulsors cannot be the goals, because they are, themselves, the product of a process of evaluation of stimuli, which must have some other source. In this way, the appropriate level of analysis of motivation would seem to be the constellation of goals that exist prior to evaluation. Although there should be expected to be within-species commonality with such goals, certainly at the level of basic physiological needs, there is also likely to be marked individual differences reflecting innate and learned components. Although it is tempting to speculate that personality influences the nature of these goals, it is more theoretically accurate to say that motivational goals and personality dispositions are different sides of the same coin, and there does not exist a good reason for trying to separate them.

Once motivated by the activation of goal representations, specific behavioral machinery is engaged. The discussion to follow elaborates the three RST neuropsychological systems that take charge of the behavioral machinery: the *Behavioral Approach System* (BAS), the *Behavioral Inhibition System* (BIS), and the *Fight-Flight-Freeze System* (FFFS). At outset it is important to note that, at the highest level of conceptual abstraction, these systems are likely to be involved in all stages of motivation (evaluation of stimuli, goal representation, type and degree of activation, as well as the specific behavior they discharge).

4.1 Behavioral Approach System and FFFS

The BAS is related to stimuli evaluated as rewarding (gain; including stimuli that signal the *relief* of nonpunishment), and it initiates and controls all reward-seeking behavior. It is associated with anticipatory pleasure and hopeful anticipation. At dysfunctional levels, BAS-related traits (e.g., sensation seeking) map onto addictive behaviors (e.g., pathological gambling) and various varieties of high-risk and impulsive behavior. But, at normal levels of operation, this system reflects what we usually term positive "motivation," or "drive," and is what we see in "highly motivated" behavior.

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In contrast, the FFFS is related to stimuli evaluated as punishing (loss; including stimuli that signal the *frustration* of nonreward). It is associated with distress, fear, and avoidance, and with a general moving away from aversive stimuli of all kinds. As discussed above, the BAS and FFFS work together to produce the net *state* of motivation that determines the class, but not specific type, of behavior.

Stimuli that are evaluated exclusively as either an attractor or repulsor activate BAS and FFFS, respectively, which then takes charge of the behavioral machinery (and associated affective and cognitive processes). But, in situations where both the BAS and FFFS are simultaneously, but *unequally*, activated, the direction and intensity of behavior will reflect the *subtraction* of one motivational impulse from the other. The net behavioral outputs leave goal representations intact, it is their activation that is either inhibited or activated.

4.2 Behavioral Inhibition System

Things are quite different in situations where the BAS and FFFS are simultaneously, but (approximately) *equally*, activated, and at a sufficiently high level of intensity to be motivational significant. Now, with this *goal conflict*—this is only one form of such conflict—no single behavioral output is able to satisfy competing goals. In this circumstance, a third system is activated, namely the BIS. In considering the forms of goal-conflict that lead to BIS activation, several things deserve our attention. First, the BIS can be activated by the presence of incompatible *behaviors* of similar strength (e.g., approach and active avoidance in the classic Miller approach-avoidance conflict situation), where these behaviors reflect different goals. But the BIS is concerned not with conflict of behaviors per se but the conflict of *goals*; it is possible to imagine two seemingly incompatible goals (e.g., fighting and freezing), which would not activate the BIS because both are motivated by the same central motivational state of increasing distance from a high-intensity source of danger. Secondly, goal-conflict may be found *within* systems, as in the BAS case of being offered two equally attractive job offers: both highly attractive, but opposing goals (accepting one entails rejection of the other). In short, the BIS activation may be described as a "*what-shall-I-do*" state of mind, irrespective of whether the choice is between several positive, negative, or more complex goal-conflicts. Now, much of life entails some form of goal opposition, or conflict, and this is the reason why the BIS has been

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most prominent in RST. It is also related to the high prevalence of anxiety-related disorders. For example, in a romantic dating situation, there may be opposing goal states reflecting the need for (BAS-related) lust and (FFFS-related) fear, and somehow these two opposing forces need to be regulated.

It is known that, over and above the subtractive effect outlined above, the (passive) *inhibition* of approach by approach-avoidance *conflict* is neurally and psychopharamcologically distinct from FFFS-related simple (active) avoidance (Gray, 1982; Gray & McNaughton, 2000). Although avoidance and inhibition can look very alike, their *functional* roles are quite distinct. Whereas the BIS is generally sensitive to anxiolytic drugs, the FFFS is *relatively* insensitive to them but sensitive to panicolytic ones (see also Mitchell, McNaughton, Flanagan, & Kirk, 2008).

The main task of the BIS is to detect and resolve goal conflicts. In doing this, it inhibits any prepotent approach behavior that the BAS and FFFS were about to carry out, but it allows the BAS to continue with *cautious* approach behavior (involving risk assessment behaviors) where the avoidance tendency is somewhat less than the approach tendency (Gray & McNaughton, 2000). The BIS activates a number of psychological processes: risk assessment, checking for sources of threat, and the inhibition of ongoing behavior. BIS activation leads to activation of the FFFS, which has the effect of increasing negative affect and the negative valuation of conflicting stimuli, which fuels rumination and worry. In normal operation, this is an adaptive process of caution, weighing up all the possibilities (Perkins & Corr, 2006), and it is self-terminating. But, in hyper-BIS individuals, its activation leads to a marked and chronic passive avoidance and cognitive rumination. However, this is not all bad because it can lead to adaptive solutions to "problems" in those with the cognitive *aptitude* along with the motivational *appetite* (Perkins & Corr, 2014). Another reason for the greater prominence of the BIS in RST is the fact that human beings have developed strategies to avoid being confronted with immediate, high-intensity threatening stimuli. In contrast, there is no end of possible goal conflicts to activate the BIS, and these conflicts are less likely to self-terminate because they are often abstract and not amenable to resolution in terms of simple behavior.

In summary, RST assumes two "avoidance" systems, one for simple active avoidance/escape (FFFS), and one for goal conflict (passive avoidance; BIS). These systems interact with the BAS in a number of ways (e.g., FFFS«»BAS, in a subtractive fashion and BIS»BAS/FFFS in an inhibitory

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fashion; see Boureau & Dayan, 2011). The relationships between, and functions of, the BAS, FFFS, and BIS are shown in Fig. 1.

The structure of RST has received supportive evidence from independent sources, which suggests it reflects something fundamental about the nature of motivation and emotion. First, in a sample of 5600 twins, an analysis of 10 major psychiatric disorders (Kendler, Prescott, Myers, & Neale, 2003) revealed two major dimensions, one relating to *internalizing* disorders (i.e., major depression, generalized anxiety disorder, and phobia), the other to *externalizing* disorders (i.e., alcohol dependence, drug abuse/dependence, adult antisocial behavior, and conduct disorder). These two factors resemble the original BIS and BAS model. Of particular interest here, the structure of genetic risk for internalizing disorders broke down into an "anxious-misery" factor (i.e., depression, generalized disorder, and panic) and a specific "fear" factor (i.e., animal and situational phobia). This differentiation is very similar to the distinction between the BIS and FFFS, respectively.

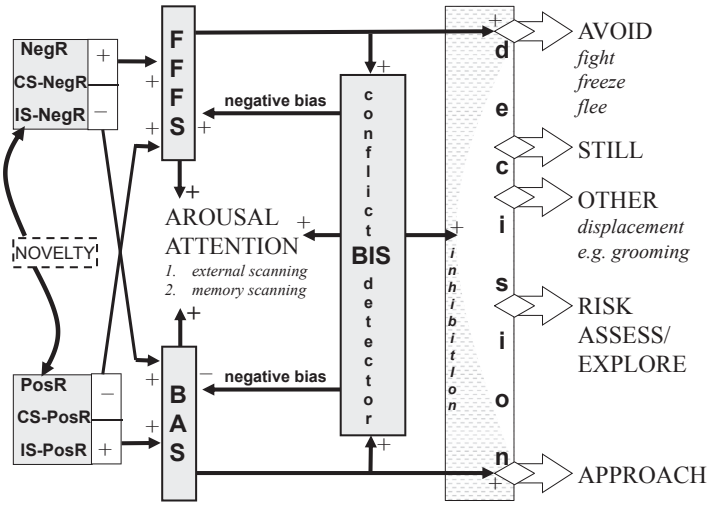

Figure 1 Overall relation of approach (BAS), avoidance (FFFS), and conflict (BIS) systems. The inputs to the system are classified in terms of the delivery (+) or omission (−) of primary positive reinforcers (PosR) or primary negative reinforcers (NegR) or conditional stimuli (CS) or innate stimuli (IS) that predict such primary events. The BIS is activated when it detects goal conflict. It suppresses prepotent responses and elicits risk assessment and displacement behaviors. The *shaded areas* are all points at which traits appear to operate. *Taken from McNaughton, N., & Corr, P. J. (2014). Approach, avoidance, and their conflict: The problem of anchoring.* Frontiers in Systems Neuroscience*, 8(124), 1–4.*

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Secondly, in a structural equation modelling exercise of common psychiatric disorders, Krueger (1999) reported a confirmatory factor analysis (N = 8098) of patterns of comorbidity among 10 common mental disorders, finding that a three-factor model best fit the data: (1) externalizing disorders, (2) internalizing disorders—fear, and (3) internalizing disorders—anxious-misery. But, unlike the Kendler et al. (2003) study, panic went with the "fear" factor, which is more consistent with revised RST. As Krueger (1999, p. 921) noted, "The substantial correlation between anxious-misery and fear (0.73) suggested that these two factors were most appropriately conceived as subfactors of a higher-order internalizing factor."

4.3 Separable and Joint Subsystems

As seen, one complexity that must be faced in the motivation literature is that what we observe in behavior is the end product of separate processes that often interact. It is for this reason that RST has the potential to split the motivation atom. In terms of the dynamic nature of the actions of RST systems, there are two logically driven possibilities. The systems function independently or they interact, a question that is still not fully resolved in the RST literature. In the first case, the separable subsystems hypothesis (SSH) states that individual differences in the functional capacity of one system are independent of the individual differences in the functional capacity of the other system. In contrast, in the second case, Corr (2001, 2002, 2004) discussed the implications of the "joint subsystems hypothesis" (JSH) of RST, which states that RST systems have the *potential* to influence both attractor- and repulsor-related behavior. Specifically, it is predicted that effects consistent with the SSH should be observed: (1) when strong appetitive/aversive stimuli are used, (2) when hyper-active individuals are tested, and (3) in experimental situations that do not contain mixed attractor and repulsor stimuli or demand rapid attentional and behavioral shifts between them.

However, we need to say that in examining these two hypotheses some methodological precautions are needed. Empirical support is not straightforward regarding the confirmation of JSH or SSH. There is evidence for the JSH (e.g., Corr, 2002; Hundt, Nelson-Gray, Kimbrel, Mitchell, & Kwapil, 2007; Jackson & Francis, 2004; for further review see Ávila & Torrubia, 2008; Corr, 2004). On the other hand, Gomez and Cooper (2008), in their review article on mood induction studies of RST, concludes that most of the studies support the SSH. Although both the SSH and JSH are expected under different experimental conditions, such an ambiguous state in literature

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indicates the importance of carefully planned laboratory settings elaborated above. In addition, studies with different BAS scales used in prediction of emotional and motivational outcomes (e.g., Krupić & Corr, 2014) show that these personality scales interact with experimental variables in complex ways. It is most likely that studying BAS as a one-dimensional construct is an oversimplification of approach motivation, since different BAS scales correlates differently with avoidance scale (see Krupić, Corr, Ručević, Križanić, & Gračanin, 2016). This fact has been typically overlooked in earlier studies. We would urge researchers to design carefully their laboratory set-ups with these considerations in mind and to treat the BAS as a multidimensional construct (discussed and further explained in Section 6). We also urge the routine examination of putative interaction effects between RST measures.

Whilst thinking about these problems, Fig. 2 shows how we conceptualize the causal cascade of processes in the RST of motivation. This figure suggests several possibilities. There is most probably a reciprocal relationship between goals and RST systems. Strong RST systems may strengthen certain goals, and this could come about exclusively via a conditioning route. For example, an addiction could be conditioned, strengthened by RST systems, and then become an *idea fixe* goal that comes to dominate one's life. What we can say is that a hyperactive FFFS, BAS, or BIS is very likely to lead to the establishment of corresponding goals, which then can come to activate these systems, in this instance a vicious, and pathological, circle; virtuous circles are less likely to be established by conditioning. In this way, there is a complementarity of goals and RST systems. It is much less probable that goals could arise without any influence from RST systems, or in opposition to them, and for this reason the arrow from "RST Processes" to "Goal Representations" should be stronger than the one going in the opposite direction. In this way, the relationship between goals and RST systems is asymmetrical. However, as shown in Fig. 3, there is an influence on goal representations from societal norms, values, and beliefs but, as yet, these have not been concerned in relation to RST.

As discussed above, and worth repeating, reinforcement is the key to motivation because, rather like simple gradients in the form of taxes, feedback from the environment is the central link between behavior and its consequences, and therefore the mechanism by which goals are achieved. "Motivation" is the cascade of processes that enable this process. To date, these separate processes have not been empirically differentiated.

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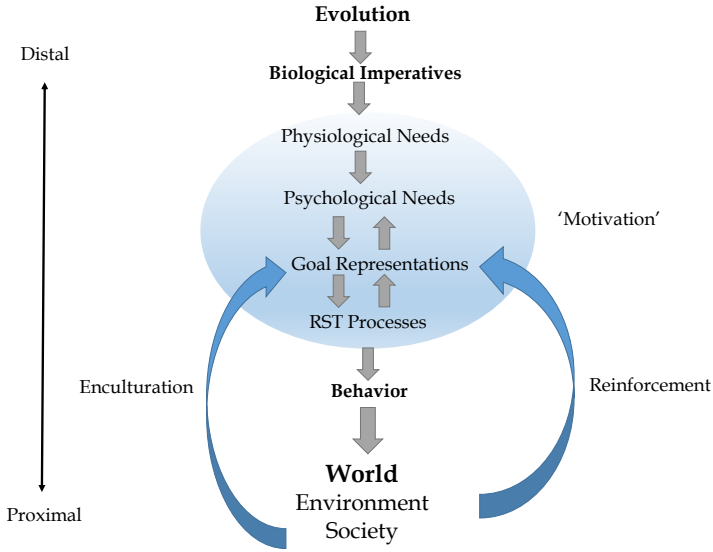

Figure 2 Schematic representation of the causal cascade of influences from distal to proximal levels. It is assumed that physiological needs take priority and must be met before psychological needs can take charge of motivated behavior; this is similar to Albert Maslow's hierarchy of need. At the "Psychological Needs" level are found theories such as Deci and Ryan's (2008) Self-Determination Theory. The level of Goal representations is the central process of motivation because it has two-way links to the Psychological Needs above it and RST Processes below it. This cascade of processes are what we typically call "motivation" (shown as the *shaded area*). RST processes control behavior that impacts upon the world, from which reinforcement feeds back to RST processes; a more detailed diagram of this part of the causal cascade is shown in Fig. 3. Also added is an enculturation link from the world (society) to show how goal representations are influenced at a more general and abstract level. The sensitivity of RST processes (FFFS, BAS, and BIS) have the potential to set in motion the casual cascade of motivation and, thus, affect goals and the frequency and quality of reinforcement feedback. We assume that this is typical in pathological conditions where hypo/hyper sensitivity of RST systems set the motivational context of behavior.

5. CONSCIOUSNESS AND ITS (DIS)CONTENTS

It might be thought that conscious awareness has no place in any discussion of relatively low-level motivation processes, nor, indeed, any place in psychology! What our RST journey has revealed, once again inspired by Jeffrey Gray (2004), is the need to account for both automatic-reflexive and controlled-reflective processes (Corr & Morsella, 2015). Indeed, the BIS can lay some claim to pointing to the functions of

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conscious awareness (Corr, 2013). Perhaps somewhat counter-intuitively, it is the analysis at this low level that gives us just cause to suspect the involvement of higher-level control processes. It is more than a little ironic that we know much about the need for controlled processes because of the problems raised by automatic processes, especially those that generate an "error signal." However, it would be a mistake to assume that human motivation consists entirely, or indeed largely, in high-level goal representation; we think it does not.

In an attempt to extract the implications of the contents and functions of conscious awareness in relation to RST, Corr (2010a) based his level-of-processing model on foundations of the neuropsychological model of consciousness proposed by Gray (2004). This model states that all behaviors (and related thoughts, feeling, and so on) are automatically organized and executed, without *immediate* control by higher-level controlled processes (and certainly not conscious processing, which simply takes too long to be generated by the brain to have immediate control over the events it represents). The model further states that when everything is "going to plan" (i.e., things are as expected), we are not generally aware of on-going events; however, events and stimuli that are particularly important for ongoing goals do attract controlled processing. It is only at these critical junctures (i.e., the expected does not happen) that the outputs of processing attract conscious awareness, and these outputs tend to entail (BIS-mediated) error, usually in the form of actual states of the world departing from expected states. For example, whilst driving a car we may find ourselves braking hard and only *then* realize why this happened. That is, we are conscious of the behavior only after it has occurred and only after the brain has executed the appropriate (reflexive-automatic) response (Fig. 3). All of this makes intuitive sense in terms of motivation and goals, as when automatic-reflexive processes are insufficient to resolve conflict and achieve end goal states, then higher-order processes are required, which make these problematic goals, literally, the center of attention. And, importantly, they are experienced as more immediately related to the external world, which is modeled and experienced as "the world" (e.g., colors in the world, when we know that only electromagnetic energy exists).

Level of abstraction of the goals of motivation, and the environmental affordance to achieve them, is important too. In the case of threat, the proximal-distal distinction is relevant, as is the level of intensity. High intensity threat in the context of goal-conflict can quickly resolve itself in the form of automatic and prepotent FFFS-related (avoidance/escape) behavior.

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But when threats are less intense or perceived to be distant, in terms of space or time, then BIS-related processing allows the individual to engage in approach behavior but in a much more cautious and risk-averse manner. As this entails goal-conflict (i.e., error, as things are not going to plan) and is more complex, reflective processes are generated and there is the *experience* of apprehension, worry, and risk. Therefore, in general terms, when threats are intense and immediate, automatic processing dominants, but when threats are less intense and not immediate, then controlled processes are activated to risk assess the problem situation.

The assumption of the model is that stimuli associated with error have the capability to enter conscious awareness where they can then be replayed for detailed analysis. After this analysis, the automatic neural-behavioral machinery that controls behavior at any given moment is (re)adjusted so that future behavior is more appropriate when the same set of stimuli, which led to the error signal, are encountered again. By this route, we *learn* from our mistakes and the machinery that control our automatic behavior is better prepared when it encounters a similar situation next time.

When this process goes wrong, we witness pathological behaviors, for example, continuing with the same behaviors that are leading only to frustration. This is also a problem of motivation, which is central to most forms of psychiatric disorder. In this regard, and built upon this elaborate modeling of the world that *seems* so real, are interpretations, attributions, and so on, that can make these maladaptive behaviors both self-perpetuating and fulfilling. It is little wonder that the complaints of patients with various anxiety disorders (e.g., Generalized Anxiety Disorder and Obsessional-Compulsive Disorder) are so dominated by the experience of these contents of consciousness. In general terms, goals that cannot be achieved, where there is a mismatch between expectation and outcome, if sufficiently intense, will activate the BIS and this will lead to the cognitive, affective, and behavioral features of being "stressed." The BIS sets in motion processes aimed at detecting the source of this mismatch and resolving it.

The involvement of higher cognitive processes and conscious awareness has been one of the more surprising developments of RST in recent years. As should be expected, there is still much to learn, but what this shows is that work at basic levels has the potential to throw new, and sometimes revealing, light on higher levels, which we may assume serve rather basic functions even when they seem so complex and mysterious. This is one of the reasons we believe that an RST-inspired perspective has much to offer motivation research.

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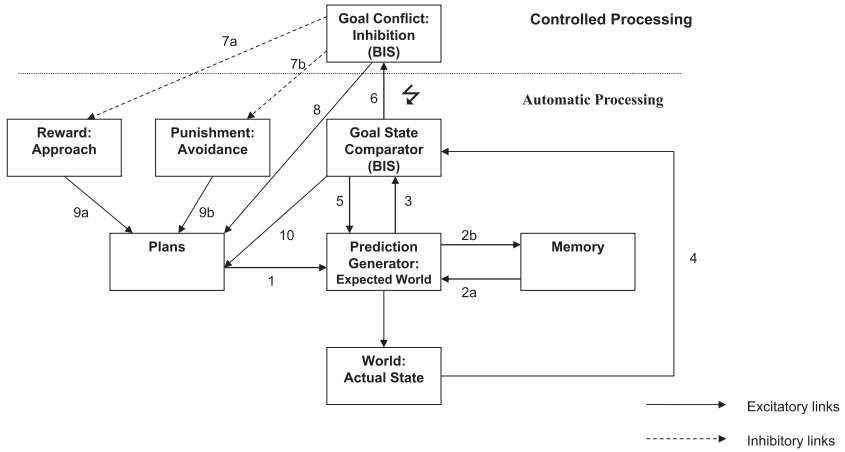

Figure 3 Information processing diagram of the functioning of the BIS in automatic and controlled processing modes. The *flow diagram* shows basic reward:approach and punishment:avoidance processes, as well as goal-conflict device related to the BIS. Behavioral plans (Plans) lead to predictions (Prediction Generator; 1) of future states of the world, which receives input from (2a), and sends output to (2b), stored previous experience (Memory). The BIS (Goal-State Comparator) receives input from the Prediction Generator (3), and then compares the response-reinforcement outcomes (World: Actual State) with predictions (4), and then one of two things happen: (a) "everything is going to plan," and the BIS Goal-State Comparator sends input to the Prediction Generator to continue the motor program ("just checking mode"; 5); or (b) the BIS Goal-State Generator detects a mismatch between prediction and outcome and generates an error signal (↯), which leads to activation of the BIS and controlled processes (6). Upon activation of the BIS, there is inhibition of the reward:approach system (BAS; 7a) and the punishment:avoidance system (FFFS; 7b), and at this time the BIS initiates cautious behavior and risk assessment, which then informs Plans (8), which simultaneously receives input, about current states, from the BAS and FFFS (9a, b), as well as input, about the nature of the conflict, from the BIS Goal-State Comparator (10). Plans initiate appropriate behavior and the above cycle is repeated, until behavioral resolution is achieved in the form of punishment-related avoidance/escape or reward-related approach. *Taken from Corr, P. J. (2010a). Automatic and controlled processes in behavioural control: Implications for personality psychology.* European Journal of Personality, 24, *376–403.*

6. RST MEASUREMENT MODELS AND INSTRUMENTS

The crucial distinction between, on the one hand, reward/punishment and, on the other, attractor/repulsor—and now in this article the finer-grained distinction between attractor/repulsor and goal representations—have not yet been incorporated into questionnaire

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measures that, somewhat inevitably, lag behind, by some considerable distance, the underlying theory. To put some psychometric flesh on the above RST bones, in this section, we summarize attempts to develop adequate psychometric measures of RST constructs. Then, we relate RST-related motivational processes to the Big-5 model of personality. These are important issues because virtually all personality studies include the use of questionnaires, either specific RST ones or broader Big-5 ones.

The lurking complexity of theoretical formulation becomes clearest when attempting to operationalize them in a measurement model. This is especially true for the RST of personality, but is no less relevant for motivation research in general. For this reason, it is instructive to survey the trials and tribulations of recent attempts to model RST (for a detailed survey, see Corr, 2016).

Two sets of questionnaires designed to measure RST exist. The first set measures the original version (oRST; Gray, 1982), which focuses on the BIS and BAS to the neglect and exclusion of the FFFS (this literature has also been reviewed by Torrubia, Ávila, & Caseras, 2008). As noted above, this is because the BIS seems far more relevant to human motivation than the FFFS, and this was especially true when the oRST considered the BIS to be sensitive only to *conditioned* rewarding stimuli, which is highly prevalent in human society. With the shift of focus to the FFFS being responsible for all aversive stimuli, this neglect has seriously impeded research and, although to lesser extent, continues to do so. The second set of questionnaires focus on revised RST (rRST; Gray & McNaughton, 2000), which, as we have seen above, makes a categorical distinction between FFFS-fear and BIS-anxiety.

Before summarizing these questionnaires, and seeing the problems they pose for the adequate psychometric delineation of RST, it should be noted that there is now good evidence to support FFFS/BIS separability. First, psychometric measures of fear and anxiety have been differentiated by confirmatory factor analysis (Krupić, Corr, et al., 2016). Secondly, predictive validity studies point to the different functions of FFFS and BIS (Perkins, Kemp, & Corr, 2007). Thirdly, separate facial expressions have been identified for the FFFS and BIS (Perkins, Inchley-Mort, Pickering, Corr, & Burgess, 2012). This separation of the FFFS and BIS is recognized in psychopathological research (Bijttebier, Beck, Claes, & Vandereycken, 2009; Sylvers, Lilienfeld, & laPraririe, 2011), and as we will see below it is confirmed by the successful statistical separation of the FFFS and BIS in recent studies.

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In addition, the widely used BIS/BAS scales of Carver and White (1994), though not designed to separate FFFS and BIS factors, submits to this statistical differentiation. Corr and McNaughton (2008) suggested that it may be possible to recover separate FFFS and BIS factors from these BIS/BAS scales, and this has proved to be the case (e.g., Beck, Smits, Claes, Vandereychen, & Bijttebier, 2009; Heym, Ferguson, & Lawrence, 2008; Poythress et al., 2008). But, one problem is that the putative FFFS-fear subscale has only a few items (two or three, depending on the study), which are reverse-keyed and, therefore, comes with their own attendant problems (van Sonderen, Sanderman, & Coyne, 2013). This may produce apparently separate, yet spurious, factors and thus may be nothing more than a method artefact. Fortunately, RST researchers have been busy in recent years developing specific scales for revised RST constructs. There are now four contenders, and these are summarized below.

The eponymously named "Jackson-5" (Jackson, 2009) contains five factors, labeled the BAS-, BIS-, and FFFS-related Fight, Freezing, and Flight. This questionnaire has a number of features that call for attention. First, there is only one BAS factor, which is not consistent with Carver and White's (1994) multidimensional (3-factor) BAS model, theoretical models of the BAS (Corr, 2008; see below), or the differentiation of reward sensitivity and rash impulsivity (Dawe, Gullo, & Loxton, 2004; Quilty & Oakman, 2004; Smillie, Jackson, & Dalgleish, 2006; Smillie, Pickering, & Jackson, 2006). Secondly, the BIS scale has several peculiar features. First, many of the items suffer from a lack of face validity (e.g., "Prefer projects to prove my ability"; "Want to do well compared with others"; "Aim better than peers"). Such "BIS" items could well be assigned to a BAS factor and, indeed, in support of this claim this BIS measure is highly correlated with BAS measures from other questionnaires (Krupić, Corr, et al., 2016; see Table 2 from Jackson, 2009; this matter is discussed further in Corr, 2016).

A second attempt to operationalize revised RST by questionnaire was made by Reuter, Cooper, Smillie, Markett, and Montag (2015). Their questionnaire has measures for FFFS, BIS, and FFFS, along with Fight. As with the Jackson-5, this too has only one BAS factor, and the correlations between the BAS and BIS (−0.29) and, especially, FFFS (−0.41), respectively, are larger than we should expect on the basis of theoretical or psychometric concerns. Of more concern is the fact that the Fight factor is strongly *negatively* correlated (−0.78) with the FFFS; this may well be the result of the contents of the scale (e.g., "I am a rather quick-witted person"), which would appear, not to reflect FFFS-related defensive fight, but a form of

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predatory psychopathy, which itself is known to be negatively correlated with the FFFS (Broerman, Ross, & Corr, 2014; Corr, 2010b).

A third attempt to measure rRST is found in the work of Smederevac, Mitrović, Čolović, and Nikolašević (2014). But, as with the above two questionnaires, this, too, has only one BAS factor. In addition, there is too little differentiation of the BIS and FFFS scales (path coefficients range from 0.73 to 0.86) to accept that they are measuring dissociable factors.

6.1 Reinforcement Sensitivity Theory of Personality Questionnaire

The fourth attempt is the Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ; Corr & Cooper, 2016). This was developed on the basis of qualitative responses to defensive and approach scenarios, modeled on typical rodent ethoexperimental situations (Blanchard, Hynd, Minke, Minemotom, & Blanchard, 2001; see Fig. 4 below). With the use of exploratory and confirmatory factor analyses, supported by validation evidence, a robust six-factor structure was found. There were two unitary defensive factors, FFFS (related to fear)—but given its composition, this "FFFS" scale would be better labeled the "Flight-Freeze-Avoidance system" (FFAS)—and the BIS (related to anxiety). In addition, there were four BAS factors: Reward Interest, Goal-Drive Persistence, Reward Reactivity, and Impulsivity. To conform to theoretical and empirical considerations, the RST-PQ offers a separate scale for Defensive Fight, which is correlated most clearly with the BAS factors. This finding is consistent with previous research (see Carver & Harmon-Jones, 2009; Corr & Cooper, 2016; Harmon-Jones, 2003; Smits & Kuppens, 2005).

6.2 Multidimensionality of the Behavioral Approach System

A growing body of evidence supports the multidimensional nature of the BAS, and this is shown by the fact that unidimensional scales of the BAS from various questionnaires do not measure the same underlying construct (Krupić, Corr, et al., 2016; Smillie, Jackson, et al., 2006; Smillie, Pickering, et al., 2006; Smits & Boeck, 2006). Furthermore, evolutionary theories lead us to believe that differences between BAS measures may be related to different resource strategies, which is associated with cooperative and competitive ones (Krupić, Gračanin, & Corr, 2016). In addition, neuroscientific studies favor the multicomponent view of the reward system suggesting that its components are placed in different brain regions (e.g., Berridge, Robinson, & Aldridge, 2009) and influenced by a different

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neurobiology (Kranz, Kasper, & Lanzenberger, 2010; Trezza, Baarendse, & Vanderschuren, 2010). We take up this specific matter in Section 8.

6.3 "Defensive" Fight

The construct and measurement of defensive fight remain problematic in revised RST. The data where this issue has been examined seems clear enough. Questionnaire measures of defensive fight positively and nontrivially correlate with questionnaire measures of the BAS (see also Carver & Harmon-Jones, 2009; Corr & Cooper, 2016; Harmon-Jones, 2003; Smits & Kuppens, 2005; for discussion of this matter, see Corr, 2013). Indeed, this observation was first made in Gray's own attempt to develop a questionnaire measure of his RST systems: The *Gray-Wilson Personality Questionnaire* (GWPQ; Wilson, Barrett, & Gray, 1989; Wilson, Gray, & Barrett, 1990). The reasons for these associations have been discussed elsewhere and are not repeated here (Corr, 2013; 2016; Corr & Cooper, 2016).

The development of the RST-PQ provides a good example of some of the problems associated with developing an RST questionnaire. For example, the use of broad-based items and ones entailing emotion words tend to lead to a general neuroticism factor, and not separate FFFS and BIS ones. In relation to defensive fight, the results of Corr and Cooper (2016) confirm previous work in showing that their personality factor Defensive fight correlates most reliably and highly with BAS factors. But why should this be the case?

It is possible that the RST-PQ defensive fight items may not have sufficiently differentiated between defensive and offensive aggression. However, in developing this questionnaire, the temptation was avoided to develop highly specific items keyed to the FFFS; this might not have been impossible to achieve, but its theoretical relevance would be called into question. Instead, defensive fight items (which are quite different from offensive, predatory ones) were left to speak for themselves, statistically speaking. Defensive fight in human beings does not resemble the "rat cornered by a cat" seen in rodent studies, which demand an immediate defensive reaction. Instead, they are more abstract, relating to fighting back when provoked, standing up for one's self at the workplace, not tolerating bullies, etc. There may well be an agentic or assertive aspect (i.e., "I'm not going to stand for that!") in human defensive aggression. Although this might be thought to be different to the type of fight seen in high-intensity animal situations (Gray, 1987), it is a typical form of human defensive fight. It is not doubted that there is an

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FFFS-mediated form of *behavioral* defensive fight under immediate, high-intensity threat, but most people, especially those who take part in psychology studies, have learned strategies to avoid such situations in the first place.

6.4 Defensive Human Scenarios

One method used to get around the limitations of questionnaires is to use defensive scenarios modeled on the ethoexperimental approach. This strategy has potential to provide a different perspective on motivation, following the work of Blanchard et al. (2001) who developed such a human approach based on the basis of their extensive rodent behavioral studies (Blanchard & Blanchard, 2008). Twelve scenarios present different threatening situations modeled on distance to threat and situational factors of avoidance/escapability. Additionally, 10 behaviors are provided from which participants must choose to match the 12 threat scenarios: hide; freeze, immobilization; run away, try to escape; threaten to scream or call for help; yell, scream, or call for help; threaten to attack; attack or struggle; check out, approach, or investigate; look for something to use as a weapon; and, beg, plead for mercy, or negotiate. Studies have indicated that threat scenarios can predict (Erber, Szuchman, & Prager, 2001) or even elicit emotional and physiological reactions (Bernat, Calhoun, & Adams, 1999; Conklin, Tiffany, & Vrana, 2000). The first study to relate this approach to well-established personality factors was Perkins and Corr (2006), who found Spielberger's trait anxiety was associated with the BIS tendency to orientate towards threat; psychoticism (tough-mindedness) negatively related to defensive intensity overall, while the Carver and White (1994) BIS scale positively correlated with both defensive intensity and direction (see also, Perkins, Cooper, Abdelall, Smillie, & Corr, 2010). More recently, Krupić, Križanić, and Corr (2016) applied a factor analytic approach to these threat scenarios and found two factors: (1) defensive direction *towards* threat and (2) defensive direction *away* from threat. In terms of correlations with well-established personality questionnaires, BIS, Flight, and Freezing scales predicted the tendency to move away from threat, while Fight and some BAS scales predicted the tendency to move toward threat. These findings challenge some aspects of RST, especially the lack of association between the BIS and defensive direction toward threat. In any case, much more work is needed using threat scenarios, which seem to hold considerable promise in the assessment of defensive motivation.

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6.5 RST and Biological Anchors

Despite its claims to be a biological theory of motivation and personality, RST research has not been successful, or especially productive, in establishing biological markers, or anchors (McNaughton & Corr, 2014), for its systems. However, some work is under way. This work includes a noninvasive EEG technique in relation to the BIS (McNaughton, Swart, Neo, Bates,

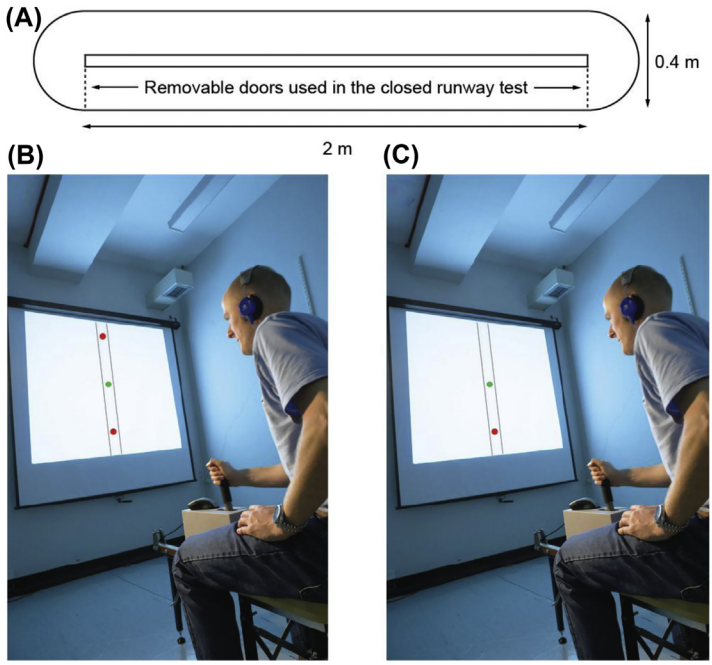

Figure 4 Runway task used in the Mouse Defense Test Battery (A; Blanchard & Blanchard, 2008) and its human translation (B, C). In A, a mouse is placed in the runway and then pursued by a hand-held anesthetized rat (rats are predators of mice). In the endless runway configuration (without doors) the running speed of the mouse away from the rat is an index of fear. When the two doors are fitted, the frequency of approach-withdrawal oscillations in the resulting closed alley is an index of anxiety. In B, the participant uses a force sensing joystick to control the speed of the *green dot* cursor when it is trapped between two *red dot* threat stimuli (these replace the doors in the mouse version). The magnitude of approach-withdrawal oscillations during this phase was used as a measure of anxiety. In C, the average velocity of the participants' cursor during pursuit by a single *red dot* threat stimulus was used as an index of fear. *Taken from Perkins, A. M., Ettinger, U., Williams, S. C. R., Reuter, M., Hennig, J., & Corr, P. J. (2011). Flight behaviour in humans is intensified by a candidate genetic risk factor for panic disorder: Evidence from a translational model of fear and anxiety.* Molecular Psychiatry, 1, *242–244.*

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& Glue, 2013) and BAS (e.g., Cooper, Duke, Pickering, & Smillie, 2014; Wacker, Chavanon, & Stemmler, 2010). This is one area that is starting to yield to scientific analysis. The use of anxiolytic drugs, and the like, can be used to anchor these motivational processes. In a demonstration of the potential, it is remarkable that all clinically effective anxiolytic drugs reduce the frequency of hippocampal rhythmical slow activity (RSA). Neo, Thurlow, and McNaughton (2011) developed a human homologue of rat RSA as a biomarker for BIS activity.

A related source of knowledge concerning the physiological and psychological structures of motivation and personality comes from functional neuroimaging of reactions to motivationally significant stimuli. This rapidly expanding literature is bound to throw important new light on the issues that concern this article, but as yet the pattern of findings are not conclusive enough to illuminate our current interests (this literature is reviewed by McNaughton et al., 2016). With respect to motivation research, what is specifically missing in the neuroimaging literature are distinctions between valuation of stimuli, systems of behavior reactions, and intervening goal representation states that, as we have seen, are central to the discussion of motivation. Also, as we have seen above, drive (desire), situational factors, conditioning, and memory serve only to complicate the picture and pose a challenge for future neuroimaging research.

One marked exception to the lack of adequate biological studies of RST in human beings is the work of Adam Perkins, who took seriously the notion that human experimental analogues of animal-based paradigms could not only be developed but would be the best way to test RST in humans (Perkins, 2010). This follows the lead of Jeffrey Gray who long argued that behavioral tests of motivation and emotion should be validated with the use of those drugs known to be clinically effective against relevant clinical conditions (e.g., fear, panic, and anxiety).

Using his Joystick Operated Running Task (JORT; see Fig. 4), Perkins et al. have undertaken pharmacological and genetic studies, which are now being extended to the neuroimaging of patients. For example, Perkins et al. (2009) examined the effects of lorazepam and citalopram on human defensive reactions. The work is based on the findings that drugs that are clinically effective against generalized anxiety disorder preferentially alter rodent risk assessment behavior, whereas drugs that are clinically effective against panic disorder preferentially alter rodent flight behavior (Gray & McNaughton, 2000). Perkins et al. used a repeated-measures, placebo-controlled, design with the use of citalopram (antianxiety/panic) and

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lorazepam (antianxiety) on the defensive behavior of 30 healthy adult male humans. Using the JORT, they found that lorazepam significantly reduced the intensity of defensive behavior during approach to threat (hypothetically anxiety-related) but not departure from threat (hypothetically fear-related). This is one example of experimental work in human beings, which shows that anxiety is an emotion elicited by threat stimuli that require approach. These data also contribute to the validation of a novel human analog of an established experimental model of rodent fear and anxiety. In related work using the JORT, Perkins et al. (2011) identified a specific genetic risk factor for panic disorder. What is especially appealing about experimental paradigms such as the JORT is they provide an operational measure of the otherwise elusive emotions of "anxiety" and "fear." The JORT is now being used to identify brain areas that are dysfunctional in anxiety patients.

More generally, Perkins has shown that anxiety has adaptive properties, and its positive features are seen especially among the cognitively able. Studies from military selection and occupational performance support this assertion (Perkins & Corr, 2014). He has also marshaled evidence to support the claim that the facial expression of anxiety may deserve to be considered an Ekman-type basic emotion (Perkins et al., 2012). This is the most promising line of research and worthy of future attention.

6.6 RST and the Big-5 Personality Traits

The dominant descriptive model in personality psychology is the "Big-5," comprising extraversion, neuroticism, conscientiousness, agreeableness, and openness to experience—sometimes called "OCEAN." Whatever its true scientific status, these five factors are easily enough recovered by the factor analysis of a sufficiently large and diverse set of semantic trait markers (Markon, Krueger, & Watson, 2005). If the claim is, indeed, true that basic motivational systems of approach, avoidance, and their conflict, are central to personality, then we should find the expression of these systems in all personality models, not just ones designed to measure them. As discussed by Corr, DeYoung, et al. (2013), it is reasonably easy to find such basic motivational influences, both in terms of theory and data, in these five factors (see also, Denissen & Penke, 2008; DeYoung, 2010b; Wilt & Revelle, 2009). In particular, we should expect traits primarily related to attractors and repulsors to be related to extraversion (E) and neuroticism (N), respectively (Elliot & Thrash, 2002), as RST originally developed from a critique of Eysenck's causal model of

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personality (Gray, 1981). And, indeed, this is found (for a summary, see Corr, DeYoung, et al., 2013). Much less obvious are relationships with the other three factors.

6.6.1 Openness to Experience

The openness to experience (O) factor is concerned with cognitive exploration, that is, the propensity to seek, detect, appreciate, understand, and utilize both sensory and abstract information (DeYoung, Grazioplene, & Peterson, 2012). In terms of motivation, curiosity about information is central as is the reward of novel experience. For example, functional neuroimaging confirms that learning the answers to trivia questions activates reward systems in a similar fashion to monetary or social rewards (Kang et al., 2009). In Corr and Cooper's (2016) study, the openness to experience correlated with BAS Reward Interest (0.23), and negatively with the FFFS (−0.18), but not the BIS (−0.01), while in Krupić, Gračanin, et al. (2016) it correlated positively with exploration tendencies. Being open to new experience seems to be about exploring potentially rewarding environment without undue fear of them.

6.6.2 Conscientiousness

The conscientiousness (C) factor reflects the propensity to be organized, reliable, self-disciplined, hard-working, and orderly. Much speculation and some evidence suggests that this factor is related to individual differences in the top-down control systems that govern effortful control of impulses and avoidance of distraction, thereby allowing people to pursue nonimmediate goals and to follow rules (DeYoung, 2010b). This is a form of motivation in controlled-reflexive processing mode. Corr, DeYoung, et al. (2013, p. 170) speculate that the C factor "reflects individual differences in the top-down control systems that govern effortful control of impulses and avoidance of distraction." However, this leaves open the question of what motivates conscientious behavior. The motivation toward work and order might be motivated by desire either to avoid punishment or to approach reward.

Consistent with these lines of thinking, achievement motivation is positively correlated with C (Markon et al., 2005; Roberts, Chernyshenko, Stark, & Goldberg, 2005), as is the Assertiveness part of Extraversion that reflects BAS sensitivity (DeYoung, Quilty, & Peterson, 2007). Corr, DeYoung, et al. (2013) go on to claim that impulsivity (e.g., pursuing immediate reward without deliberation), which is a good marker of low

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C, is related positively to Extraversion and BAS (Depue & Collins, 1999), which may be taken to imply that reward sensitivity can drive both conscientious and impulsive behavior, despite the fact that the latter pair of traits are directly opposed. C appears to reflect individual differences in the way reward motivation is channeled, rather than BAS sensitivity per se. High C may also allow people to avoid punishment. However, in the Corr and Cooper's (2016) study, correlations of C with the FFFS (0.07) and BIS (−0.13) were small when compared with the positive correlation with BAS Goal-Drive Persistence (0.38) and the negative one with BAS Impulsivity (−0.30).

6.6.3 Agreeableness

The agreeableness (A) factor reflects the tendency toward altruism, cooperation, and empathy, as opposed to aggression, callousness, and exploitation of others. We could describe A as a general motivation toward altruism. Although the literature is not clear, and more research is needed (rather like the C factor), the A factor could well be motivated by reward (the gratification of helping others) and by punishment (discomfort at hurting or thwarting others or anxiety about others' well-being). In the Corr and Cooper's (2016) study, A was positively, though modestly, correlated with all four BAS factors (0.10—0.20), and unrelated to either FFFS (0.05) or BIS (−0.01).

We thus have good reason for assuming that approach-avoidance motivation permeates all forms of personality models, as might be expected to be the case if the argument made above holds that the goal representations at the heart of motivation are also at the heart of personality.

7. THE MOTIVATING PERSONALITY RESEARCH AGENDA

The foregoing discussion raises many issues that will require further thought and empirical scrutiny. This is in the very nature of a progressive theory. Below we point to some of the issues that may prove motivating for the student of RST.

One issue facing the field is that, although RST has focused on relatively low-level processes, it would be tempting, but unjustified, to conclude that it is not applicable to higher-order, even abstract, goal presentations. For example, there is evidence that BAS-related positive-incentive motivation

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is associated with the holding of Right-Wing Authoritarianism attitudes (Corr, Hargreaves-Heap, Russell, Tsutsui, & Seger, 2013), which makes sense once one appreciates the finding that some aspects of the BAS are related to competition for resources (Krupić, Gračanin, et al., 2016). We think it is more justified, and scientifically fecund, to believe that motivation processes permeate all levels of cognition, belief, and attitude.

More generally, RST has been related to a variety of behaviors, many of which have a strong motivation component. Among recent studies that have used the more refined RST-PQ, these include attachment styles (Jiang & Tiliopoulos, 2014), eating styles (Tsancheva, 2014), perfectionism (Stoeber & Corr, 2015), and perhaps inevitable, Facebook behavior (Gerson, Plagnol, & Corr, 2016). In regard to the Facebook study, we found a number of statistically significant and theoretically meaningful associations. The intensity of Facebook use (e.g., number of friends) was found to be positively correlated with all four BAS scales, but not with the BIS or FFFS, suggesting this is a positive-incentive form of motivation. Time spent on Facebook was correlated with all BAS, BIS, and FFFS scales, suggesting a heightened state of drive reflecting positive and negative features. Of interest, too, social comparison on Facebook was negatively associated with all four BAS scales and positively associated with both the FFFS and BIS, indicating that this is an especially negative form of motivation driven by fear, anxiety, and a lack of positive-incentive motivation. Given the prevalence of social media, and the roles played by motivation and personality, much future work is in the offing.

The above studies are interesting in their own right, but important also for demonstrating the multidimensionality of the BAS, to which we turn next.

7.1 BAS Processes

The roles of BAS processes in approach behavior is still debated. As already discussed above, although there are good reasons for believing that the BAS is multidimensional it is surprising that apart from the RST-PQ (Corr & Cooper, 2016), and the original BIS/BAS Scales (Carver & White, 1994), all other RST questionnaires contain a single measure of it. In Fig. 5 we show how the complexity of approach motivation can, and we contend should, be parsed into four stages. Although based on extant research, the full implication of these separate processes requires the astute eye and capable hands of future RST workers.

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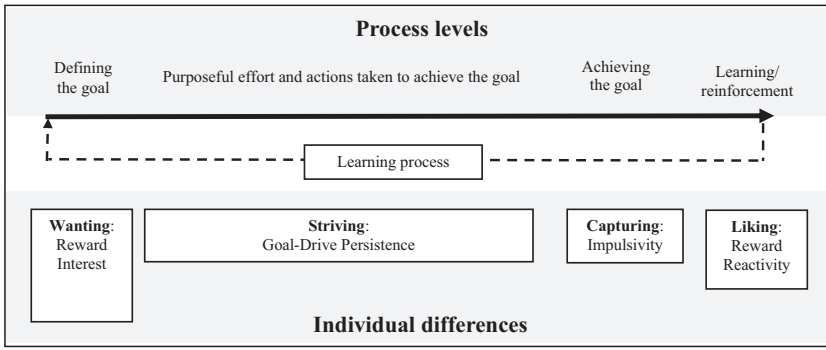

Figure 5 Schematic showing dynamic BAS processes while moving across temporo-spatial continuum toward final reinforcer. Approach motivation starts with defining the goal, then planning actions to achieve it. Once the goal has been reached, the level of subsequent positive reactions of achievement enhances the desirability of the goal, which in the future situation should have impact on valuation of the desired goal (see text).

The first stage is necessary for the onset of approach behavior. The goal needs to be identified, defined, and evaluated before it can exert any motivational influence. Individuals higher on Reward Interest are more likely to have a broader range of desired goals, which could be interpreted as having higher incentive motivation. These individuals find many things interesting and worth exploring. Although interest in the goal is crucial for activating approach to it, the key question is the nature of the function between Reward Interest and actual approach behavior. No interest at all should result in the absence of approach behavior. However, having too much (especially equally desired) goals may result in indecisiveness (i.e., goal-conflict that would inhibit approach motivation), which defeats the ultimate aim of positive-incentive motivation. Simply, many goals cannot be pursued and attained at the same time. This is frequently seen in the intrinsically motivated PhD student during the process of selecting the topic of his/her doctoral thesis, as well as by more seasoned academics who are confronted by an array of fascinating projects many of which they simply do not have the time to pursue. A moderately motivated student, or academic, would have a narrower list of topics from which to select, and would make decisions more quickly, and start working much earlier without interference by distraction and inhibition. As this example shows, it is very probable that a nonlinear relationship exists between the Reward Interest and approach behavior prevails.

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However, just showing interest for the goal is not sufficient. Once some particular goal captures our attention, the next phase is goal planning and "digging" for the goal. The goals can vary in complexity or attainability. In this perspective, individuals high on Goal-Drive Persistence should show a tendency to strive or persist in accomplishing more sophisticated or complex long-term goals. This has been found in a recent study examining the relationship of the BAS scales and motivation within evolutionary psychology. Krupić, Gračanin, et al. (2016) observed that individuals high on Goal-Drive Persistence showed greater motivation toward cooperative motives reflecting the long-term resource acquisition strategy.

Furthermore, as discussed above, temporal bridging plays an important role in achieving complex or long-term goals (e.g., Duckworth, Tsukayama, & Kirby, 2013). Moving along the temporospatial gradient requires a delay of immediate gratification and investment of further effort to achieve the more desired, yet distant, final goal. For instance, a student has to invest his/her time in studying for several years, sacrificing several dozens of immediately available payments that would allow him/her a number of immediate gratification opportunities. One intriguing possibility is that the local form of reinforcement received to maintain goal-drive persistence across the temporal bridge may lead to some people being stranded on this "local high," with the neglect of the longer-term goal. This might be especially expected when the high goal-drive persistent individual is also high on impulsivity where these immediate micro reinforcement may be especially attractive.

In addition, self-control in maintaining motivation for long-term goals (e.g., O'Gorman & Baxter, 2002) is likely to be important. Available data show that self-control (defined as a trait) correlate positively with Carver and White's (1994) Drive factor and negatively with impulsivity/Fun seeking (Ein-Gar & Sagiv, 2014; Morean et al., 2014). Despite the fact that many studies have used the total score of the Carver and White (1994) BAS scale, nevertheless these studies implicate the BAS in self-control (e.g., Hofmann, Baumeister, Förster, & Vohs, 2012; Yam, Reynolds, & Hirsh, 2014). But once self-control exceeds its upper boundary, formerly suppressed impulsivity has a greater capacity to take control of behavior. This state, so-called ego-depletion (Baumeister, Bratslavsky, Muraven, & Tice, 1998), has not yet been related to RST processes. This would seem an important target for future research. It is reasonable to assume that individuals high on Drive/Goal-Drive Persistence would have a higher threshold for the occurrence of ego-depletion.

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At the very end of all purposeful effort invested in attaining the goal, the final stage reflects capturing the goal. Once the goal is attained, the hedonistic reaction following attainment of the goal should enhance the learning process, which can then influence valuation of the goal. Krupić, Gračanin, et al.'s (2016) data showed that individuals high on Impulsivity and the Sensitivity to Reward (Torrubia, Avila, Molto, & Caseras, 2001), which is more related to competitive motivation than cooperative, are highly motivated by external motives such as displaying wealth, intellectual and physical superiority, higher social status, and the like.

To examine the interaction of the approach and avoidance systems, more consideration should be given to the joint roles of separate BAS processes. For example, in unstable and unpredictable situations high Reward Interest accompanied by Impulsivity may produce greater success in comparison with individuals high on Drive-Goal Persistence.

7.2 Motivation, Personality, and Gambling

We end this section with a specific example of the applications of RST to understanding complex motivated behavior: gambling. As discussed above, there is much further scope for considering the influence of the interplay of the BAS, BIS, and FFFS along the lines suggested by the joint subsystems hypothesis (JSS; Corr, 2001, 2002, 2004), that is, how these processes interact under specific situational constraints. We illustrate this configural approach to RST effects with the likely personality factors associated with gambling, as depicted as in Table 1.

Here, as elsewhere, we may think of the interaction of RST factors in terms of personality *types*. Indeed, this perspective allows a harmonious relationship between dimensions and traits, something that has long been missing in personality psychology. We have previously found this perspective to be useful in the characterization of the general factor of "drive" in the workplace (Corr et al., 2017). Although we must never fall into the trap of assuming that situational and contextual factors are unimportant, we can rather easily create a general classification scheme of different gambling personality types. We should expect the type most vulnerable to gambling to be the "Reckless" one, characterized by strong BAS and weak FFFS/BIS. In contrast, we should expect the least vulnerable type to be the "Cautious" one, characterized by weak BAS and strong FFFS/BIS. Given that the BAS is multidimensional, then the impulsivity component of the BAS should be most predictive of the reckless gambling type. These associations

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Table 1 Personality types derived from combinations of BAS, FFFS, and BIS factors in gambling

BAS−			
FFFS−		FFFS+	
BIS−	BIS+	BIS−	BIS+
Insensitive to wins and losses, and low detection of goal conflict detection	Insensitive to wins and losses, but high goal conflict detection	Insensitive to wins, sensitive to losses, and low goal conflict detection	Insensitive to wins, sensitive to losses, but with high goal conflict detection
Weakly driven gamble, but if this happens, lack fear/anxiety of losing	Weakly driven to gamble, but if this happens, lack fear but adequate anxiety	Weakly driven to gamble, but if this happens then strong fear of losing, but with inadequate anxiety	Weakly driven to gamble, but if this happens then strong fear of losing, with adequate anxiety
"Apathetic"	**"Indecisive"**	**"Avoidant"**	**"Cautious"**
BAS+			
FFFS−		FFFS+	
BIS−	BIS+	BIS−	BIS+
Sensitive to wins, insensitive to losses, and low detection of goal conflict detection	Sensitive to wins, insensitive to losses, but high goal conflict detection	Sensitive to wins and losses, and low goal conflict detection	Sensitive to wins and losses, but high goal conflict detection
Strongly driven gamble, accompanied by lack fear/anxiety of losing	Strongly driven to gamble, accompanied by lack fear of losing, but adequate anxiety	Strongly driven to gamble, accompanied by fear of losing, but inadequate anxiety of losing	Strongly driven to gamble, accompanied by fear and anxiety of losing
"Reckless"	**"Striving"**	**"Tentative"**	**"Volatile"**

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have yet to be put to the empirical test, and this should be rather easily achieved by the adequately goal-driven and persistent researcher.

This approach to personality typology raises some intriguing possibilities. For example, consider the "Indecisive" type. Although an unlikely combination of dimensions, since BIS activation is usually the result of highly active BAS and FFFS, although the BIS could be hypersensitive without much involvement of the BAS and FFFS, this personality type would have poor executive functioning and goal planning. Such a person would approach and avoid stimuli in the environment at random, without risk assessment, and it should be assumed that they may become conditioned to gambling as a secondary consequence of their personality type. Indeed, their chasing of loses and sensitivity to near-misses may be promoted by their heightened FFFS, which may strengthen the power of negative reinforcement to maintain their gambling behavior (an example, of the phenomenon of "relieving nonpunishment"; McNaughton & Corr, 2009).

It would, indeed, be interesting to examine empirically these personality/motivation characterizations, especially in relation to different forms of gambling and betting. For example, high impulsivity might be more predictive of fun-seeking excitement on the casino roulette table, whereas the reward interest and goal-drive persistence component might be more predictive of strategic forms of betting, such as devising multileg combinations (e.g., parlay), the playing out of which may take hours, days, weeks, even months (e.g., using "betting bots" to hit infrequent, but high payout, accumulators). As in other areas of motivated behavior, state drive, negative affectivity, and self-control should be expected to influence the behaviors associated with these broadly defined personality/motivational types. These different styles may be found in the same person at different times (e.g., the fun-seeking, impulsive style under ego-depletion).

The above issues are far from being an exhaustive list and many other problems linking RST to motivation remain to addressed, or even conceived. It is hoped that the discussion in this section, and those preceding it, generates possibilities in the reader's mind.

8. CONCLUSIONS

This article charts the scientific journey of the RST perspective on motivation and personality, couched in terms of basic approach and avoidance systems. It also chronicles the travails of the authors who

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remain on this journey. The structure of the article reflects some of the important stops along the way. During the course of this journey, it has become evident that, although the theory starts from a relatively low level of analysis, it has become increasingly sophisticated and can now account for many forms of motivated behavior. But there is much more to the theory than we have covered, and we have whizzed past some other important places, especially the elaborate neuroscience that underpins RST (Corr & McNaughton, 2012). For the purpose of this article this is no bad thing, as it has allowed us to focus on the major conceptual elements of motivated behavior and personality. Furthermore, it has also provided the opportunity not just to summarize what is already known but to propose some new conceptual schemes and to pose new questions that should stimulate tomorrow's student of motivation and personality.

In summary, we have shown that RST processes are not concerned with the individual's specific needs or motivations, although these are important and compatible with our approach (see Fig. 2), but with how "goals" interact with approach, avoidance, and conflict systems. We view overt behavior as providing the proximal means of the organism's interaction with the external world and the form taken by overt behavior is less important that the functions it serves. Specific forms of behavior should not be identified with RST systems, which Janus-like both drive behavior but also influence goal presentations. In our view, RST systems provide the tools by which goals are able to interact with the world, and it is by the taxes-like influence of reinforcement that the organism shapes its goal representations. This provides the potency and legitimacy of "reinforcement" in RST.

We have also seen the consequences of a mismatch between (1) expectations of the effects of behavior and (2) feedback (reinforcement) from the external world, which leads to a BIS-mediated brake imposed on prepotent behavior. In consequence, controlled processes then analyze the nature of the error signal, which, then, leads to behavioral adjustment and learning. This process seems to play a not insubstantial part in the generation of the contents of consciousness, still something of a mystery but one that is informed by low-level processing of motivation systems.

We end by contending that RST plays a crucial role in the causal cascade of motivation that enables the organism to interact with the external world in an adaptive fashion to satisfy distal evolutionary imperatives clothed in the proximal cloth of personal needs and goals.

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