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Review Article

The Regulation of Personal Security

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Although most motivational psychologists recognize that security is important for healthy development and functioning (e.g., attachment theory), we add to prior work by proposing that the ongoing regulation of security under potential threat involves three unique features. Specifically, security regulation involves an initial preconscious system of threat processing (neuroception) and an internally (vs. externally) generated stop signal of goal completion (yedasentience) as well as the sequential activation of avoidance and approach systems (anxiety-to-approach). Throughout, we consider how the integration of these insights across social and biological sciences accounts for both adaptive and maladaptive patterns of security regulation (e.g., obsessive-compulsive disorder, reactive attachment disorder, contingent self-esteem).

1. Introduction

Among the pantheon of psychological needs, some scholars have argued that personal security is the most fundamental [1, 2]. For example, Maslow argued that the satisfaction of security needs represented a necessary prerequisite before one could turn to pursue other important needs, such as belongingness and esteem. Indeed, with only one notable exception (see [3]), over fifty years of theory and research suggest that people have a fundamental need to feel secure that, when satisfied, predicts greater well-being and, when deprived, predicts diminished well-being [1, 2, 4–6]. Moreover, prior work has extolled the virtues of security as a central, unifying, concept capable of connecting a diverse array of seemingly disconnected topics under one explanatory roof [7]. Just within social and personality psychology, it can organize topics as varied as the self, relationships, helping, world-views, aggression, and stereotyping and prejudice [8–12].

Although important in their own right, the primary point of this article is not to restate these points (see [3]). Instead, we integrate prior work into a novel model proposing three unique features that distinguish the regulation of security from other needs. This seems especially important because, despite the general consensus regarding the importance of security, there is less agreement regarding the unique features of its regulation. In particular, we bring together unique insights from neurobiology, social neuroscience, and social psychology on the different stages of security regulation under potential threat. Before we present our model of security regulation, we first step back to define personal security as well as other key terms.

2. Defining Personal Security

Building from prior work on security [7, 13], we define *personal security* as the feeling of freedom from concern over personal (physical or emotional) vulnerability. We define personal *insecurity* as the feeling of concern over personal vulnerability. Here, we take *concern* to have the meaning supplied by the law of concern [14], which states that only events that are relevant to important goals, motives, or concerns will elicit emotions (e.g., anxiety). Of course, beyond other advantages, the concept of concern fits nicely with the work we review on the “alarm bell” of anxiety evoked by potential threats to important goals [15].

Consistent with prior work on security [2, 7], we define potential *threat* as any stressor that activates concerns over vulnerability, or insecurity. This is also consistent with the definition offered by Blascovich and Tomaka [16] who defined threats as any stressor that exceeds one's personal coping resources. As stated otherwise, threats are stressors that arouse concerns over personal vulnerability. Threats may include basic threats to life or health (e.g., [17]) as well as threats to psychological (e.g., social inclusion, self-worth, control, meaning), or even basic material resources [18]. In all cases, though, threats must evoke *concern* over personal vulnerability to create insecurity. For example, losing a free 1-month magazine subscription is unlikely to represent a threat that creates insecurity in the same way that losing one's job, marriage, home, or life would. Unlike the former, losing one's job, marriage, home, or life represent potential threats that would evoke vulnerability concerns because these events are centrally relevant to our survival and well-being. Each time one cognitively registers a threat, the mental system initiates coping processes to deal with it. Responses to threat may overwhelm other active goals ([19]; see [20]), which occur through the operation of the law of concern.

Before proceeding, we would like to clarify one final point regarding the present focus. The focus of the work reviewed here is on *potential* rather than actual threat. As such, it focuses primarily on the anticipatory emotion of anxiety rather than fear or panic. In this sense, the focus differs from that in other work on other protective systems. For example, some prior work has proposed a fear module that handles fear-based, avoidant responses to manifest threats [21]. This system functions by conditioning the central motive of fear to imminent threat, such as the actual presence of predator. Thus, unlike the focus of the fear module on present or existing threats, this paper focuses on the anticipatory emotion of anxiety that motivates the regulation of security in response to *potential* threat [22].

3. The Unique Features of Security Threat Regulation

Having defined security, we now review prior work suggesting that the regulation of security involves three unique features. Specifically, this paper integrates prior work into a new model proposing that the regulation of security involves three unique features: (1) an initial preconscious system of threat processing (neuroception), (2) an intervening process of the sequential activation of anxiety-based avoidant and approach systems as well as (3) an internally (vs. externally) generated stop signal of goal completion (yedasentience or "feeling of knowing"). In particular, we incorporate insights from neurobiology on the initial and ending stages of security regulation (polyvagal and biological security system theories) with insights from social psychological models on the intervening stages (anxiety-to-approach). Throughout, we consider how the integration of these insights across social and biological sciences accounts for both adaptive and maladaptive patterns of security regulation (e.g., obsessive-compulsive disorder, reactive attachment disorder, contingent self-esteem).

3.1. Sequential Activation of Anxiety to Approach Systems. We begin our review by considering unique insights from social and developmental psychology models of security regulation. In particular, we argue that, despite their unique features, most converge upon the common point that compensatory threat responses involve the sequential activation of anxiety to approach systems [23].

With respect to prior models, attachment theory represents one of the most notable and well-established models that focused squarely on the shift from anxiety to approach-oriented systems in the ongoing regulation of security [24]. Moreover, within this work, the primary purpose of the attachment system was to achieve a sense of security via proximity to caregivers. Bowlby [25] began with the observation that human infants are unusually vulnerable to threat because of their slow rate of physical maturation relative to other species. Despite their vulnerability, they do have one important means of security.

Namely, they are born with a repertoire of evolved *attachment behavior programs* that were selected during evolution to assure proximity to supportive others (*attachment figures*) as a means of protection from predation, starvation, and injuries [2, 26]. In terms of organization, security-promoting attachment behaviors are organized by an innate *attachment behavioral system*, which Bowlby [25] viewed as a system of cybernetic goal programs that include the detection of threats, the ability to signal a need for help from attachment figures, and actions that establish contact with those figures and reliance on them for reassurance and safety. So long as caregiver proximity is not assured, the security-regulating attachment system maintains the alarm signal of anxiety that motivates the infant to restore proximity to caregiver. When attachment behaviors repeatedly assure proximity to a responsive attachment figure, they contribute to a general sense of "felt security" [5]. In these models, it is only after the achievement of "felt security" that anxiety recedes and the pursuit of growth needs (e.g., power, mastery, esteem) proceeds [2]. That is, the shift occurs from initial anxiety to approach-oriented pursuits as opposed to the other way around.

Although the attachment system is most important early in life, Bowlby [27] viewed it as active over the entire human life span. For example, the continued operation of this system later in life accounts for the formation and maintenance of emotional bonds with close friends and romantic partners as well as the intense grief reactions when those bonds are severed (e.g., separation, divorce, or death of loved one).

Bowlby [24] also described important individual differences in attachment-system functioning. In his view, these individual differences are rooted in the reactions of one's relationship partners to bids for proximity and support in times of need, and in the incorporation of such reactions into working models of self and relationships. The empirical assessment of attachment security consists of the two measurement dimensions of anxiety and avoidance. When a person's attachment figures are not reliably available and supportive, a pervasive, dispositional sense of security is not attained. From an empirical standpoint, higher scores on attachment anxiety and avoidance would reflect an underlying dispositional sense of insecurity. This dispositional sense of insecurity may involve higher attachment anxiety, stronger worries about one's social value and about others' intentions, and a greater tendency to adopt strategies of affect regulation other than normal proximity seeking (known as *secondary attachment strategies*, characterized by anxiety or defensive *avoidance*).

By contrast, interactions with attachment figures who are available, sensitive, and supportive in times of distress facilitate the smooth functioning of the attachment system, promote a sense of connectedness and security, and contribute to positive working models of self and others. From an empirical standpoint, lower scores on attachment anxiety and avoidance would reflect underlying dispositional senses of security. Moreover, repeated exposure to responsive caregivers reduces anxiety with the deactivation of the attachment system which, in turn, promotes positive emotion and creative exploration.

Thus, consistent with the point of the present section, attachment theory suggests that the restoration of proximity to caregivers deactivated the attachment system responsible for the generation of anxiety which, in turn, permitted the individual to experience positive emotion and the pursuit of more approach-oriented needs (e.g., developing new social bonds)–that is, a shift from an avoidant to an approach-oriented system.

Building from these insights, several contemporary models within social psychology propose that anxiety-regulation systems develop as outgrowths of the original attachment system. Importantly, like the original attachment model, these models emphasize the reliable pattern of anxiety to approach in security regulation. For example, terror management theory [28] and the tripartite security system model [7] suggest that self-esteem and world-views develop as more abstract anxiety buffers in childhood and adolescence and, importantly, are patterned or modelled after the innate attachment system for managing separation anxiety. Specifically, these models suggest that self-esteem and world-view systems are scaffolded from the developmentally and phylogenetically older attachment security system. Scaffolding refers to the process whereby developmentally later arising behaviors coopt a foundation established by earlier innate or learned behavior (e.g., [29–32]. Thus, various aspects of one goal (e.g., relevant means, affective reactions, completion criteria) transfer to the second, younger, goal.

Applied to the present context, the processes and means for regulating the older attachment system should transfer to the newer systems to govern their regulation. Specifically, the process of regulating one's distance from some source of security illustrates this point. In attachment theory, anxiety arises when there is a separation or discrepancy between one's physical position and secure base caregivers. In response, the infant strives to close the discrepancy between their position and the caregiver. Consistent with the assumptions of scaffolding logic [29], terror management theory and, later, the tripartite security system suggest that the self-esteem and world-view ideals may, in fact, operate much like the early secure base of caregivers. Rather than physical responses that maintain proximity between oneself and important security-providing caregivers, world-view and self-esteem expressions may represent psychological responses to maintain proximity between oneself and important security-providing cultural or self-standards.

Thus, the implication is that, like actual caregivers, world-views and self-evaluation can function as secure base objects. Moreover, like representations of any relational secure base, people monitor and resolve any discrepancies (or separation) between oneself and self-esteem and world-view secure base objects. Important for the present purposes, moreover, these contemporary models converge with attachment theory to propose that anxiety evoked by threat leads to compensatory processes involving the sequential activation of avoidant and approach systems. Specifically, both assume that anxiety provides the primary signal or "alarm bell" evoked by the threat that motivates the compensatory responses to meet self or cultural standards which, in turn, diminishes anxiety to promote growth need pursuit, social bonding, and positive emotion.

Beyond the terror management and tripartite model, other contemporary models propose that responses to threat entail the sequential activation of the avoidant-oriented behavioral inhibition and approach-oriented behavioral activation systems [15, 33]. For example, in both the reactive approach motivation (RAM) [34] and anxiety-to-approach [23] models of threat management, the initial anxiety evoked by the activation of the behavioral inhibition system (BIS) and anterior cingulate cortex (ACC) triggers a compensatory process of behavioral activation system (BAS) and left prefrontal cortex activation that results in greater positive emotion and goal conviction [23, 34]. Across these perspectives, the operation of the approach system (caregiver or BAS) responsible for approaching opportunity is not independent of the anxiety system responsible for avoiding threats (attachment or BIS). Rather, BIS activation precedes and ultimately gives rise to BAS activation. Thus, despite their unique features, the social psychological models reviewed above all converge upon the common point that the regulation of security threats entails the sequential activation of avoidant and approach systems. In contrast to the foregoing social psychological models, the security motivation system models suggest that, rather than interdependent and co-acting systems, different systems have evolved to solve different problems related to self-preservation. Specifically, Woody and Szechtman [6] distinguish the security motivation system for dealing with threats within unsafe environments from the separate saftey system for dealing with social opportunities within safe environments. Relevant to the present point, although these theorists conceptualize the security and safety systems as independent, their description of the temporal relationship between the offset of the security motivation system and the onset of the safety system seems to suggest an interdependent relationship, whereby the resolution of insecurity produced by the security system precedes the enhancement of safety cues by the safety system. That is, despite proposing an *independent* relationship in which the safety system could precede or co-occur with the security motivation system, the description of their operation implies an interdependent relationship because the neurological influence of the security motivation system almost invariably precedes and gives way to the influence of the safety system. For example, beyond the completion of precautionary behaviors as a way to inhibit the security appraisal system, these authors [6] note that "the enhancement of safety cues that arises from the onset of the safety system exerts a secondary inhibitory influence on the security appraisal system (see p. 1022)." Of course, this proposed relationship between the safety and security systems would imply that the security motivation and appraisal systems are not distinct from the operation of the safety system. By definition, independent systems do not exert direct influence on one another. That is, if truly independent, the inhibition of the security system should not typically give rise to the safety system, and in turn, the onset of the safety system should not exert some "secondary inhibitory influence" on the security system. Thus, it seems difficult to defend the position that the security motivation and safety systems are truly independent. As importantly, this characterization of the two systems in the security motivation system model actually contradicts the relationship originally outlined by Trower and colleagues. Specifically, Trower et al. [67] regarded the safety system (hedonic system) as following from the anxiety defense system (agonic system). That is, similar to attachment work, this work suggests that a time-dependent sequence running from the resolution of anxiety by the anxiety defense system which, in turn, corresponds with the onset of the hedonic or, "safety," system. And, although the anxiety-to-approach model does not implicate security per se, it does converge with earlier attachment work on the point that approach-oriented behavior follows from the resolution of anxiety by an avoidance system. Thus, although the security motivation system characterizes avoidance and approach systems as independent, most threat regulation theories view the operation of these as interdependent (approach following from avoidance activation). Taken together, the preponderance of theory and evidence over the past 50 years seems to converge with the position of most contemporary social psychological models–namely, that the sequential activation of avoidance and approach systems represents a unique feature of the process of regulating security threats.

3.2. Missing Links. Beyond extracting the unique insights offered by these models of security regulation, we attempt to offset some of their limitations as well by looking outside of social and developmental psychology. In particular, the foregoing models are limited in their ability to account for certain unique features identified by neurobiological research on security regulation. First, although many existing models discuss automatic affective reactions (e.g., BIS-BAS activation), they do not address the origins of those affective responses. By contrast, neurobiological research suggests the onset of security regulation begins with *neuroception*–an automatic and ancient information processing system that serves primarily to discriminate secure from insecure environments and, importantly, precedes many of the processes (perceptual; cognitive) discussed within existing models [35].

Second, the foregoing models do not address the underlying mechanism by which the shift occurs from anxiety-to-approach systems. By contrast, neurobiological researchers point to a specific internally generated stopping signal that would govern the shift from anxiety-to-approach. Specifically, neurobiological researchers suggest that the regulation of security is open-ended such that the achievement of security under potential threat does not correspond to some clear, *external*, consummatory signal [36]. That is, the successful resolution of a potential security threat is a nonevent (nothing happens) that does not clearly signal the removal of a potential threat in the same way that attaining a typical positive (competence) goal would correspond to clear external signals of impending goal consummation (e.g., getting the promotion). Thus, these researchers have demonstrated that, unlike other needs, the regulation of security depends upon an *internally* generated stopping signal referred to as *yedasentience* or the "feeling of knowing" [6]. (As it turns out, the actual term "yedasentience" is a combination of the Hebrew word for knowledge or to know (yeda) and the Latin word for feel (sentire)).

This paper attempts to integrate the key advantages of the above social psychological models with the key advantages of polyvagal theory and the security motivation system model from neurobiology on the unique front-end (neuroception) and back-end (yedasentience) features of regulating threats to security. Figure 1 depicts the explanatory province of each of these three lines of work in the first three path models (a–c) whereas the fourth (d) depicts the integration of the unique insights provided by each into our unified model of security regulation. In particular, this model suggests that the regulation of security involves neuroception and yedasentience, as well as the sequential activation of anxiety to approach systems. In the following sections, we now turn to consider how the integration of these insights accounts for adaptive and maladaptive patterns of security regulation.

3.3. Neuroception in Security Regulation. In prior work on needs, scholars propose that important needs should correspond to neurobiological systems that evolved to support those needs [37]. Although it is common to find neurobiological and psychological mechanisms that support multiple motivational systems (see [38]), it is quite rare to find neurobiological mechanisms that function exclusively to support the regulation of one particular motivational system. However, the polyvagal theory makes just such a claim regarding security and the process of neuroception that modulates the polyvagal system. Porges [35] coined the term neuroception and defined it as an ancient and automatic bottom-up processing system that evolved to serve one purpose–to distinguish secure from insecure environments [4, 39, 40].

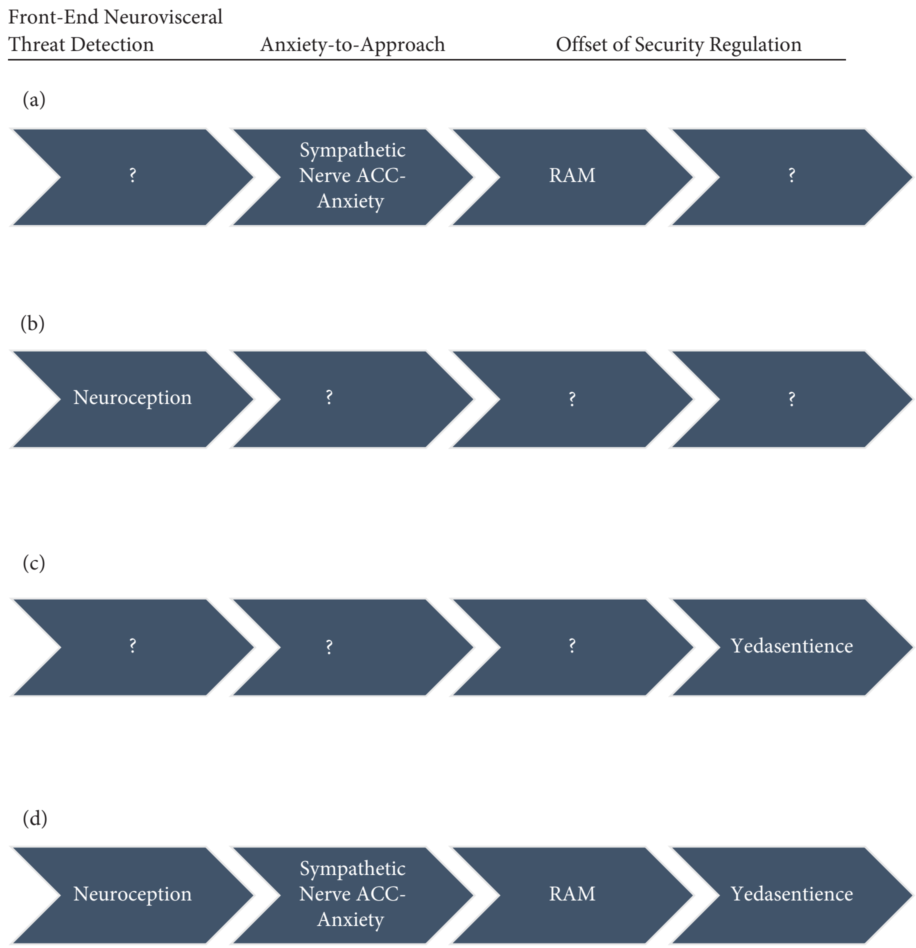

Figure 1: Models of the regulation of personal security.

Whereas cognition and perception involve top-down neurocognitive processing effects and awareness (mind to body), neuroception is a bottom-up process (body to mind) involving vagal and sensory inputs related to external threats and endocrine mechanisms that detect and evaluate environmental risk prior to the conscious elaboration by higher brain centers [35]. These layers reflect our biobehavioral evolution: neuroception does not require attention and is something we share with more primitive vertebrates, including reptiles.

Like the reptilian brain, the human brain reacts first to protect itself even without awareness. However, unlike the purely reptilian brain, the special features of our mammalian brain and neurobiology (e.g., left PFC; myelinated vagal nerve) also enable us to think abstractly and create attachments to sources of comfort (people and ideas). According to Porges [39, 40], though, these positive attachments cannot occur unless neuroception *first* identifies the environment as secure. Thus, first and foremost, neuroception controls polyvagal activity to respond to security threats. Polyvagal theory has elaborated the concept of neuroception and applied it to account for both normal and abnormal patterns of motivated behavior (reactive attachment disorder; PTSD, etc.) [39].

Neuroception has several noteworthy outputs that have implications for security regulation [39]. In particular, the discrimination of unsafe from safe environments controls the polyvagal system that modulates activity between three phylogenetically ordered circuits. Within secure environments, the myelinated vagal nerve originating in the nucleus ambiguus connects to and innervates the sinoatrial (SA) node for the right atrium of the heart. The SA acts as a cardiac pacemaker to inhibit the activity of the sympathetic/adrenal nerve to diminish anxiety and increase positive emotion and approach systems for social engagement. Within insecure environments characterized by possible threat, the myelinated vagal brake stops inhibiting the sympathetic adrenal gland, thereby enabling sympathetic adrenal engagement should threat become imminent. Within the context of imminent potential threat, the sympathetic adrenal nerve increases anxiety, vigilance, and precautionary behavior to permit available fight-flight responding. By contrast, when fight-flight responses are no longer available under imminent and extreme life threat, the oldest unmyelinated vagal is engaged to produce "freezing," fainting, and immobilization. Thus, although the activation of the myelinated vagal in the neuroceptual identification of safe environments would diminish the automatic regulation of security threats, the activation of the other two components would enhance this process.

Of note, polyvagal theory suggests an empirical index of the shift from myelinated vagus to threat-oriented systems. Specifically, it can be measured by changes in an index of normal heart rate variability (interval between heart beats) known as respiratory sinus arrhythmia (RSA), which normally ranges from 0.12 to 0.4 frequency intervals between heart beats in calm states. Indeed, the engagement of the vagal brake occurs within the normal RSA range [6]. Under potential threat, the nucleus ambiguus-myelinated vagal influence as a "vagal brake" is attenuated and, in turn, RSA is reduced to show less variability and greater regularity to enable mobilization of metabolic resources via sympathetic adrenal engagement. Thus, reductions in the RSA index of normal heart rate variability are a good index of the shift from secure to potentially insecure contexts.

Although polyvagal theory is perhaps the most well-established account of vagal influences on motivation and behavior, there are other models that have also focused on the interplay between the parasympathetic vagus and the sympathetic system. For example, the neurovisceral model [41, 42] suggests that higher vagal tone (indicator of strong myelinated vagal influence) in the connection running from the prefrontal cortex through the heart to the remainder of the autonomic nervous system is linked to better executive control functioning as well as better social and emotional functioning. The biological behavioral model [43] also assumes that the higher vagal tone is adaptive given that it plays a key role in the regulation of energy exchange by synchronizing the cardiac and respiratory processes attendant to behavioral and physiological changes. In particular, higher resting vagal tone diminishes needless energy expenditure and metabolic cost, thereby providing a higher resting energy capacity from which the organism can draw from in the case of subsequent extreme threat. Thus, rather than a limited perspective, the extant literature seems to include several examples of theory and research suggesting important vagal influences on motivational and behavioral responses to threat.

At this point, it may be helpful to mention just a few important benefits of incorporating neuroceptual modulation of the polyvagal system into models of security regulation. First, Porges [35] noted that the process of neuroception provides insights into new measures of attachment-related responses not captured in traditional paradigms. Specifically, Porges [35, 39] notes that infant and adult pair bonding and attachment depend upon reducing the psychological or physical distance to secure bases. However, the infant does not have a fully developed corticospinal pathway for voluntary somatic motor movement to decrease the distance from caregivers following separation.

Fortunately, although the corticospinal pathways are too immature for the infant to move *themselves* across distances, the corticobulbar pathways controlling movement in the facial and neck muscles allow the infant to signal and, thereby, effectively *motivate caregivers to move* toward the infant. For example, the corticobulbar pathways enable the infant to still signal the caregiver via facial expressions (smile or grimace), expressive prosody of vocalizations (cooing or crying), and eye contact (gazing or diverting eye contact). In this sense, even though the infant cannot express attachment behavior via voluntary motor movement, the neurobiological hardware supporting neuroception provides other avenues that effectively reduce the distance by motivating caregivers to approach the infant.

Of course, although these avenues of proximity-seeking would diminish with the development of voluntary somatic movement avenues of proximity-seeking, these avenues should continue to operate throughout life and play some measurable role, even if a lesser one, in adult attachment, processes [40]. For example, the interpersonal security compensation model suggests that partners of chronically insecure targets may monitor and respond to counteract subtle expressions of target insecurity." Within this model, many of the expressive signs of target insecurity seem similar to those described in polyvagal theory as expressions of attachment behavior, such as emotional distress (e.g., crying) or overreactions (e.g., frustration, anger) [11].

These sorts of behaviors do not literally (physically) close the distance between the insecure target and their partner. However, when partners have positive relationship goals, these target expressions of insecurity can enhance target security by motivating *the partner* to close the distance between themselves and the previously insecure target through greater responsiveness, reassurance, praise, and support. Although not exhaustive, this represents just one model of security regulation that could potentially benefit from the incorporation of different insights and measures of insecurity and proximity-seeking behavior from polyvagal theory.

Second, beyond expanding the range of measures for normal attachment responses, the concept of neuroception can also help explain abnormal behavioral patterns. For example, anxiety and reactive attachment disorders stem from maladaptive patterns of neuroception that involve the invalid perception of objectively safe environments as dangerous [39, 40]. Conversely, William's disorder, characterized by an inability to activate defense systems in objectively risky environments, may stem from an invalid neuroception of objectively unsafe environments as subjectively safe [35].

Third, the incorporation of neuroceptual modulation of the polyvagal system helps to further illuminate the processes underlying the initial activation of the sympathetic adrenal system and, by extension, anxiety that most of the social psychological models reviewed above focus on. Indeed, regardless of whether these models connect anxiety-regulation to security maintenance or not (e.g., anxiety-to-approach model), they all focus on the regulation and resolution of evoked anxiety produced by perceived potential threat [23]. Of course, the continuous operation of the fast neuroceptual system precedes and, hence, does not require any top-down perceptual or cognitive awareness to evoke anxiety or comfort. This has implications for many of the threat response models (attachment, tripartite, reactive approach motivation, anxiety-to-approach, or terror management models) in the social and developmental literature. Again, we propose that the incorporation of neuroceptual modulation of the polyvagal system may benefit this work by clarifying the process that initially generates the anxiety regulated by the mechanisms outlined in their models.

Indeed, if neuroception provides the input for the attachment system and, if the world-view and self-esteem systems are patterned after the older attachment system, neuroception should provide the inputs of these later systems (world-view and self-esteem). For example, the activation of the sympathetic adrenal nerve during neuroception would certainly produce the anxiety and personal uncertainty which, in turn, motivates the endorsement of abstract ideals to down-regulate the sympathetic adrenal system in the reactive approach model (perhaps, by activating the myelinated vagal and approach behavior to live up to ideals). Of course, it is worth noting that one conceptual review has discussed how the incorporation of polyvagal theory can advance work on contextual factors that shape automatic evaluations in response to threat of outgroup stereotype target [44]. Despite the unique insights regarding the regulation of anxiety once aroused provided by RAM and anxiety-to-approach models, a clearer understanding of the front-end process (neuroception) that generates anxiety in the first place would likely also benefit these models.

Consistent with this point, recent research in developmental psychopathology suggests that an integration of Grey's motivational theory with polyvagal theory would provide a clearer understanding of the processes underlying both the BIS/BAS system and polyvagal system operation than either theory could provide alone [45]. For example, both fight (appetitive) and flight (avoidant) behaviors are related to sympathetic nervous system disturbances stemming from BAS hypo-activation and BIS hyper-activation [46]. Recent work demonstrates how deficient vagal modulation accounts for how (1) the over-activation of the BIS system produces sympathetic nervous system (SNS) mediated avoidant (flight) behaviors as well as when (2) the under-activation of the BAS system leads to SNS-mediated approach (fight) behavior [47, 48]. Moreover, this work shows that interventions to improve vagal modulation of negative emotion buffers participants at risk for anxiety disorders due to chronically overactive BIS systems as well as those at risk for aggression and sensation seeking due to chronically under-active BAS systems [46–48].

3.4. Yedasentience in Security Regulation: The Open-Ended Nature of Security Goals. Of course, beyond the unique quality of the front-end of security regulation, the back end of security regulation is also unique from other needs. Specifically, one issue that all models of security regulation must address is the unique nature of the test-operate-test-exit (TOTE) sequence (see [49]) associated with goal *attainment*. (All TOTE loops include four phases [49]: (1) the initial test phases (T) involve monitoring discrepancies between the actual state and some reference or standard (i.e., goal). In most systems, the detection of a discrepancy initiates (2) the operate (O) phase to eliminate the discrepancy. In turn, the discrepancy is again (3) tested (T), and if eliminated (i.e., actual state matches reference or standard), the loop is exited (E). For example, in pursuit of the long-term goal to break their career rushing record, the running back would continually monitor the discrepancy between their current and desired rushing yards. The running-back would strive to eliminate any such discrepancies to reach their ultimate goal. Unlike positive or approach goals (e.g., getting the food, mate, grade, or award), the attainment of security to potential threat is "open-ended" such that the environment does not provide a clear external signal of goal completion [50]. In essence, the attainment of security from potential threat is marked by the absence (versus the presence) of something in the external environment. For example, if probing the environment does not reveal signals of a predator, this does not provide a definitive signal that the precautionary behavior has completely removed the risk of potential predation (e.g., there could be predators out of view) [51]. By contrast, the positive goal to find a potential food source would be terminated by the consummation of food (external signal). That is, the consumption of food provides a clear terminating signal from the environment that the goal is attained.

In this way, whereas positive goal systems terminate with clear external consummatory signals, the lack of any clear terminating environmental signals associated with attaining security from potential threat necessitates the incorporation of some *internal* terminating signal. The security motivation system (SMS) advances the concept of yedasentience as exactly that sort of internal terminating signal [6]. Yedasentience is a feeling of security that is internally generated by engagement in precautionary behavior, ranging from environmental probing/checking to hand-washing [51]. Importantly, daily life is filled with examples of what it is like to experience this security signal of yedasentience. For example, just as people experience a sense of being full when they have eaten enough, people experience yedasentience when they have locked their door enough to feel safe from intruders, washed their hands enough to feel safe from germs, or turned off their stove enough to feel safe from fires. Whatever the circumstances, it is an intuitive security signal that one has done *enough* to feel safe from threat. Thus, although introduced as a "feeling of knowing," yedasentience is more than that–it is a feeling of knowing that one is safe.

At the neural level, yedasentience is marked by increased stimulation of serotonin output in the pathways from the brainstem to limbic system that mediate the performance and automatic reinforcement of security regulatory behavior. This hypothesized role of the brainstem is consistent with research strongly implicating it in the production of affect [52, 53]. However, there is a more specific reason to posit its involvement in a satiety-like mechanism for the security motivation system. Glickman and Schiff [54] found that even in the absence of reinforcing stimuli, animals engage in investigatory behavior that is reinforcing in and of itself. For example, they used brain stimulation and lesion studies to demonstrate that the same brainstem system mediated the performance of these species-typical investigatory behaviors and the reinforcing effects of brain stimulation. Moreover, the mediated inhibition of the limbic system by the brainstem occurs via the effect of the brainstem output on serotonergic pathways that exert an anxiolytic, or anxiety-reduction effect. At the psychological level, yedasentience is associated with a reduction in anxiety [6]. (Of course, an important point deserves mention before proceeding. Even though security goal pursuit would require some internal signal like yedasentience to terminate goal pursuit, that does not mean that positive goals *only* involve external consummatory cues. Indeed, secondary reactions such as joy, happiness, or even pride might result from attaining the food source, mate, or job. However, unlike security goals, the attainment of these positive goal pursuits would also have the clear external signal and, thus, would not depend entirely upon the internal signal that is required for security goal attainment. Moreover, the internal signals of happiness, pride, and joy would likely follow rather than co-occur or contribute to the external consummatory signal of goal completion. That is, joy or happiness over acquiring new food, mates, or jobs would likely follow from the external signals associated with the actual acquisition of the food, mate, or job rather than co-occur with or cause the external signals associated with the acquisition of the food, mate, or job).

The SMS model already has been applied to clinical disorders, such as anxiety-related disorders such as obsessive-compulsive disorder (OCD) and generalized anxiety disorder (GAD), as well as depression [6, 36]. Obsessive-compulsive disorder is characterized by symptoms, including recurrent, persistent thoughts (obsessions) and repetitive, ritualistic behaviors (compulsions), both typically connected to the theme of protection of self and others from potential danger. Rather than conceptualizing OCD in terms of a general underlying cognitive disability to achieve closure, the SMS model suggests that OCD results from the breakdown of the specific satiety-like mechanism by which engagement in security-related behavior normally shuts down the security motivation system ([6, 36]; cf. [55]). Consistent with this point, Zald and Kim [55] speculated that OCD stemmed from a deficient "sensory specific satiety" signal experienced as "a failure to feel "satiated" in their safety." Szechtman and Woody [51] suggest that this stopping mechanism is phenomenologically associated with yedasentience.

In particular, the SMS proposes that the hypothesized dysfunction is a blockage in the brainstem-limbic system-mediated feedback loop linking enactment of precautionary, security-related, behavioral programs (e.g., washing hands) to yedasentience (feeling safe) [51]. The result of this blockage is that the performance of security-related behavior fails to inhibit the security motivation and appraisal of potential danger components of the overall security motivation system. Without the internal terminator for these species-typical programs, they continue with abnormal intensity and persistence, yielding the behavioral profile of OCD [56, 57].

Consistent with this point, several studies showed that people both with and without OCD show initial activation of areas, like the hypothalamic-pituitary-adrenal (HPA) axis, associated with the security motivation system in response to uncertain signals of potential danger [6, 58]. However, unlike people without OCD, people with the disorder did not experience the termination of the security system upon precautionary hand-washing and locking behaviors–this was as measured by higher subjective measures of anxiety and vigilance as well as reduced variability in respiratory sinus arrhythmia (RSA) [51, 59, 60]. Thus, the absence of feelings of yedasentience poses a stopping problem in the regulation of security that explains the behavioral profile of OCD. Yedasentience helps to explain both why the system works well in most people (because yedasentience can emerge) as well as why the system fails and produces abnormal patterns of security regulation.

Let us consider how contemporary models of threat processing might benefit from the incorporation of yedasentience. Given the innate nature of the attachment system, yedasentience should arise from the enactment of the species-typical behavioral program associated with that system. As noted earlier, attachment theorists propose that it represents an innate system of behavioral responses enacted to maintain proximity to caregivers. As species-typical security programs, the enactment of proximity-seeking behaviors should evoke yedasentience in the same way as any other species-typical defensive responses (like hand-washing or probing behavior). That is, it seems reasonable to propose that the deactivation of the attachment "alarm" system may involve the experience of yedasentience generated from the enactment of relevant protective behaviors (proximity seeking).

If the world-view and self-esteem systems represent outgrowths of the earlier attachment system as suggested by the tripartite security system and terror management theory [28, 61], it may be that the enactment of these mental or behavioral responses generates the signal of yedasentience that terminates threat responses much like the species-typical defensive response of proximity seeking. Consistent with this point, the RAM model notes that defensive behaviors like compensatory conviction are rewarding and reassuring in their own right as they create a sort of tunnel vision that removes anxiety evoked by threat and allows the person to redirect attention toward the pursuit of long-term approach goals. More important for the present section, though, the RAM model makes a very similar point to the one suggested above regarding the potential parallel between the security-providing effects of compensatory conviction and self-affirmation responses and the more concrete defensive displacement compulsion responses in other species to threat that produce yedasentience [62]. Specifically, these theorists noted:

> *Reactive ideological extremes might be understood as akin to other animals' more concrete displacement compulsions in the face of anxiety (p. 143).*

As this quote nicely illustrates, the most parsimonious approach may be to view more concrete and abstract compulsory defensive reactions across species as serving the same basic function–restore felt security or yedasentience. This line of reasoning would explain why merely affirming one's ideals in an unrelated domain would be reassuring and neutralize anxiety evoked by specific threats to self-worth despite never addressing the source of the original threat. Just like the enactment of hand-washing or probing behaviors or even proximity-seeking are intrinsically reassuring because they produce yedasentience, compensatory ideological conviction or self-affirmations may be intrinsically reassuring even in the absence of external reinforcement because they produce the internal security signal of yedasentience on their own. We shall return in the closing sections to consider several novel lines of inquiry that could flow from the integration of the security motivation system with contemporary models of attachment, self-esteem, and world-view defense.

4. Integrating the Front (Neuroception), Middle (Anxiety-to-Approach), and Back (Yedasentience) Ends of Security Regulation

Although we could view the three unique features independently, we have already seen how they may work interdependently instead. For example, Woody and Szechtman [6] suggest that the offset of the myelinated vagal system corresponds to the onset of the security motivation system in the brain stem. Specifically, these scholars review evidence suggesting that the onset of the security motivation system occurs with the removal of the inhibitory vagal brake. Given that higher (vs. lower) RSA variability is associated with myelinated vagal engagement and spontaneous breathing in safe environments, a reduction in RSA variability provides a reliable index of the removal of the vagal brake and the onset of the security motivation system [6, 39]. Consistent with this point, evidence suggests that the inhibition of the nucleus ambiguus-vagal circuit (see [39]) predicts the reduction in RSA variability and, in turn, increased security-related precautionary behavior [60]. Moreover, in these studies, engagement in precautionary behavior (controlled by the security motivation system) predicted a corresponding increase in RSA variability associated with the engagement of the myelinated vagus in safe environments.

In addition to the established links between the security motivation and polyvagal system, the activation of the security motivation system leads to the subsequent activation of neural regions associated with threat detection that are highlighted in the attachment, RAM, and anxiety-to-approach models of threat management. For example, the regions involved in the activation of the security motivation system would include the ACC and amygdala involved in threat detection via the operation of the avoidant-oriented behavioral inhibition system that precedes the activation of the approach-oriented behavioral activation system [63].

These regions would also be involved in the operation of the HPA axis that modulates precautionary behavior engagement associated with the removal of the vagal brake following security motivation system activation. The release of glucocorticoids (GC) and corticotropin-releasing hormones (CRH) by the HPA in the hippocampus may play a role in the compensatory transition from the behavioral inhibition to the behavioral activation system such that it produces the precautionary behavior engagement that evokes yedasentience which, in turn, offsets the security motivation system and re-engages the myelinated vagal brake [6]. This transition could be measured empirically by a return to higher baseline levels of RSA. Of course, along with the role of neuroception in initiating anxiety and BIS activation, the neural pathways (brain stem-limbic system pathways) associated with yedasentience following engagement in species-typical precautionary behavior (like compensatory endorsement of ideals) provide a potential neural switch that would account for the inhibition of the avoidant system following approach system operation.

The important point is that the various models we have reviewed do not focus on completely independent processes but, instead, overlapping ones in a continuous sequence of security regulation under potential threat. In essence, polyvagal theory and security motivation system account for the onset and offset of security regulation system whereas the social psychological models nicely account for the intervening process (involving avoidant followed by approach-motivated compensatory responses). Indeed, as noted earlier, the RAM model has explicitly connected responses like compensatory conviction to the more concrete compulsive responses displayed by other species and discussed within the security motivation system as producing yedasentience. Thus, by incorporating the insights of models like RAM and anxiety-to-approach, the connection between the front end (polyvagal modulation via neuroception) and the back end (yedasentience and stimulation of serotonergic pathways from brain stem-hippocampus) is fully illuminated. As such, rather than treating these as mutually exclusive, the present model treats these as interdependent and interlocking systems that work in a complementary fashion to regulate threats to security.

4.1. Future Directions. We now consider a few novel lines of future inquiry that would flow from the integration of these features into a unified security-regulation model. For example, future work could test the role of neuroception and polyvagal modulation as providing the anxiety input for world-view defense and self-esteem as well as attachment systems. In particular, using both neural and psychological indices, it should be possible to use structural equation modeling to test predictions regarding the time-dependent relationship we have proposed among these unique processes (neuroception, anxiety-approach, yedasentience).

Building from the security motivation system, RSA may provide a unique empirical index with which to evaluate this prediction. For example, as noted earlier, reductions in heart rate variability have been used to index the removal of the vagal brake to allow sympathetic nerve engagement whereas an increase in heart rate variability has been used to index the re-engagement of the vagal brake on the sympathetic nerve [6]. In this sense, RSA provides a window into the movement from the first component (neuroceptual detection of threat) to the second component (sympathetic nervous system engagement) through to the last component (yedasentience and re-engagement of vagal inhibition of sympathetic nerve). Moreover, greater ACC activation provides an index of greater sympathetic nerve activity whereas left frontal activity provides an index of reduced ACC activity and greater positive emotion [23]. Thus, this pattern of activation should provide an effective window into the transition from neuroception and anxiety-to-approach through to yedasentience.

Using these measures along with measures of anxiety, we predict that the process of security regulation should begin with a reduction in RSA that corresponds to the removal of the vagal brake following neuroceptual threat detection. In turn, the removal of the vagal brake should give rise to heightened ACC activity and the experience of anxiety associated with the sympathetic nerve engagement. Of course, this should also correspond to the onset of the security motivation system which, in turn, should give rise to species-typical defensive behavior, like proximity-seeking. Although hand-washing and proximity seeking would represent species-typical defense behaviors that would evoke yedasentience, we also agree with the RAM model that more abstract compensatory responses like world-view defense or compensatory conviction would operate like more concrete compulsions and, thus, would evoke the same internal signal of yedasentience and, thereby, reduce anxiety and ACC activation by re-engaging the vagal brake. If that is the case, an increase in RSA should follow from the engagement in compensatory conviction to the same extent as washing one's hands or approaching an attachment figure. This also seems consistent with the position of the tripartite security system that the means and goals of the world-view and self-esteem systems would be roughly patterned after the original attachment system. If that is the case, engagement in world-view or self-esteem affirmation should evoke yedasentience and re-engage the vagal brake, giving rise to increased positive emotion and exploration as the social engagement system becomes active again.

Moreover, consistent with the earlier noted work on BIS-mediated anxiety responses and BAS-mediated aggressive responses [47], future work could examine whether exercises designed to increase vagal tone and polyvagal modulation can inhibit world-view defense and/or self-esteem strivings before they arise. Presumably, interventions shown to increase vagal tone should limit the onset of anxiety responses that activate these defense systems in the first place. Of course, it should be noted that the interventions did not rely upon overly sophisticated or expensive equipment to produce these vagal tone improvements. Rather, the interventions use relatively simple and inexpensive exercises, like yoga and meditation (e.g., mindfulness) training, that improve vagal tone by manipulating body posture, breathing, and/or thinking patterns [64].

Whereas incorporating neuroception would explain the overactivation (or under-activation) of attachment, world-view, and/or self-esteem defense systems at the front end of threat responses, the incorporation of yedasentience may explain the conditions under which we are unable to derive feelings of security from these systems at the back end of threat responses. Future work could examine whether the defense of world-views, self-esteem, and attachments typically reduces anxiety even when no clear environmental signals exist (e.g., social validation of one's position) to signal threat resolution. If so, one could then examine whether the inability to generate the internal satiety signal from these defense processes might lead to dysfunctional perseverative expressions of these systems. For example, future work could examine whether people that score higher on attachment anxiety and lower on avoidance suffer from an inability to experience security from proximity seeking.

At a neural level, this would involve a breakdown in the typical brain stem-mediated pathways that stimulate serotonin production upon the performance of species-typical "proximity-seeking" behavior. Even though people low on anxiety should show increased serotonin production and inhibition of dopamine in the hippocampal region following the enactment of proximity seeking, people high in anxiety would show no such elevations even after enacting and re-enacting the same behavior repeatedly. This pattern would suggest that these individuals enact the same attachment-seeking behavior as people low on attachment anxiety but, unlike people low on anxiety, they would need constant reassurance from external attachment figures because they cannot generate their own internal "satiety" in security signal from the mere enactment of these behaviors. Moreover, like the person with OCD who lacks the internal signal of yedasentience, this may actually create further distress [59] because, on the one hand, the person higher on attachment anxiety may know that they are close to their secure base attachment figure objectively speaking but, on the other hand, cannot generate the subjective "feeling of knowing" one is secure that normally comes from attaining that closeness.

In addition, future work could examine the link between yedasentience and unstable, externally derived, self-esteem contingencies, whereby individuals stake their internal self-regard on external signs or markers of worth that may change over time (e.g., getting into the best medical school, getting a job at Boston General Hospital). This work suggests that these individuals are never fully satisfied with the question of their self-worth and engage in excessive self-esteem strivings to attain that external validation in the contingent domain [65]. Given the apparent inability of these individuals to "stop" their own self-esteem strivings, one might ask whether the relentless preoccupation of those with self-esteem contingent on external validation signals may stem from dysfunction of the normal internally generated signal of yedasentience that most people attain by mere enactment of esteem defense and affirmation responses. This would suggest that the problem with contingent self-esteem is not some excessive need to defend self-esteem. Rather, the problem stems from their inability to generate the internal terminating signal of yedasentience normally produced by the mere enactment of self-esteem defense that would be reinforcing (of self-worth) in and of itself in most people. Without the internal signal to "stop" the pursuit of self-validation, they depend upon external signals of worth to continually support their fragile sense of self-worth.

Regarding world-view defense, those high on identity fusion [66] confound the self and group and, in turn, may show exaggerated responses to world-view threats. In many ways, the fusion or confounding of the group and self may arise when the mere engagement in world-view defense does not satisfy security concerns. As an outgrowth of the attachment system, it may be that the subsequent fusion of self and group is an extreme attempt to resolve the subjective sense that the self is not securely bonded to the group. Of course, the degree to which yedasentience plays a role in the proper functioning of these "open-ended" defense systems remains a promising, yet untested, empirical question.

5. Conclusion and Summary of Present Model

Taken together, the foregoing theory and evidence appear consistent with the present case for the three unique features of security regulation. In so doing, it unifies a wide range of diverse processes and phenomena under one regulatory system. That is, rather than exalting one feature over the other, the present analysis situates each within their proper time-dependent sequence of security regulation (from neuroception, to activation of the avoidant-approach system, through to yedasentience).

Data Availability

No underlying data was collected or produced in this study.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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