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Social Allostasis and Social Allostatic Load: A New Model for Research in Social Dynamics, Stress, and Health

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Abstract
Theories such as social baseline theory have argued that social groups serve a regulatory function but have not explored whether this regulatory process carries costs for the group. Allostatic load, the wear and tear on regulatory systems caused by chronic or frequent stress, is marked by diminished stress system flexibility and compromised recovery. We argue that allostatic load may develop within social groups as well and provide a model for how relationship dysfunction operates. Social allostatic load may be characterized by processes such as groups becoming locked into static patterns of interaction and may ultimately lead to up-regulation or down-regulation of a group's set point, or the optimal range of arousal or affect around which the group tends to converge. Many studies of emotional and physiological linkage within groups have reported that highly correlated states of arousal, which may reflect failure to maintain a group-level regulatory baseline, occur in the context of stress, conflict, and relationship distress. Relationship strain may also place greater demands on neurocognitive regulatory processes. Just as allostatic load may be detrimental to individual health, social allostatic load may corrode relationship quality.

Keywords
allostatic load, health, emotion/affect, interpersonal relations, family, intragroup processes, social baseline theory, social cognition, stress contagion

Social relationships present a paradox: For many people, they are both our greatest protection from stress and our greatest source of stress. Research on social support has consistently found that the presence of others can dampen the acute stress and threat response (Christenfeld & Gerin, 2000; Coan et al., 2017), that social support promotes well-being (Chen & Feeley, 2014), that social connectedness decreases risk for disease and all-cause mortality (Steptoe, Shankar, Demokakos & Wardle, 2013), and that loneliness and isolation carry significant health costs (J. T. Cacioppo, Cacioppo, Capitanio, & Cole, 2015). At the same time, social evaluative threat spikes stress response systems (Dickerson & Kemeny, 2004), relationship conflict taxes the body (Robles & Kiecolt-Glaser, 2003), and poor-quality social relationships exert a profound toll on health (Holt-Lunstad, Birmingham, & Jones, 2008). The same relationships can accommodate both supportive and conflictual behavior. How can relationships be so health-promoting and yet health-compromising? This article introduces the notion of *social allostatic load* to extend theory about the functioning of relationships as regulatory systems and to describe how social regulation may induce potential costs.

Social Relationships as Regulators

Traditionally, research on emotion and stress has treated the individual as the unit of analysis. However, new theories and methodological perspectives have challenged this assumption; evidence has been found that emotional and physiological states can be shared or coordinated within groups. For example, phenomena

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such as emotion transmission and emotion contagion have been detected within both large and small groups (Hatfield, Cacioppo, & Rapson, 1993) that include families (Larson & Almeida, 1999; Lunkenheimer, Olson, Hollenstein, Sameroff, & Winter, 2011), workplace organizations (Menges & Kilduff, 2015), large social groups (Goldenberg, Halperin, van Zomeren, & Gross, 2016), and online social networks (Kramer, Guillory, & Hancock, 2014). Likewise, markers of physiological arousal, including products of the sympathetic nervous system and endocrine system, have been found to covary within couples (Timmons, Margolin, & Saxbe, 2015), parent–child dyads (Ostlund, Measelle, Laurent, Conradt, & Ablow, 2017), coworkers (Henning, Armstead, & Ferris, 2009), friends (Goldstein, Field, & Healy, 1989), therapist–client dyads (Marci, Ham, Moran, & Orr, 2007), and even groups of strangers (Silver & Parente, 2004). People appear to attune to those around them, even without conscious awareness that they are doing so (Hatfield et al., 1993). In sum, many social groups show *physiological entanglement*, a term borrowed by Palumbo and colleagues (2017) from quantum physics, in which it refers to particles better understood as an interdependent system rather than individual units.

Many theorists have argued that this entanglement serves a homeostatic purpose: People may regulate their emotions and their physiological arousal more effectively within groups than as individuals. That is, echoing Hofer (1984) and Field (2012), relationships serve as regulators. Hofer observed that both animals and humans in isolation (e.g., rats separated from their mothers and bereaved spouses) showed dysregulated patterns of mood and physiology. Feldman's (2012) model of biobehavioral synchrony suggests that in early childhood, emotional and physiological synchrony with a caregiver serves to scaffold the maturation of regulatory systems and helps to entrain circadian rhythms. Sbarra and Hazan (2008) defined the maintenance of physiological homeostasis within a relationship as *coregulation*, a process that reflects secure attachment.

Social baseline theory (SBT; Beckes & Coan, 2011) suggests that at baseline, the human brain expects the presence of social conspecifics—and that the brain and body tend to operate more efficiently when social conspecifics are in fact available. SBT draws on the principle of economy of action, which states that organisms must take in more energy than they consume. According to SBT, being with others is on average less energetically costly than being alone because groups can distribute the load of responding to the environment (e.g., vigilantly scanning for threats or resources) and cooperate to accomplish shared goals. Within the context of this theory, *baseline* refers to a default state both in terms of behavior and also in terms of brain function (within neuroimaging, the resting baseline refers to the brain's activity when not engaged in a specific task). The word *baseline* also connotes another meaning: that of a setting point around which individuals converge (Gross & Proffitt, 2013; Bar-Kalifa & Rafaeli, 2015).

Humans are adaptive organisms who maintain a stable internal milieu in the face of changing environmental conditions. Allostatic setting points reflect conditions that are optimal for human survival, such as a pleasant temperature range or a level of satiety that lies between hunger and surfeit (Killeen & Reilly, 2001). The theory of relationships as regulators suggests that groups as well as individuals show homeostatic regulation of emotion and behavior; individuals coordinate with each other to maintain an optimal group-level baseline. In terms of affect and arousal, an optimal homeostatic baseline might constitute the calm, neutral-to-positive state that Feldman (2016) described as *low intensity* and noted as essential to the coconstruction of positive emotions and the fortification of biobehavioral ties. For example, an attuned parent might help to soothe a distressed infant, or a sympathetic spouse might calm an agitated partner, helping to bring the dyad's arousal level back to a low intensity baseline. We call this process *social allostasis*, which means stability through change, or the continual adjustment of multiple systems to maintain homeostatic balance.

Social Relationships and Allostatic Load

If relationships serve as regulators, then it is reasonable to ask whether this regulation carries costs. The theory of allostatic load (McEwen, 1998) suggests that sustained stress creates wear and tear on regulatory systems, providing a model for how chronic or repeated stress can accumulate over time to contribute to disease and poor health. McEwen's (1998) theory begins with the reflection that the stress response is not itself inherently damaging but is adaptive, helping to protect the body from threat. For example, during acute stress, innate immunity is up-regulated to protect the body from potential injury (Segerstrom & Miller, 2004). However, chronic or repeated stress can compromise immune functioning and other bodily functions. Allostatic load provides an elegant explanation of why an inherently adaptive process can lead to disease. To borrow the metaphor used by early stress researcher Marius Tausk, firefighters extinguish fire with water—but too much water may damage buildings and decrease water pressure. In other words, water removes the immediate threat of fire, but its overuse compromises the system's efficiency and creates accumulated costs. Likewise, the stress response provides needed homeostatic regulation but creates costs for regulatory systems that may lose flexibility and efficiency over time. As a corollary, if we consider relationships to be adaptive regulatory systems, it follows that they might also lose flexibility and efficiency when their regulatory function is overused, perhaps under conditions of chronic stress or threat or mental or physical illness.

Four pathways to social allostatic load

What conditions might knock relationships out of balance, taxing their regulatory functioning? McEwen (1998) described four pathways to allostatic load. First, *repeated "hits"* from multiple stressors can trigger recurrent deployment of the stress response, as when firefighters need to put out many blazes. Although each hit might be small (as in the case of daily hassles; Lazarus, 1990), the stress system becomes overburdened by continual adjustment. Within a social relationship context, repeated hits might occur in a stressful environment or within a group characterized by recurrent conflict. For example, a couple that bickers frequently, a family with an ill member, a group of students enrolled in a rigorous program of study, or a community experiencing food shortages might all show multiple hits from internal or external stressors that challenge the homeostatic regulation of the group.

Next, allostatic load can occur when organisms show a *lack of adaptation* or habituation to stressors. For example, most people can adjust to a recurring loud noise, but some people become sensitized and react more strongly each time they hear the noise. Given this sensitization, even a mild stressor might trigger a full stress response, as an ember might burst into flame in high winds. A similar lack of adaptation might occur in a social relationship in which conflict or discord escalates quickly, perhaps because group members are overreactive to each other and cannot effectively modulate conflict or negative mood/stress states. Through their research on couples, Levenson and Gottman (1983) developed the term *negative affect reciprocity* to characterize couples who amplify each other's negative emotions and become locked in negative interaction spirals that escalate, rather than defuse, tension. Sensitization can also occur in the wake of trauma: For example, youths exposed to family violence might show heightened stress responses to conflict (Saxbe, Margolin, Spies Shapiro, & Baucom, 2012), as might groups with a legacy of political conflict, such as settlers near the Israeli–Palestinian border.

Third, a prolonged stress response occurs when *recovery and return to baseline is delayed or insufficient*, similar to a fire that is difficult to extinguish. Poor recovery from stress may actually contribute more to long-term health problems than the magnitude of the initial stress response itself (Brosschot, Pieper, & Thayer, 2005). Likewise, within the couples literature, the success of repair attempts following conflict have been identified as an important predictor of relationship outcomes (Gottman, Ryan, Swanson, & Swanson, 2005). Within groups that fail to repair or recover from perturbations such as conflict or disruption, disagreements can go unresolved and grudges can endure, creating conditions of simmering discontent.

Finally, an *inadequate stress response* can demand a compensatory response from other systems. For example, a weak flow of water might require firefighters to use different strategies, such as confining a rapidly spreading burn to one area to protect other structures. Within a relationships context, an inadequate response might occur within a system in which the dyad or group relationship fails to effectively regulate mood or physiology and individuals look outside the relationship for comfort, intimacy, support, and other forms of regulation. Such reliance on other systems may lead to relationship dissolution and deterioration over time. This inadequate response might also occur when individuals within a group show the dampened or blunted responses to stress that have been found in the wake of early or chronic adversity (e.g., Voellmin et al., 2015) and thereby fail to elicit regulatory responses from other group members.

Factors that increase social allostatic load

Social relationships can be perturbed by external challenges such as food scarcity, poverty, social exclusion and stratification, violence, and income inequality. As an example of external challenge, animal researchers have used models of rearing stress such as variable foraging demand (VFD) environments, in which the availability of food is manipulated to create uncertainty, such that food is plentiful on some occasions and scarce on others. Primates reared in these environments show more insecure attachment to their mothers (Andrews & Rosenblum, 1991). In humans, poverty may represent the closest equivalent of VFD, given that it is also characterized by unpredictable resources. Financial hardship has been found to strain relationship quality within families across dozens of studies (Conger, Conger, & Martin, 2010; Conger & Elder, 1994). Stress can affect caregiving relationships across generations; one study found that adults exposed to childhood poverty showed less sensitive responses to infant cry sounds accompanied by differences in neural activation to cry stimuli (Kim, Ho, Evans, Liberzon, & Swain, 2015). Relationship researchers have consistently found that couples with low socioeconomic status are more likely to report dissatisfaction and more likely to divorce (Amato, Booth, Johnson, & Rogers, 2007; Karney & Bradbury, 2005). On a broader scale, high-poverty neighborhoods may also show less community cohesion and integration (James, Schulz, & Van Olphen, 2001).

Besides poverty, other challenges to equilibrium, such as natural disasters, may strain relationships. For example, divorce rates in South Carolina increased in the year following Hurricane Hugo (Cohan & Cole, 2002). The social support deterioration model, which posits that stress compromises social support, has been corroborated by studies of other natural disasters (Norris, Baker, Murphy, & Kaniasty, 2005), posttraumatic stress disorder (King, Taft, King, Hammond, & Stone, 2006), and racial discrimination (Prelow, Mosher, & Bowman, 2006). In all of these studies, increased stress led to decreases in social support and social embeddedness. Research on stress and social support has typically emphasized the stress-buffering role of social support, but these findings complicate this literature, suggesting that stress may actually erode the quality of social support over time.

Social relationships can also be affected by internal challenges, such as illness, psychopathology, or challenging traits such as narcissism or neuroticism. For example, a fussy infant requires more regulatory work (soothing) from parents, which can stress the parent–child relationship. Infants who are more temperamentally prone to distress tend to show more insecure attachment relationships with their parents (Goldsmith & Alansky, 1987). Likewise, an anxious or intrusive parent might heighten his or her child's arousal rather than helping modulate it. A depressed parent might fail to effectively comfort an infant, compromising the infant's recovery from stress. Maternal depression has been consistently linked with less responsive and reciprocal interactions with infants (Lovejoy, Graczyk, O'Hare, & Neuman, 2000). On the other end of the life span, research on Alzheimer's disease has illuminated the corrosive role of caregiver stress on relationship quality (Betts Adams, McClendon, & Smyth, 2008). More broadly, income inequality has been characterized as a stressor endemic to societies, and it has been consistently found that societies characterized by greater socioeconomic stratification show poorer population-level health outcomes, perhaps because of declines in social capital and cohesion (Mackenbach, 2012; Marmot & Bell, 2012; Pickett & Wilkinson, 2015).

In conclusion, whether at the dyadic, group, or societal level, these examples suggest that external and internal stressors—ranging from natural disasters to depression—that increase the regulatory load on relationships may compromise relationship quality and functioning over time.

Types of groups susceptible to social allostatic load

Social allostatic load may vary according to the type of social group being studied. The term *group* has been applied to many social structures and situations, ranging from two people who have some small outcome in common to broad social identity categories with millions of members, such as race or gender identity groups. Our boundary conditions for defining groups come from SBT and the mechanisms it proposes for the social regulation of risk and effort (Beckes & Coan, 2011; Coan, Brown, & Beckes, 2014; Coan & Sbarra, 2015).

SBT argues for two types of mechanisms by which animals use social groups to regulate their own risk and effort. The first mechanism, most broadly employed throughout the animal kingdom, is *risk distribution*. Risk distribution refers to the fact that groups serve to diminish both the amount of risk any one individual takes on and the amount of effort one must expend when engaging with the environment. For example, birds forage in groups to reduce risk and effort despite the increased competition for food from conspecifics. Group foraging limits risk in part because of the distribution of risk to any given individual across the group, as reflected in the old saw that when with a group of friends, one does not need to outrun an aggressive bear, only one's slowest friend. Likewise, risk distribution limits both risk and effort because vigilance for threat can be distributed across the group. More eyes and ears are available to detect threat, so each individual can forage more efficiently (G. Roberts, 1996).

SBT also argues that unlike many other social species, we have evolved to assume that we are "embedded within a relatively predictable social network characterized by familiarity, joint attention, shared goals, and interdependence" (Beckes & Coan, 2011, pp. 976–977). This fact means that humans and speculatively a small number of other highly social species regulate our risk and effort through another mechanism, *load sharing*. Humans often form relationships based on trust and interdependence, which are required for load sharing. It manifests in relationships as helping each other with a variety of life challenges such as child care, work projects, sharing of resources, and aid and comfort when ill, injured, or upset.

We might expect that groups with higher levels of interdependence and load sharing will be more susceptible to social allostatic load; in other words, these processes will likely be more detectable within couples and families than groups of strangers or loosely connected peers. That said, even less closely affiliated groups may experience a form of symbolic interdependence that is produced by shared goals, largely at institutional, national, and cultural levels. Such symbolic interdependence may sometimes lack salience but begin demanding attention because of a triggering event such as a natural disaster, war, or external threat (e.g., Onraet, Dhont, & Van Hiel, 2014). Minority groups may experience such events much more frequently because of discriminatory practices used by majority groups (Kochel, 2019), potentially indicating chronic social allostatic load on identity groups with relatively lower social power. For example, criminal justice system discrimination has led to disproportionately high incarceration rates of young African American men (D. E. Roberts, 2004), which removes key members of social networks and may challenge the homeostatic balance within families, neighborhoods, and communities (Wakefield, Lee, & Wildeman, 2016). Likewise, within military families, recurrent deployments may contribute to social allostatic load and compromise the well-being of children and families (Chandra et al., 2010).

Consequences of Social Allostatic Load

We have conceptualized social relationships as regulatory systems and described how perturbations to these systems may contribute to allostatic load, or the wear and tear that occurs over time when systems repeatedly adapt to challenges. According to this framework, social allostatic load is a relationship-level process. In other words, just as allostatic load damages an organism, social allostatic load damages the relationship.

In individuals who develop allostatic load, stress response systems become less flexible and adaptable, contributing to a vicious cycle that exacerbates the conditions that promote allostatic load (e.g., lack of adaptation and poor recovery from stress). Within relationships, an inflexible system may be characterized by more stereotyped interactions that either escalate quickly (individuals overrespond to each other), show a lack of repair (poor recovery and ability to return to baseline), or are marked by withdrawal and disengagement. The accumulation of allostatic load can also shift the system's homeostatic baseline over time, leading to chronic up-regulation or down-regulation.

Recent research on affective flexibility and rigidity helps to illustrate how decreased flexibility and a chronic shift in baseline can emerge. Hollenstein (2015) explained affective flexibility using a systems approach, applying the logic of complex, open systems to dyads, groups, and intraindividual affective processes. Complex open systems have an infinite amount of possible states, but only a small number of states actually arise. A state refers to any characteristic of the system such as reactivity of the hypothalamic–pituitary–adrenal (HPA) axis in an individual or affective expressions within a group. Over time, states interact reciprocally and repeatedly, which may result in spontaneous coordination of states (Lewis, Lamey, & Douglas, 1999). Certain states, called *attractors*, will dominate the system in frequency and intensity and can ultimately alter the system itself by shifting the overall baseline over time. From a social allostatic load perspective, an overall shift in the system baseline as a result of negative affect or heightened HPA axis reactivity indicates a failure of adaption. An important indicator of system adaptation is its flexibility or rigidity. Flexibility refers to the inhibition of one state and activation of another state within the system, which allows for a fluid interaction between positive and negative feedback loops. When applied to emotion processes, flexibility can refer to the experiencing of emotions and the regulation of emotions, two areas that are frequently considered as discrete constructs rather than interacting states within a larger system. Rigidity, which occurs when there are fewer shifts between states, is more likely to occur when affective states are negative.

Clinical psychologists have long conceptualized group relationships in terms of interdependent systems and devised treatments that aim to increase flexibility and adaptability within these systems. For example, family systems therapy might include mapping of family interconnections and feedback loops in which family members can become stuck in repetitive patterns of interaction (Minuchin, 1985). Likewise, coercive family process theory observes that rigid, coercive cycles of interchange between parents and children can reinforce child behavior problems and teaches parents to reprogram these interactions (Patterson, 1973). Integrative behavioral couples therapy (Jacobson & Christensen, 1996) also notes that dysfunctional processes, such as polarization, in which minor differences between partners become exaggerated over time, can lead couples to become entrenched in set roles (e.g., the demand-withdraw dynamic in which one partner demands change and the other avoids these demands). Just as allostatic load is marked by a loss of flexibility and adaptability, so too are unhappy couples and families characterized by rigid, repetitive patterns; poor ability to repair ruptures; and a diminished behavioral repertoire. The goal of these therapies is to make the system more flexible by releasing individuals from their prescribed roles and encouraging new patterns of interaction. Likewise, intergroup conflict may be characterized by a hardening or polarization of the stances and behaviors held by opposing groups, and strategies to deescalate conflict may focus on relaxing these stances and behaviors. For instance, superordinate goals for which two groups must work together can decrease behavioral rigidity directly by changing the desired outcome during interaction and often lead to improved intergroup relations (Gaertner et al., 2000).

A shifting of the social group's homeostatic baseline

If social allostasis is the balancing and modulation of emotional and physiological arousal around a shared homeostatic baseline, then what would an out-of-balance group look like? As mentioned, Feldman's (2016) low-intensity state might represent an ideal baseline that helps foster biobehavioral synchrony and facilitates attachment between parents and children. In keeping with this, the physiology of pair bonding model (Mercado & Hibel, 2017) suggests that under low-stress conditions, linkage in physiological stress response systems may support pair bonding and promote emotional connectedness, whereas under high-stress conditions, linkage might prevent partners' adaptive recovery. This model is consistent with the concept of social allostatic load because it suggests that the conditions that make homeostatic balancing more demanding (e.g., lack of recovery) are detrimental to relationships over time.

Stress contagion might constitute a form of deviation from the optimal low-intensity state and occur when one group member's emotional or physiological state serves as an attractor, or state toward which a dynamic system tends to evolve, pulling other members away from the group baseline. This situation would manifest as group members showing positively correlated levels of arousal, suggesting mutual up-regulation or down-regulation that might shift the homeostatic setting point over time. From a systems science perspective, this shift would represent a move from a high-utility attractor basin (a neighborhood of states proximal to the attractor) to a lower-utility attractor basin (with *utility* defined in terms of factors that facilitate well-being; Oken, Chamine, & Wakeland, 2015). Many studies of within-group linkage in emotion and physiology have reported that positively correlated levels of sympathetic or endocrine system arousal may indicate relationship distress. We briefly review these findings in the following paragraphs.

Couples. Within adult couples, a review of physiological linkage studies (Timmons et al., 2015) reported that stronger positive correlations in momentary physiological arousal were associated with relationship distress in 13 of 17 studies, including studies measuring heart rate, cortisol, and other physiological indices. Several subsequent studies have also found physiological linkage in negative relationship contexts. For example, stronger positive cortisol linkage in low-income parents was associated with greater intimate partner aggression risk (Saxbe et al., 2015). S. Liu, Gates, and Blandon (2018) also found that couples showed stronger correlations in respiratory sinus arrhythmia when wives reported greater marital conflict. Couples discussing a meaningful interpersonal loss showed more closely correlated heart rates when the partner listening to the loss experience showed less compassionate behavior (Corner et al., 2019). These results suggest that strongly correlated physiology within dyads may reflect *codysregulation*, or a process of stress contagion that may promote social allostatic load.

Parents and children. Parent–child autonomic synchrony has been found to be stronger, across multiple studies, when parents are under greater stress (reviewed by Palumbo et al., 2017). Likewise, stronger cortisol linkage has been found in mother–child dyads with a history of family aggression and intimate partner violence (Hibel, Granger, Blair, Cox, & The Family Life Project Investigators, 2009) and in dyads that include a depressed mother (Laurent, Ablow, & Measelle, 2011; LeMoult, Chen, Foland-Ross, Burley, & Gotlib, 2015). Strong positive mother–child hair cortisol correlations emerged in a particularly high-risk sample (dyads living in the slums of Sao Paulo) compared with low-risk samples that have yielded weaker correlations (C. H. Liu, Fink, Brentani, & Brentani, 2017). One cleverly designed study that randomized mothers to either have a positive or conflictual discussion with their romantic partners (Hibel & Mercado, 2019) found stronger mother–child cortisol synchrony in the conflict condition. Along similar lines, a study that randomized mothers of infants to either a negative or positive evaluation task (Waters, West, & Mendes, 2014) found that mothers' physiological reactivity predicted only infants' subsequent physiological reactivity within the negative evaluation condition. Among primates, one study found that mother-infant pairs exposed to VFD environments showed positively correlated increases in corticotropin-releasing factor, a marker of physiological stress (Coplan et al., 2005). By triggering positively linked stress responses, the VFD environment may have challenged the homeostatic balance of physiological activation within these dyads. Taken together, these studies show that stress may promote codysregulation away from the social baseline. In contrast, negative coordination in parasympathetic activity (such that mothers and infants showed inverse covariation of respiratory sinus arrhythmia) has been noted during recovery from stress (Ostlund et al., 2017). Other work has found that dyadic emotional flexibility when paired with positive affect predicts fewer child behavior problems over time (Lunkenheimer et al., 2011).

In addition to external stressors, parent–child behavior and relationship quality also appear to influence physiological linkage. For example, stronger parent–child HPA axis linkage within parent-preschooler dyads was observed when parents showed less sensitive behavior and the dyad showed less behavioral coordination and reciprocity (Saxbe et al., 2016). Likewise, within parent–child dyads, less mother–child reciprocity was associated with greater linkage in diurnal cortisol (Pratt et al., 2017). However, other studies have found the opposite, finding that more sensitive parents showed greater linkage (Atkinson et al., 2013; Hibel, Granger, Blair, & Finegood, 2015; Sethre-Hofstad, Stansbury, & Rice, 2002; van Bakel & Riksen-Walraven, 2008). Ghafar-Tabrizi (2008) found that for high-conflict dyads, mother–daughter linkage in finger-pulse amplitude was stronger during a conflict discussion. In another study, cortisol linkage between mothers and preschoolers increased when the dyad did a more challenging task (Ruttle, Serbin, Stack, Schwartzman, & Shirtcliff, 2011).

In conclusion, research on parent–child synchrony has consistently detected synchrony and in many cases, heightened synchrony in conditions of risk and stress, but more research is needed to fully elucidate the contextual factors that might influence coordination of emotional and physiological states. These contextual factors include task characteristics (e.g., structured laboratory tasks vs. free play), psychopathology (e.g., maternal depression or child externalizing behavior), and family and relationship risk factors (Davis, West, Bilms, Morelen, & Suveg, 2018).

Other groups. An innovative study randomized stranger dyads to either a mixed-race or same-race condition and found that African Americans became more strongly physiologically linked to European American partners who showed greater stress and anxiety (although the anxiety of African Americans did not transmit to their European American partners; West, Koslov, Page-Gould, Major, & Mendes, 2017). In addition to stranger dyads, emotion contagion and stress contagion processes have also been noted within larger social groups. For example, one workplace study found that coworkers rated their work teams as less productive and effective when they showed greater synchrony in heart rate variation (Henning et al., 2009). Writ large, this “contagion” may lead to problematic outcomes on a grand scale, or societal codysregulation. Psychologists who have studied phenomena such as mass hysteria, mob violence, and the “madness of crowds” have noted that the spread of emotion and physiological arousal within groups may lead to more dangerous, dysregulated behavior (Balaratnasingam & Janca, 2006), perhaps because positive coordination moves the group’s set point upward. For example, episodes of “mass sociogenic illness,” or collective outbreaks of unexplained symptoms, have been noted throughout history (Bartholomew & Wessely, 2002).

Up-regulation or down-regulation of a dyad or group’s homeostatic baseline may not always have a negative connotation. A literature on collective effervescence suggested that joyful rituals, particularly those that involve synchronized rhythms and movements (e.g., dance), may promote community cohesion (Durkheim, 2012). However, relatively few rigorous empirical tests of this theory exist. One study found heart rate synchrony between spectators and walkers at a Spanish fire-walking ritual, but only among spectators who were personally related to the fire walkers (Xygalatas, Konvalinka, Bulbulia, & Roepstorff, 2011). Another study found that marching and moving in synchrony led to greater cooperation (Wiltermuth & Heath, 2009). Anecdotally, laughter has long been regarded as contagious. In other words, more research is needed to determine whether contagion is always maladaptive, up-regulating the system’s baseline outside an optimal zone, or can sometimes engender positive group processes.

Neurocognitive implications of social allostatic load

SBT (Beckes & Coan, 2011; Coan et al., 2014; Coan & Sbarra, 2015) assumes that proximity to high-quality social relationship partners minimizes stress and effort across various contexts, particularly the cognitive effort needed for self-regulation. Neuroimaging studies have found that prefrontal cortex regions that are typically activated when individuals regulate their emotions during threat are less active during social contact with a loved one than when participants are alone, indicating diminished self-regulatory load (Coan, Beckes, & Allen, 2013; Coan et al., 2017; Coan, Schaefer, & Davidson, 2006; Connor et al., 2012; Johnson et al., 2013). This consistent finding informs SBT’s argument that social proximity represents a natural baseline condition for humans.

We conceptualize cognitive effort as a physiological resource that aids in allostasis and is itself regulated similarly to other resources, such as energy. The brain limits effort in a number of contexts, such as making a particular hill seem steeper if carrying a heavy backpack (see Stefanucci, Proffitt, Banton, & Epstein, 2005), and may discourage expenditures of executive effort by making people tire of tasks requiring constant self-regulation (e.g., Baumeister & Vohs, 2007; Blazquez, Botella, & Suero, 2017; Etherton et al., 2018). The prefrontal cortex may lose the competition for energetic resources when demands are high. For example, physical exertion leads to decreases in prefrontal resource use (hypofrontality), accompanied by increased resource use from brain regions required for motor coordination, perception, and autonomic activity (Dietrich & Audiffren, 2011). Likewise, high-intensity threats lead to hypofrontality as resources are diverted to more basic functions (Mobbs et al., 2007).

SBT posits that social proximity decreases the predicted costs of engaging in the environment by limiting risk and distributing effort (Beckes & Coan, 2011; Coan & Sbarra, 2015). Therefore, the brain assumes tasks will be easier if undertaken with reliable partners: High-quality relationships free up cognitive energy by limiting the need for self-regulation. But when internal or external stressors disturb the relationship balance and make social allostasis more challenging, individuals may need to expend more effort on vigilance, problem solving, and resolving ambiguity, increasing the cognitive burden on the relationship.

The degree of coherence or incoherence in cognitive processing between two or more individuals may be a marker of social allostatic load because it reflects the cost of reaching a joint baseline. For example, in a social network analysis of a single graduate cohort, participants who were friends showed greater similarity in their neural responses to videos relative to nonfriends (Parkinson, Kleinbaum, & Wheatley, 2018). Similar findings indicate increased electroencephalogram gamma correlation between interacting partners relative to strangers, increased gamma coherence in both strangers and couples during eye gaze and positive affect (Kinreich, Djalovski, Kraus, Louzoun, & Feldman, 2017), greater similarity in neural response between highly connected mothers and adolescents (Lee, Qu, & Telzer, 2018), and the larger body of evidence that behavioral synchrony is associated with increased affiliation, liking, and emotional satisfaction with the interaction (Cacioppo et al., 2014; Hove & Risen, 2009; Jones & Wirtz, 2007; Miles, Nind, Henderson, & McCrae, 2010). Such findings suggest that greater predictability is associated with increased neural cohesion between group members, possibly enhancing coordination of efforts and cooperative behavior. Cognitive responses to other-threats are more correlated with cognitive responses to self-threat when the other is more familiar (Beckes, Coan, & Hasselmo, 2012), which suggests an implicit assumption of similarity in response from familiar others to one's own response. This result may be due not only to an assumption but also to increasing similarity in perception through shared experience and coordinated behavior. More research needs to focus on situations in which cognitive similarity and difference contribute to or diminish social allostatic load. One can imagine scenarios in which such coherence might be damaging, such as during intragroup conflict. Furthermore, such research will require the use of novel techniques, such as hyperscanning (Schilbach et al., 2013), to simultaneously examine nervous system activity in people during actual interaction.

Future Directions in Studying Social Allostatic Load

Statistical approaches

Advances in methodology have improved the modeling of physiological and emotional coordination within social groups. More sophisticated analyses have examined in-phase and antiphase coordination using time-lagged models, which represents an advance over cross-sectional correlational approaches. Butler's (2011) model of temporal interpersonal emotion systems (TIES) describes emotions in terms of time-bound (e.g., rhythmic or progressive) affective interchange within dyads or groups. Butler described two kinds of TIES models: *between person* models, in which emotion processes in one person interact with similar emotional processes in another person, and *interpersonal state* models that characterize emotions as dynamic emergent states "that generate interdependent emotional observations for two or more people over time" (p. 129). For example, rather than testing whether one person's anger influences another person's anger, an interpersonal state model would measure a dyadic anger state shared by both people that reflects fluctuations in both partners' linked experiences of anger. This latter type of model taps into the notion of social allostasis and can help inform research on relationships as regulatory systems.

Dynamic modeling using state space grids has also been applied to psychological constructs. Operationalization of social allostatic load may best occur via state space grids applied to dyadic and group behavior states (for methods, see Lewis et al., 1999). State space grids can model time-adjacent activity, thus allowing for statistical modeling of transitions and the dyad or group interaction pattern over time and across states. For example, Hollenstein and Lewis (2006) applied state space grid analysis to mother–child dyadic emotional behavior so that flexible mother–child dyads can be compared with rigid mother–child dyads in relation to negative and positive affective experiences. Because flexibility may be a key indicator of social allostatic load, these more process-focused approaches that explore how and when emotion and physiology are transmitted within social groups may complement content- or valence-focused approaches that focus on which emotions and physiological states are communicated.

Implications for other homeostatic systems

Allostasis as a process balances loads across multiple homeostatic systems. We tend to measure it as accumulated stress through peripheral nervous system or endocrine measures of autonomic nervous system arousal and adrenal hormones, but the process also involves neural regulators of those systems and many other homeostatic systems related to energy, fluids, temperature, and sleep. For example, handholding during threat is associated with diminished activity in the hypothalamus, which in turn predicts general self-reported health (Brown, Beckes, Allen, & Coan, 2017). Dysregulation in other homeostatic systems, such as sleep, temperature, and appetite, may show bidirectional associations with social allostasis. This idea is not new: Social zeitgeber theory suggests that routine activities that include social contact (e.g., work, recreation, and shared meals) help to entrain circadian rhythms (Ehlers, Frank, & Kupfer, 1988). For example, the regulation of sleep-wake cycles has been associated with relationship quality (Strawbridge, Shema, & Roberts, 2004): People tend to get better sleep on days with more positive partner interaction, and poorer sleep in men is associated with greater negative partner interactions on the following day (Hasler & Troxel, 2010). Likewise, thermoregulation has been linked to the presence of trusted conspecifics in a variety of species, including humans (IJzerman et al., 2015).

Indeed, IJzerman and colleages (2015; Beckes, IJzerman, & Tops, 2015) argued that social thermoregulation is a critical building block for relationships and acts as a foundation for many social behaviors. Given the potentially critical role of touch in interpersonal relationships, communal thermoregulation may be an important glue for many cliques by helping individuals more quickly converge around an optimal thermal baseline. As humans begin to live in increasingly controlled environments as a result of heating and cooling, changes in the frequency of physical contact might disrupt relational bonds. Likewise, the rise of technological platforms that facilitate social contact may increase social allostatic load and disrupt in-person connection (Sbarra, Briskin, & Slatcher, 2019). Future research can explore how social allostasis affects other homeostatic processes across a number of dimensions, including the regulation of sleep, temperature, and energy, and whether modernizations that disrupt some of these processes have ripple effects on other processes.

Considering multiple levels of analysis

Social allostasis and social allostatic load can be characterized through multiple levels of analysis. For example, social network researchers map the structure of social groups and patterns of transmission between group members (Borgatti, Mehra, Brass, & Labianca, 2009). These group representations can identify the degree of centrality of individual group members (or nodes) and quantify social capital in terms of strong and weak ties between members. Social networks have been used to demonstrate how changes in obesity risk and smoking behavior can spread within large social groups (Christakis & Fowler, 2007, 2008). These approaches may also help to quantify social allostasis by examining the regulation of group-level stress and arousal states, particularly during perturbation by stressful events.

Although social network theory can quantify macro-level social dynamics, mechanistic research is also needed to elucidate the specific psychological and neural processes that underlie social allostasis and social allostatic load. For example, individual differences in interpersonal emotion regulation, or the tendency to use others to regulate one's emotions (Williams, Morelli, Ong, & Zaki, 2018), may be a key indicator of which groups and individuals exhibit social allostasis. Research on the brain that focuses on how homeostatic process and interoceptive processes intersect with social cognition can also shed light on social allostasis and social allostatic load. For example, the neural representation of self and other may be more blurred when others are closer and more familiar (Beckes et al., 2012), and individuals who have engaged in unusually altruistic acts (donating a kidney to a stranger) show greater self–other overlap in the brain when processing pain and threat cues (Brethel-Haurwitz et al., 2018). The extent to which we represent and regulate others' internal states in the brain, especially in cases of threat, stress, and distress, may offer an important clue as to how social allostatic load develops (Esménio et al., 2019).

Conclusion

SBT proposes that the presence of people with whom one shares goals, attention, and trust normatively signals a state of relatively low contextual demand, allowing for the conservation of bioenergetic resources, from the kind of top-down regulatory control found in neural activity to bodily labor and even core body temperature (Beckes & Coan, 2011; IJzerman et al., 2015). This is an inherently regulatory view of how social relationships affect emotional responding and decision making. We have also connected this social-regulatory perspective to the idea of allostatic load—the notion that regulatory systems within the body are subject to wear and tear under conditions of repeated or chronic stress. We propose that a corollary of the social regulatory systems that constitute social relationships is a kind of social allostatic load, in which repeated or chronic stress can cause wear and tear on the social regulatory system that manifests between individuals in dyads or groups. Groups either locked in static patterns of negative interaction, overburdened with chronic stress, or both may experience decrements in the effectiveness of their basal social regulatory functioning, leading to decreases in well-being and health behavior as well as increases in conflict and disease. Our review of the literature suggests that evidence for this phenomenon is already abundant. A variety of studies of physiological linkage conducted over decades, for example, point to high correlations in physiological arousal among group members under conditions of stress and conflict. Ultimately, we propose the idea of social allostatic load as an organizing principle for understanding the impact on social regulatory systems of outside sources of stress, whatever those sources may be. In the past two decades, research on the social regulation of brain, body, and behavior has increased substantially, and we are closer than ever to understanding dyads and groups as emergent regulatory systems. In our view, it is now time to start thinking not only about the internal regulatory functions of those systems but also about the larger context within which those social regulatory systems exist and how that context can either facilitate or harm the fundamentally regulatory functions of social relationships.

Transparency

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