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Rethinking the biopsychosocial model of health: Understanding health as a dynamic system

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Abstract

The biopsychosocial model has dominated research and theory in health psychology. This article expands the biopsychosocial model by applying systems theories proposed by developmental scholars, including Bronfenbrenner's ecological models and Sameroff's transactional model, as well as contemporary philosophical work on dynamic systems. The proposed dynamic biopsychosocial model construes human health as a product of the reciprocal influences of biological, psychological, interpersonal, and macrosystem contextual dynamics that unfold over personal and historical time. The importance, or centrality, of these influences varies within a person over time. The model is explicated using two hypothetical case studies derived from existing interdisciplinary health research. Implications for health, theory, research, and policy are discussed.

1 | RETHINKING THE BIOPSYCHOSOCIAL MODEL OF HEALTH: UNDERSTANDING HEALTH AS A DYNAMIC SYSTEM

Dynamic interpersonal, biological, and psychological systems interact with contextual factors to shape health over the life span. This manuscript integrates theoretical perspectives that promote health understanding and considers the implications of these perspectives for research and policy related to health psychology. We first outline the dynamic biopsychosocial model of health, highlighting its conceptual roots and then present two hypothetical research-based examples that clarify the model's utility for understanding health.

The model shown in Figure 1 and discussed below is an expanded version of the biopsychosocial model. The model integrates existing conceptualizations of the biopsychosocial model (Engel, 1980) with other systems models, especially those proposed by Urie Bronfenbrenner, Arnold Sameroff, and Evan Thompson. The major goals of this paper are to (a) explain the interactive elements of the dynamic biopsychosocial model and (b) use Bronfenbrenner's work to elaborate interpersonal dynamics in social environments and introduce centrality as a factor that modulates influences on health.

2 | COMPONENTS OF A DYNAMIC BIOPSYCHOSOCIAL MODEL OF HEALTH

This model conceptualizes biological, psychological, interpersonal, and contextual effects on health as dynamics. Each dynamic captures a set of interactive forces or systems that affect health. The term *dynamics* is used to emphasize that

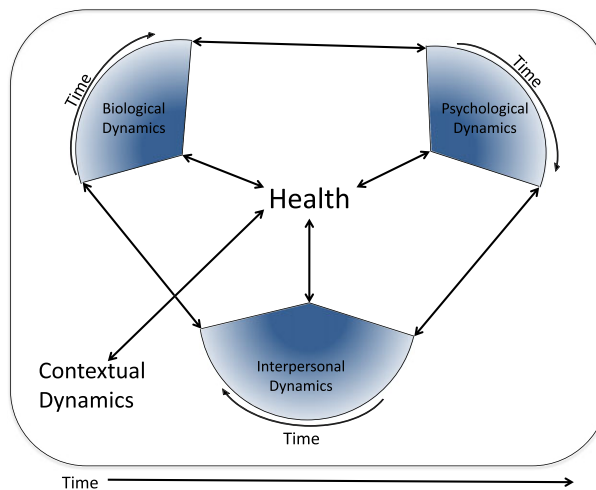


FIGURE 1 The dynamic biopsychosocial model of health. This model expands on the biopsychosocial model by incorporating a dynamic systems perspective and further clarifying social influences by applying Bronfenbrenner's theories of development. Each component of the model includes systems that reciprocally influence other dynamics in the model and also affect health. Social dynamics are divided into interpersonal factors and broader contextual dynamics (e.g., culture). Additionally, all dynamics change over time, and individual systems may ebb and flow in their level of impact on the individual's health (this ebb and flow is termed *centrality* and is represented by the blue shading in each wedge). The darker portions of the wedge include factors that are more central for the individual

these influences on health are not fixed, but rather interact with each other over time. To improve clarity in our discussion of the model's features, the word *factor* is sometimes used in place of dynamic. For an example of how the model functions, imagine an injury causes a shift in the biological dynamic. Much like the movement in a three-armed hanging mobile, an injury not only alters biological immune and muscle systems that respond to and compensate for the injury but also changes interpersonal and psychological dynamics. Interpersonal changes might occur as support and assistance is offered by others, while psychological dynamics require an interpretation of the causes and implications of the injury. As will be further elaborated below, one important way systems vary over time is in *centrality*, or the importance of the concept to a person's health. An injury might temporarily make some biological dynamics and interpersonal dynamics central, while workplace interpersonal dynamics would be less central if the person takes time off from work.

2.1 | Biological dynamics

Biological dynamics capture the physical elements of the body that affect and determine health. For example, the immune and cardiovascular systems are central to the health of the entire body, and neural systems such as the limbic system are important for understanding how psychological and physical domains affect health. Each of these systems in itself is formed by a complex, interconnected set of structures and cells. For example, the immune system not only operates to deter infection and disease but also interacts with other biological dynamics such as the circulatory system and with social and psychological dynamics. For excellent discussions of the integrated biological mechanisms central to health, see Novack et al. (2007) and Schwartz (1982). Recent advances in gene–environment interactions (Belsky et al., 2009; Duncan, Pollastri, & Smoller, 2014), social genomics and epigenetics (Cole, 2013; 2014), and psychoneuroimmunology (Dinan & Cryan, 2016; Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002) have helped to propel scientific understanding of the reciprocal role of biological factors in understanding social and psychological dynamics.

The biological dynamic can be seen in research on the placebo effect, in which inert interventions such as sham surgeries or sugar pill consumption cause shifts in biology. Upon exposure to the placebo, psychological factors such

as expectancies and prior learning about the success of medical interventions produce measurable physiological differences in patterns of neural activity (Ashar, Chang, & Wager, 2017). For example, as clearly explained by Ashar et al. (2017), neural pathways associated with pain detection and those that link pain with negative emotion become relatively less active, while those related to pain control are activated.

2.2 | Psychological dynamics

Psychological dynamics include cognitive, emotional, motivational, attitudinal, and behavioral systems that affect health. Considerable research in health psychology has probed the role of the self, identity, personality, coping strategies, substance use and addiction, stress appraisal, emotions, illness schemas, anxiety and depression, and health behavior in understanding physical and mental health. In fact, in a review of publications in *Health Psychology* (the discipline's flagship journal), Suls and Rothman (2004) noted that over 94% of studies included psychological variables, while other components of the biopsychosocial model were less consistently represented. Although the literature does not consistently organize theory into psychological systems, it seems likely that psychological factors can be understood as systems. The self has been discussed as a self-system (Morf & Horvath, 2010), and topics of behavioral activation and inhibition (Carver & White, 1994), as well as attachment (e.g., Robles & Kane, 2014) are sometimes framed as systems. Multiple interdependent psychological factors act within these domains. Because examples of psychological factors are prevalent in the study of health psychology, we will not further elaborate them here.

2.3 | Interpersonal dynamics

Interpersonal dynamics include the effects of actual or perceived social contacts on health. As elaborated using Bronfenbrenner's (1979, 1986) typology, interpersonal dynamics include direct contacts with others, as well the reverberating consequences of others' actions. For the purposes of this paper, we distinguish interpersonal social contexts from the broader macro-level contextual factors to be discussed later. Suls and Rothman (2004) note that social considerations are more neglected than other domains captured in the biopsychosocial model. Further, health research seems to frequently reduce interpersonal factors to single static measures of constructs, rather than exploring the complexities of interpersonal relationships. For example, interpersonal concepts such as physician communication style, peer pressure, or parenting strategy are complex constructs that change over time with individual health and in response to dyadic and group processes. Static measures neglect the complexity of the embedded social networks in which humans and communities operate. Using the dynamic biopsychosocial model, research testing complex interpersonal relationships might explore how adolescent peer networks and close friendships affect the development of health habits. Such research might consider how close friend involvement in organized athletics, personal perceptions of competence (a psychological factor), and competitiveness among peers interact to determine early adolescent involvement with athletics and subsequent identification with athleticism as a personal attribute (a psychological factor with physical health implications).

Bronfenbrenner's ecological framework can help to clarify the varied interactive interpersonal dynamics that affect health. Figure 2, which draws on Bronfenbrenner's (1979, 1986) classic conceptualization of microsystem, mesosystem, and exosystem factors, outlines the influence of interpersonal dynamics on health.

2.3.1 | Microsystem

The entities with which an individual comes into direct contact form the microsystem. Common health-related microsystem factors include family members, work environments, peers, and community health resources. Research with both adults and children indicates the profound effects of social support, marital, and parenting relationships on health (e.g., Kiecolt-Glaser & Newton, 2001; Reblin & Uchino, 2008; Repetti, Taylor, & Seeman, 2002). As will be evident from the detailed examples that follow, these factors change and cocreate environments over time. The

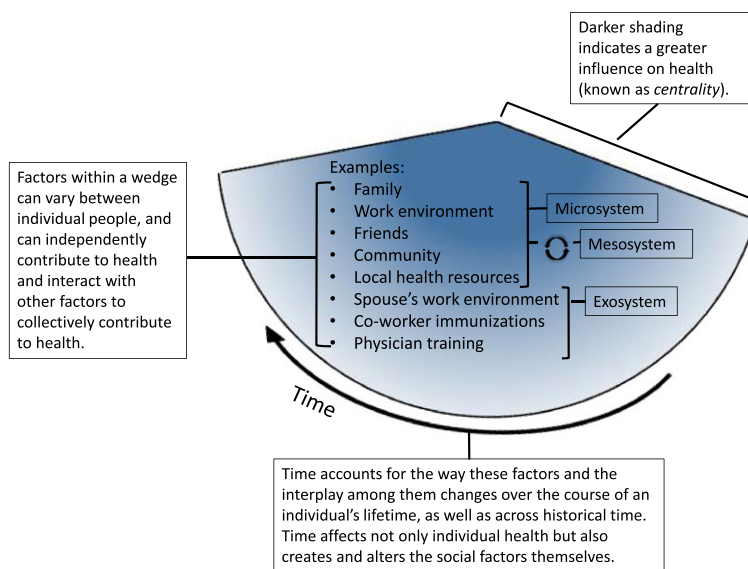


FIGURE 2 A close-up example of the interpersonal dynamic. Bronfenbrenner's classic terminology is applied to the domain of health as a way to further elaborate interpersonal factors in the dynamic biopsychosocial model of health. Each wedge of the model is influenced by factors that may change and mutually affect each other over time

effects of interpersonal environments on health are unlikely to be consistent across the life span. See Löckenhoff and Carstensen (2004) for a discussion of the importance of positive social ties for older adult health.

Health-care and social services also occur in dynamic interpersonal contexts. Prior experiences with physicians, nurses, dentists, and emergency care providers may create expectations for the type of care received at later times (e.g., Averbeck, 2015; Himmelstein & Sanchez, 2016). Recent fatal shootings of unarmed African-American men highlight the importance of community police as a microsystem factor for African-Americans (e.g., Fausset, Pérez-Peña, & Robertson, 2016).

2.3.2 | Mesosystem

Microsystem factors do not exist in isolation. The mesosystem captures interactions among various microsystem entities. For example, multiple family members and social groups may rely on the same community health resources, and medical advice may spread from that setting to others through formal or informal networks. Such interactions among family members and doctors are part of a person's mesosystem. Experiences with stereotypes and discrimination in one health-care context are likely to influence not only later expectations for treatment but also the treatment that others might expect (Averbeck, 2015). Likewise, daily strain in balancing microsystem contexts of work and family may affect emotions, physiology, and work performance, though recent research suggests that supervisor support can help mitigate such effects (Almedia et al., 2016).

2.3.3 | Exosystem

Bronfenbrenner's exosystem captures influences that occur *indirectly* when microsystem entities are affected by dynamics within their own microsystems, and those dynamics affect the target individual. For example, an individual may have little direct contact with their spouses' employment setting, yet that employer may provide health insurance. Likewise, advocates of the biopsychosocial model suggest that physician training should highlight psychosocial factors (Engel, 1977). Physician training, including whether the doctor was trained using a biopsychosocial approach, is an exosystem factor with which an individual comes into indirect contact through the physician. This physician

training exosystem factor will vary between individuals in its importance over time. For example, physician training may have a particularly strong influence on a patient who needs psychosocial support to promote recovery following chemotherapy.

2.4 | Contextual dynamics

We are using the label of *contextual dynamics* in Figure 1 in much the same way that Bronfenbrenner has discussed macrosystem factors. Specifically, contextual dynamics include broad patterns of shared culture, norms, policies, and values. These considerations not only help to shape interpersonal, psychological, and biological factors, but are in turn shaped by them.

Although it is difficult to quantify the precise cause of shifts over time in contextual dynamics, cumulative patterns of social and interpersonal factors likely produce such change. For example, many states have passed laws requiring protections and legalizing same-sex marriage, indicating a contextual shift. Greater individual and public acceptance of same-sex relationships both preceded and followed these legal changes (Herek & McLemore, 2013). Specific legal action is the result of interpersonal advocacy efforts taken by same-sex couples (see *Langbehn v. Jackson Memorial Hospital*, Civil Complaint 08-21813, 2008 for an example). In this way, interpersonal microsystem and mesosystem factors changed the contextual dynamics of legal rights and social norms for same-sex couples.

Countless examples elucidate the importance of contextual dynamics for health. Health-care policy shapes the availability and quality of medical and psychological services at the local level. Broadly held beliefs in the power of individual action and social mobility can help to uphold societal inequity and encourage blaming of people who do not rise to the top of social hierarchies (Glaser, 2005), thereby reducing sensitivity to social and medical needs and deterring policy change. Contextual technological developments alter interpersonal dynamics because relationships are affected by social media and communication technology (Manago, Guan, & Greenfield, 2015).

Contextual dynamics also shape relationships among interpersonal, biological, and psychological factors. For example, although most studies of the physical and psychological health of youth in a North American context suggest that youth who experience homelessness and multiple housing transitions have worse outcomes than children not living in poverty (e.g., Bassuk & Rosenberg, 1990; Medlow, Klineberg, & Steinbeck, 2014), Worthman and Panter-Brick's (2008) research suggests that pattern can be reversed in some cultural contexts. Specifically, Worthman and Panter-Brick compared homeless children in urban Nepal to Nepalese children living with their families in impoverished rural settings. Surprisingly, the urban children fared better than the residentially stable rural children on most indicators of physical health. Worthman and Panter-Brick suggest this pattern occurs because rural families sent their most healthy and resourceful children to urban environments in search of employment, while those who remain in the village tend to be less advantaged. The contrasting relationship between housing stability and child health in the Nepalese and American settings provides an example of the importance of contextual factors in relationships among interpersonal, psychological, and biological dynamics.

2.5 | Centrality and time as modulating factors

Biological, psychological, interpersonal, and contextual dynamics differ in the centrality of their influence on health. We use the term centrality to describe the extent to which a given dynamic is salient or important for a person's health. Figures 1 and 2 use darker shading to represent influences that are more central and therefore have more pronounced implications for health. The concept of centrality aligns with Bronfenbrenner's (1994) characterization of environmental factors that vary in proximity of influence. The centrality of a particular factor will fluctuate over time, with some factors (e.g., family relationships) remaining central throughout life, while others ebb and flow. For example, social dynamics may play a central role in understanding worry and anxiety during adolescence and young adulthood because romantic relationships, careers, and social networks are being formed, but may be less

central for mental health in older adulthood after these relationships have become more positive and stable (Goncalves & Byrne, 2013; Löckenhoff & Carstensen, 2004). Bronfenbrenner also discussed the idea of the chronosystem, which highlights the importance of time, including both historical time and developmental timing. Both conceptualizations of time are illustrated in the theory-based hypothetical examples at the end of this manuscript.

3 | CONCEPTUAL ROOTS OF THE DYNAMIC BIOPSYCHOSOCIAL MODEL OF HEALTH

The concepts described in this paper already exist in theories of health and human development. The original biopsychosocial model shaped not only research and theory on health but also the development of health psychology (Friedman & Adler, 2007). Not surprisingly given its name, the biopsychosocial model highlights the contributions of biological, psychological, and social factors in determining health (Engel, 1980). The model was originally presented in contrast to the biomedical model that dominated medical training and practice and challenged the credibility of psychiatry as a field of medicine (Engel, 1977). Engel's proposal propelled existing practice in psychosomatic medicine, and the biopsychosocial approach promoted the legitimacy of psychological study (Keefe & Blumenthal, 2004). The current dynamic biopsychosocial model builds on Engel's (1980) ideas by expanding on social dynamics, elaborating the interdependence of the model, and highlighting fluctuations in the centrality over time.

Advocacy for the biopsychosocial model in medicine coincided with calls for developmental psychologists to more seriously consider social context. Bronfenbrenner (1979) famously argued that the role of context needed to be more clearly elaborated in developmental research and outlined influences that occur through the embedded systems previously described. In this paper, we explicitly apply Bronfenbrenner's model to study *life span health*. In accord with seminal research by Sameroff (1975), Bronfenbrenner's later work emphasized the importance of considering both developmental timing and the active role of the child (individual) in influencing surrounding environments (Bronfenbrenner, 1995; Tudge, Mokrova, Hatfield, & Karnik, 2009). Bronfenbrenner's work builds on Sameroff's (1975, 2005) transactional model, which suggests that a child's own characteristics affect the surrounding environment, and that development occurs through continuous, mutually reciprocal transactions between the child and the environment. These transactions alter both the developing child and the surrounding environment over time.

Advances in both developmental and health psychology align with philosophical explications of open systems. In his work *Mind in Life* (2007), Thompson translated recent philosophical developments into a framework relevant to psychological science, with an emphasis on biological, neural, and cognitive system dynamics. Specifically, he argues that humans operate through sets of interactive, dynamic systems that reciprocally influence and recreate each other over time, suggesting that these dynamics are perhaps best conceptualized as conversations that unfold over time. Readers interested in this rich conceptualization of the interplay of biological and psychological dynamics should read his 2007 book.

Applying some of Thompson's logic to a health-related example, physical pain might unfold over an hour or a lifetime. A painful sensation is interpreted using an existing cognitive framework, which itself has been shaped by cultural and family dynamics (France et al., 2016; O'Neill, Pillai Riddell, Garfield, & Greenberg, 2016). That experience, in turn likely alters both physiological sensitivity to pain and subsequent expectations. Many experiences might operate in this way, with interpersonal experiences affecting psychological processes, which in turn affect neural activation and physiological symptoms.

Thompson (2007) notes that some dynamic systems are particularly intertwined. He applied these concepts to systems ranging from cellular activity to neural activity and gene expression. These ideas echo much earlier work by social psychologist Kurt Lewin (1939) who discussed the interdependence of coupled social networks and the

processes by which the self and environment are cocreated over time. Likewise, Schwartz (1982) eloquently applied dynamic systems logic to health. Together, these ideas resonate with sentiments that have been expressed by many. Naturalist John Muir (1911) suggested that “when we try to pick out anything by itself, we find it hitched to everything else in the universe.” (p. 211).

These theoretical considerations and the dynamic biopsychosocial model itself might best be illustrated by the two examples that follow. Please note that the following examples were derived from research on factors that affect health. Although for ease of discussion, the individuals are given names, they are not real people. Because family and socioeconomic dynamics affect health, our first example follows a young male who is affected by prenatal and early life biological, psychological, interpersonal, and contextual dynamics. The second example was chosen to illustrate the unique health challenges in rural settings and highlights the role of culture in the health dynamics of a hypothetical Alaska Native woman.

4 | BRANDON'S EXAMPLE

The following example describes Brandon, a White male growing up in an urban area in the United States (see Figure 3). We follow Brandon from the prenatal period through young adulthood.

Brandon was born into a middle-class family. His nuclear family includes his mother and father, who were both in their early 30s when Brandon was born, an older brother, and an older sister. Brandon's mother completed some college before dropping out and marrying Brandon's father. She worked as a secretary in a law firm prior to her first child, but since giving birth to Brandon's brother, has stayed at home to care for her children. Brandon's father completed a bachelor's degree and works as a public accountant. Although Brandon's parents do not argue frequently, their marriage lacks emotional intimacy, and they feel unsatisfied in their relationship.

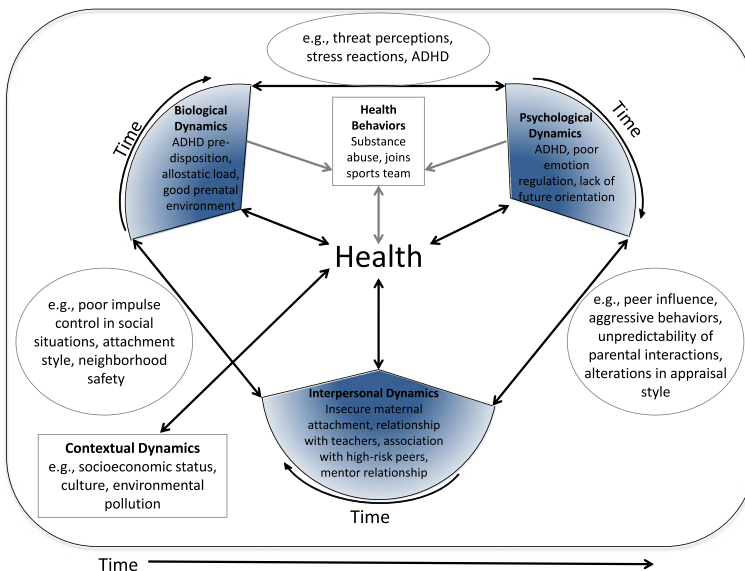


FIGURE 3 An example of the dynamics for Brandon, a young middle-class male. Brandon's biological, psychological, and interpersonal dynamics all occur within contextual dynamics and are centrally influenced by his socioeconomic status and his community culture. The blue circles highlight some ways in which the dynamics interact with one another. Together, they create his overall health and also influence his health behaviors (see the blue “Health Behaviors” box). Individual dynamics fluctuate over time from Brandon's prenatal period through his young adulthood. ADHD = attention deficit hyperactivity disorder

Brandon's prenatal environment was ideal. Brandon's mother received prenatal care, took prenatal vitamins, ate well, and abstained from smoking and alcohol. However, she has a genetic predisposition to attention deficit hyperactivity disorder (ADHD), which she passed on to Brandon (Rowland, Lesesne, & Abramowitz, 2002).

Upon returning from the hospital, Brandon's mother had difficulty caring for all three children. She did not find motherhood particularly fulfilling and struggled to find the energy to meet parenting demands, especially because Brandon was highly irritable, reactive, and easily frustrated (Kagan & Snidman, 1991). Brandon's temperament made it difficult for her to emotionally engage with Brandon, to understand and respond to Brandon's needs, and to foster a secure infant–mother attachment (Finzi-Dottan, Manor, & Tyano, 2006). These challenges contributed to the development of postpartum depression (Cutrona & Troutman, 1986). As is typical of infants, Brandon's mother was the central interpersonal influence on his life. Therefore, her postpartum depression and lack of responsiveness toward Brandon, coupled with his inhibited temperament, resulted in an ambivalent/anxious attachment style (Martins & Gaffan, 2000; Sroufe, 2005). The combination of temperament and attachment increases Brandon's health risk. Anxious attachment and emotional reactivity have been linked to decreased psychological and physiological health, as a result of an increased vulnerability to stress, reduced likelihood to seek help, and poor emotional regulation (Calkins, Dedmon, Gill, Lomax, & Johnson, 2002; Maunder & Hunter, 2001).

The chronic lack of emotional connection between Brandon's parents is a mesosystem factor that also affects Brandon's physiology throughout development. Within married couples, low marital satisfaction is linked to less sympathetic arousal in both spouses (Gottman & Katz, 1989). The resulting underarousal is theorized to negatively affect parenting styles (e.g., behaving coldly toward children or being generally unresponsive toward children). Although Brandon's parents love him, his mother struggles with Brandon's poor emotional regulation and tends to withdraw from Brandon, while his father maintains an authoritarian parenting style that has both behavioral and biological effects on Brandon (Gottman & Katz, 1989). Behaviorally, Brandon is often angry and noncompliant and lacks social competence. Biologically, Brandon experiences chronic elevations in stress-related hormones such as cortisol and poorer overall health.

As Brandon moves into toddlerhood, the interpersonal dynamics with his parents remain heavily influential. The lack of parental warmth affects his psychological emotional regulation system, leading to outbursts of irritability and frustration. In part due to Brandon's mother's inability to cope with Brandon's emotionality, she returns to work. Brandon's microsystem expands now that he and his siblings attend daycare every weekday. Although Brandon is still heavily focused on his mother, his regular caregivers also become central to his interpersonal dynamics.

Brandon continues to attend daycare until he begins school. Each day after school, Brandon and his siblings are alone until Brandon's parents return home from work. Although Brandon's family is middle class, due to an expensive housing market, they live in a low-income neighborhood. As is typical in many disadvantaged neighborhoods, Brandon's neighborhood exposes him to toxins such as lead and secondhand smoke (Evans, 2004). Additionally, residents of disadvantaged neighborhoods tend to have fewer social connections, and children tend to interact more frequently with aggressive peers (Evans, 2004). Therefore, Brandon spends much of his day at school interacting with his teacher, who shows sensitivity and emotional warmth toward Brandon. She becomes a central interpersonal influence on Brandon, and he becomes overly dependent on her (Sroufe, 2005).

Brandon's microsystem factors of neighborhood and home environment, in combination with his genetic and emotional environment, result in Brandon developing a moderately high allostatic load. Allostatic load indicates the cumulative effects of the body's physiological attempts to maintain overall homeostasis of systems. Higher allostatic load results from chronic activation of the stress response system, which can reduce synaptic plasticity, inhibit neurogenesis, and damage dendritic processes (Sapolsky, 2007). As a result of a moderately high allostatic load, Brandon becomes more susceptible to infectious disease and chronic inflammation that sets the stage for later cardiovascular disease.

As Brandon continues through childhood, he struggles interpersonally and psychologically. In second grade, Brandon's teacher notices Brandon is exhibiting symptoms of ADHD. Brandon struggles during class to sit still and

stay on task and also distracts other students (Moon, 2016). As is typical in the U.S. culture (a macrosystem factor), Brandon's teacher frequently sends him to the principal's office for poor behavior.

Brandon's parents struggle to cope with Brandon's impulsive and emotionally reactive temperament, but are unaware that ADHD could be the source of these symptoms. Like other children with ADHD, Brandon continues to have an insecure attachment style with his parents, and Brandon's father tends to exert a lot of dominance and power in an effort to control Brandon's behavior (Finzi-Dottan et al., 2006). When Brandon's teacher approaches Brandon's parents about these symptoms, they deny that these problems are a result of ADHD. Rather, Brandon's father believes that Brandon's misbehavior stems from inconsistent discipline and structure at home, difficulties influenced by the mesosystem dynamics of his parents' interactions. Therefore, despite Brandon's symptoms, his ADHD goes undiagnosed and untreated, and Brandon does not receive the support he needs to succeed academically (Martin, 2014). His repeated class failures and frequent visits to the principal's office create tension at home, and Brandon begins to internalize these failures and to believe he is unintelligent. As a result, he puts less effort into his work at school (Dweck, 2000).

Socially, as Brandon ages into middle school, he finds it difficult to make friends. Brandon lacks skills that are key to social competence in children, including behavior control and emotional regulation (Eisenberg, Fabes, Guthrie, & Reiser, 2000). At this point in Brandon's life, although he struggles to connect with peers and to succeed in school, his microsystem focus broadens from his parents and siblings to also include academic and social success.

As Brandon transitions into adolescence, the lack of sensitivity on the part of Brandon's parents as well as his genetic and environmental risk factors continue to perpetuate his high allostatic load (Evans, Kim, Ting, Tesher, & Shannis, 2007). The chronic stress he experiences has begun to affect his tissue structure and function, a consequence that has been linked with accelerated aging and its pathologies (Chen & Miller, 2012). Additionally, Brandon develops a tendency to perceive stressors as threatening, which leads to increased cortisol and increased sympathetic nervous system activity (Yeager, Lee, & Jamieson, 2016). These perceptions cause Brandon to become hostile, angry, and occasionally aggressive. When Brandon's father receives a promotion at work that requires longer hours and frequent travel, Brandon's exosystem shifts, and his mother becomes the sole caregiver at home. Her neglectful parenting style results in even less supervision, and his hostility, anger, and aggression go unaddressed.

At this point, Brandon becomes friends with adolescents who are involved in risky and criminal behaviors. His microsystem focus shifts from being primarily reliant on his parents to primarily reliant on his friends, a common occurrence in insecurely attached youth (Freeman & Brown, 2001). Brandon's ADHD combined with a lack of supervision and poor relationship with his parents increase his delinquent activities and substance abuse (Becoña et al., 2012; Repetti et al., 2002; Walther et al., 2012; Wills & Yaeger, 2003).

As an outlet for his anger and frustration, Brandon joins a football team at school. One of his coaches notices how troubled Brandon is and takes an interest in mentoring him. Brandon's coach encourages him to recognize his abilities both on and off the field and challenges Brandon to change and grow. The support Brandon's coach provides promotes outcomes such as improved coping both psychologically and physiologically, as well as improved resilience (Yeager & Dweck, 2012; Yeager et al., 2016). Brandon's coach also refers him to a no-cost local therapist to help Brandon cope with his ADHD. As Brandon internalizes these coping strategies, he makes friends with other adolescents on his football team and shifts away from the friends who were engaging in risky and delinquent behaviors. Additionally, although peers are still important to Brandon, he begins to focus more on school. As a result of this shift toward school and in conjunction with academic interventions Brandon's coach advocates for (e.g., tutoring and separate test-taking areas), Brandon's grades improve. Furthermore, Brandon's biological factors begin to improve over time as well; there is a decrease in his cortisol, inflammation, and cardiovascular reactivity. As Brandon's stress levels decrease, his allostatic load is also reduced.

As Brandon transitions into adulthood, he maintains the style of thinking that resulted from his time on the football team. His increased self-efficacy allows him to attend community college with a goal of transitioning to a university. Brandon's microsystem focus shifts from predominately peers to school. Additionally, he begins thinking about his future job and financial security and continues to make positive health choices.

5 | EVETTE'S EXAMPLE

The following example describes Evette, an Alaska Native woman living in rural Alaska (see Figure 4). We follow Evette from mid-adult to late-adult life. Evette lives in a small, geographically isolated, predominantly Alaska Native community accessible only by plane, boat, or snowmobile. Evette shares a home with her son, younger brother, and mother. Like many other rural Alaskan communities, hers is burdened with high suicide rates, substance and alcohol abuse, assault, domestic sexual violence, and mental health problems (Alaska Department of Health and Social Services, 2010; Federal Bureau of Investigation, 2014; Indian Health Service, 2016).

Evette is no stranger to the burdens of her community. As a teenager, Evette experienced sexual abuse, which has influenced her alcohol abuse (Clark & Foy, 2000), lifelong struggle with depression, and obesity (Penza, Heim, & Nemeroff, 2003; Williamson, Thompson, Anda, Dietz, & Felitti, 2002). During young adulthood, Evette's central microsystem factor was an unhealthy relationship with her boyfriend who abused alcohol and discouraged her efforts toward sobriety. However, after becoming pregnant, Evette left her boyfriend and gave up drinking.

During her pregnancy, members of Evette's community reached out and connected her with financial and maternal health resources. Since then, she has relied on her spirituality, culture, and community for emotional support and sobriety maintenance (Hazel & Mohatt, 2001; Mohatt et al., 2004). When Evette's microsystem expanded to include her newborn, these positive interpersonal relationships and sobriety were central dynamics benefiting Evette's health as she cared for her newborn. The support from her community reduced her postpartum stress and facilitated a secure attachment with her son (Jacobson & Frye, 1991).

In spite of these protective factors, Evette is still a single, working mom who is the primary caregiver for both her newborn and her mother. Her family experiences diseases common among Alaska Native populations (Indian Health Service, 2016; Mensah, Mokdad, Ford, Greenlund, & Croft, 2005). Her brother is diabetic, and her mother has heart

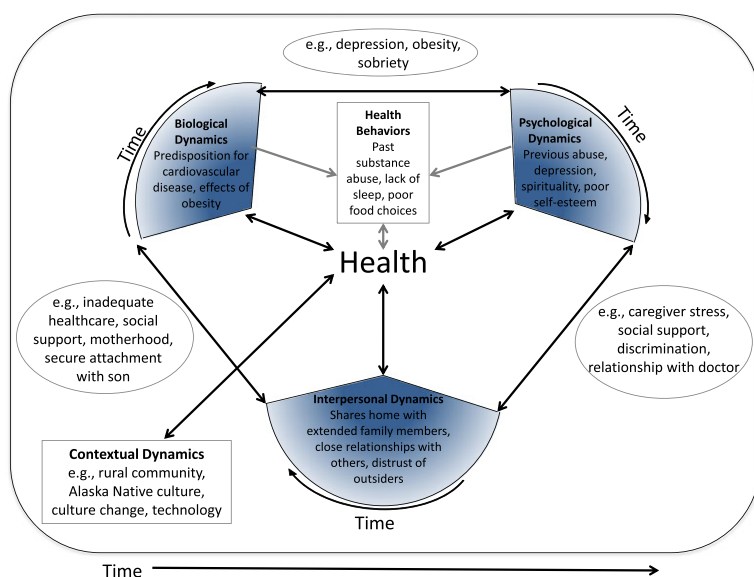


FIGURE 4 An example of the dynamics for Evette, an Alaska Native mother living in rural Alaska. Evette's biological, psychological, and interpersonal dynamics all occur within contextual dynamics and are heavily influenced by her geographic location and culture. Each blue circle highlights some ways in which the dynamics interact with one another. Together, these dynamics create her overall health and influence her health behaviors (see the blue "Health Behaviors" box). These dynamics change over time from Evette's young adulthood through old age

disease. These microsystem family demands promote Evette's chronic stress, reducing her physical functioning and worsening her depression (Marin et al., 2011).

The developmental timing of Evette's abuse and its interaction with her caregiving responsibilities is a central dynamic for her health. The abuse Evette suffered when she was younger strengthens the negative biological consequences of her caregiving stress and leaves her more susceptible to depression (Kiecolt-Glaser et al., 2011). This childhood adversity predicts health risks such as shorter telomere length (Tyrka et al., 2010), myocardial infarction, diabetes, and stroke (D'Mello et al., 2015). Her high biological risk and current interpersonal demands make it difficult to find time to eat healthfully, sleep, or exercise, exacerbating her struggles with depression and obesity.

As Evette's son starts school, microsystem dynamics such as her community relationships, and the macrosystem protections offered by her cultural identity and spirituality, remain central to her health. The support she receives from her social circle helps alleviate some of her stress and health symptoms, a pattern that is especially pronounced in collectivist cultures that value positive and warm social relationships (Shavitt et al., 2016). Her community embodies these characteristics. Evette's friends care for her son while she works and cook meals for her family. These supports help reduce Evette's depression.

When Evette's son is a preteen, their community is introduced to telemedicine. Telemedicine allows community members to avoid expensive travel by using their phones and internet to contact doctors and specialists. Telemedicine holds promise for improving health care in rural communities (Nesbitt, Marcin, Daschbach, & Cole, 2005). Evette personally benefits from telemedicine in part because it provides greater anonymity; her community's only doctor is a White male with whom she feels uncomfortable disclosing information. Like other minority patients, the community doctor rarely includes Evette in decisions related to her health care (Ferguson & Candib, 2002), and therefore, Evette feels that she lacks basic health knowledge (Kutner, Greenburg, Jin, & Paulsen, 2006). Due to this, she avoids seeking medical help and never received proper treatment for her depression and obesity.

Mesosystem dynamics influence Evette's health as well. One time, she saw her community doctor as she was entering an Alcoholics Anonymous meeting and, after that, was even more hesitant to disclose personal information to him. Evette worried that he would mistakenly attribute her health problems to an alcoholic relapse, an error that can occur in health-care delivery anywhere (Croskerry, 2003). Physicians in small communities are also concerned about patient confidentiality and fear that patients may conceal information to avoid stigmatization, as doctors have both professional and personal community relationships (Warner et al., 2005). Evette's inability to communicate openly with her doctor was a central health influence prior to the implementation of telemedicine, when she could not confidentially access health resources.

Another macrosystem dynamic that affects Evette is the distrust of outside agencies due to a complicated and painful relationship with outsiders. Historical timing contributing to this distrust includes trauma from colonization and loss of culture and native language (for discussion of historical trauma and health, see Sotero, 2006). Although Evette lives in a community where people are closely interconnected, some intergenerational tension exists. Many older people in the community, Evette included, prioritize the conservation of their culture. Many younger community members do not view the historical context as central to current community and social health (Wexler, 2014). This tension is reflected in Evette's interactions with her son, who does not embrace the cultural traditions endorsed by the community elders and is not motivated to learn the native language. The combination of her son's negativity about their culture and a recent influx of outsiders coming to the community has promoted ambivalence in Evette's cultural and ethnic identity. Without her strong cultural identity as a buffer, Evette becomes depressed again (Walters & Simoni, 2002).

After Evette's son graduates high school, he leaves the community and gets a job in the Midwest. Around the same time, her younger brother gets married and moves out of the home. Evette now shifts her focus onto caring for her aging mother. Eventually, her mother passes away, and Evette's depression takes over. Luckily, her friends notice her increasingly unhealthy behaviors and withdrawal and contact her son. Evette joins him so that he can help meet her physical and emotional needs.

6 | IMPLICATIONS AND CONCLUSIONS

The preceding examples were designed to highlight the utility of the dynamic biopsychosocial model for organizing the complexities of health dynamics and behavior and for highlighting gaps in health research, practice, and policy. Brandon's example highlights potential benefits of mentorship for youth (Chen & Miller, 2012, for examples with low-income youth). Although many mentorship programs have lost financial support because of inconsistent program evaluations of their success, in 2015, the Department of Justice allotted 90 million dollars to support mentorship programs (Fernandes-Alcantara, 2015). Research using a dynamic biopsychosocial perspective can both help to isolate the ideal timing and format for mentoring interventions and to advocate for these programs.

Evette's example clarifies the utility of the proposed model for considering how historical trauma, cultural, and community dynamics can affect health. Although the Indian Health Service provides services to American Indians and Alaska Natives who are members of federally recognized tribes, not all Alaska Natives are members of federally recognized tribes, and many rural areas lack health-care access. The implementation of the Affordable Care Act (Patient Protection and Affordable Care Act, 2010) in Alaska has been a controversial process (Cunningham, 2016). The recent expansion of Medicaid in Alaska will contribute financial resources to the Indian Health System (Trahant, 2015), providing a step toward reducing health disparities. As financial support is allocated for Alaska Native health care, the dynamic biopsychosocial model should be used to promote culturally competent interventions and ensure effective health-care delivery.

As seen in both examples, social support can be a central interpersonal dynamic for health. Brandon's mother likely could have benefited from social support postpartum to facilitate bonding with her newborn and improve her mental health (Cutrona & Troutman, 1986; Negron, Martin, Almog, Balbierz, & Howell, 2013). Evette's ability to maintain sobriety stemmed from her community social support (Hazel & Mohatt, 2001; Mohatt et al., 2004). Physicians and other health-care providers need to consider these interpersonal dynamics in community health and well-being. For example, physicians may consider promoting culturally appropriate community interventions to reduce social isolation among single parents or older adults, or to identify and support those at greatest risk for addiction. Likewise, the doctor–patient relationship is of particular concern in rural areas and for minority patients (as seen in the relationship between Evette and her physician). Even if health services are available, utilization may be inconsistent if trust and confidentiality cannot be assured. Training for medical providers should address these interpersonal and contextual dynamics.

This paper has applied emerging philosophical and developmental approaches to propose the dynamic biopsychosocial model of health. Bronfenbrenner (1986) reviewed developmental research that investigated factors operating at the microsystem, mesosystem, exosystem, and macrosystem levels. Similar research should be conducted using the dynamic biopsychosocial model to evaluate the extent to which current research on health considers variations in interpersonal dynamics, centrality, and timing in proposing and testing biopsychosocial explanations for health. Methodological tools such as social network analysis, multilevel modeling, and emerging structural equation modeling approaches that capture dynamic systems (e.g., Ferrer & Gonzales, 2014) can help to push research, theory, practice, and policy in a direction that more completely captures lived experiences.

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