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The ontogeny of chronic distress: emotion dysregulation across the life span and its implications for psychological and physical health

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Development is characterized by continuity and change across the lifespan. This is especially true of emotions and emotion regulation strategies, which become increasingly complex and variegated over development. Recently, researchers have begun to characterize severe emotion dysregulation (ED) across the life span. In particular, there is increasing data delineating mechanisms by which emotional distress leads to poor health, early mortality, and intergenerational transmission of psychopathology. In this review, we present converging evidence that many physical and psychological problems have identifiable and treatable origins in childhood ED. When the literature is examined from an ontogenic process perspective it becomes clear that many phenotypically distinct forms of mental and physical distress emerge from the same underlying emotional processes expressed differently across development.

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Introduction

Ontogenesis is the characterization of an organism or a behavioral/anatomical feature from early development through maturity [1]. In medicine the study of ontogenic processes is common. For example, researchers studying cardiovascular disease have found that higher sympathetically mediated tachycardia during adolescence can mark a nascent stage of a disease that emerges decades later [2]. Only recently have researchers begun to take a similar approach to understanding psychological problems, such as emotion dysregulation (ED), across the life span. The ontogenic model outlined by Beauchaine and McNulty [3••] encourages the examination of psychopathology from a multiple-levels-of-analysis perspective across development. This reveals processes by which early, biologically-based trait vulnerabilities interact with complex contextual factors, heightening risk for multiple conditions. From this perspective, many diagnoses that are perceived as distinct can be demonstrated to have common origins and, therefore, to co-occur at higher-than-expected rates at single time-points and over the life span.

The *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5 [4]) is the predominant tool for cataloging and diagnosing mental disorders. Diagnoses are listed as discrete entities, in spite of a wealth of research questioning the categorical system [5]. This obscures etiological commonalities across conditions, with implications for research and treatment. In particular, this approach artificially increases homotypic comorbidity (i.e., co-occurrence of more than one internalizing or externalizing disorder within a person [6]) and heterotypic continuity (i.e., emergence of presumably different disorders across development [7]). However, comorbidity is better understood by examining a small number of trait vulnerabilities ontogenically rather than studying each phenotypically distinct disorder separately.

Researchers in psychology and medicine have each examined shared etiologies across comorbid conditions within their respective disciplines. However, there have been few attempts to articulate an integrated life span model of co-occurring psychological *and* physical distress. For example, many scholars disregard early emotional origins of non-genetic obesity, addiction, cardiovascular disease, and personality disorder, in spite of evidence that these conditions have many common features. Indeed, these diagnoses appear quite different from one another and from temperamental difficulties in infancy or behavior problems in childhood. However, there is increasing evidence that ED is a core feature of these seemingly distinct forms of distress.

Subjective distress is the most common criterion in the DSM followed closely by impulsivity [8]. *Distress* is extreme unhappiness, pain, or fatigue and the word has physical and emotional implications. Among those with severe psychopathology, distress is an enduring psychological state punctuated by painful moments of crisis [9,10]. This raises questions regarding how chronic physical and emotional distress emerge, from the earliest stage of embryonic development through death. To what

extent should hundreds of psychiatric diagnoses be conceptualized and treated as distinct versus developmentally-driven manifestations of the same underlying vulnerability? Many scholars believe that ED is the predominant thread connecting early life experiences to later morbidity, mortality, and intergenerational transmission of psychopathology [11–13]. The specific manifestations of this thread are shaped into distinct diagnoses via complex interdependent contextual risks, producing a tapestry of emotional and physical conditions. We assert that ED underlies many forms of chronic distress (e.g., from early behavioral dysregulation to later cardiovascular disease). Thus, when chronic distress is studied ontogenically it is possible to observe relations across psychiatric and medical diagnoses that have previously been studied by different scholars across distinct scientific disciplines.

ED, psychopathology, and health

Clinically significant ED is typically viewed as a problem that emerges in childhood, potentiates psychopathology by adolescence, and worsens in adulthood [14–16]. It can be defined as the absence of: first, understanding and awareness of emotions; second, acceptance of emotions; third, the ability to control impulsive behavior when upset; and fourth, the ability to apply regulation strategies to meet goals and demands [17]. The links between ED and psychopathology are robust. It is a core feature of internalizing disorders, including depression and anxiety [13,18], panic disorder symptoms [19], suicidal ideation [20], suicidal and non-suicidal self-injury [21,22], and borderline personality disorder [16]. In addition, ED predicts prospective increases in internalizing disorders, rather than vice versa [23]. Research on borderline pathology and self-injury has focused extensively on ED, which is a key etiological factor in the emergence and maintenance of self-harming behaviors [24,25]. Indeed, there is evidence that a predominant function of self-injury is to provide relief for emotional distress [26].

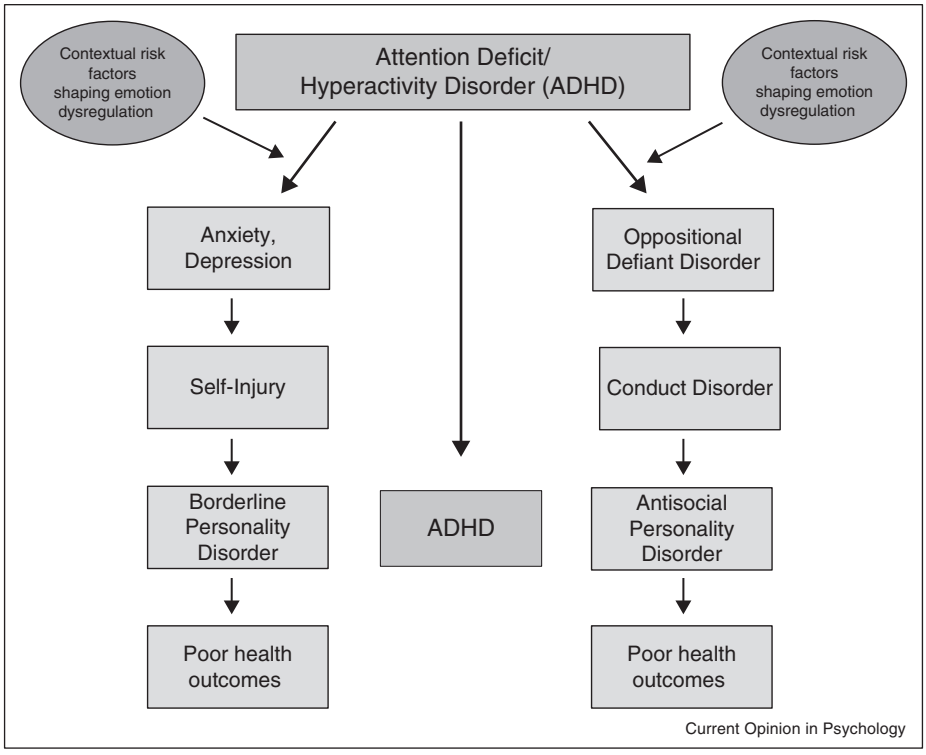
ED, especially emotional impulsivity, has also been linked to externalizing disorders such as ADHD [27•,28]. Longitudinal research suggests stressful life events and peer victimization are associated with later aggression, mediated by higher ED [29]. Dysregulation is also linked to alcohol-related problems and substance use disorders [30,31]. Early identification of ED among externalizing youth could also help predict risk for later antisocial behavior [32]. There is strong theoretical and empirical evidence linking early ADHD to later conduct problems, self-injury, borderline and antisocial personality disorders, substance use, and completed suicide [7,33,34]. Contextual processes shaping increased emotional lability appear to underlie this heterotypic developmental trajectory leading from ADHD to more severe psychopathology. There are several contextual factors that are associated with increased emotional lability over time, such as emotional invalidation, abuse, and coercive family processes characterized by negative reinforcement of conflict escalation [3••]. Broadly, these contextual factors increase ED via two interrelated processes: first, communication that emotions are invalid or inappropriate and second, intermittent reinforcement of extreme negative affect. Together, these processes increase ED by failing to teach emotional awareness and by reinforcing behavior dysregulation, especially during conflict. There is now considerable evidence that contextual factors shaping ED play a significant role in the development of borderline and antisocial personality disorder among impulsive (i.e., vulnerable) children (see Figure 1).

More recently, it has become clear that ED is associated with negative health outcomes such as cardiovascular disease, arthritis, type II diabetes, osteoporosis, periodontal disease, certain cancers, Alzheimer's disease, frailty, and functional decline among older adults [35,36]. Dysregulation also contributes to sleep difficulties among those with generalized anxiety disorder and borderline personality disorder [37,38]. The mechanisms linking ED to negative health outcomes are complex [39]. Although there is some evidence that emotions can have a direct effect on health via epigenetic [40,41] and biological changes (e.g., inflammatory processes [36]), indirect mechanisms also drive these associations. This could include unhealthy stress management (e.g., smoking), poor situation selection (e.g., into stress generating environments), or risk-taking behaviors (e.g., drunk driving; self-injury). Furthermore, ED has interpersonal origins and consequences [42]. Dysregulated emotions and behaviors may increasingly alienate sources of emotional support, reducing access to healthy friends and romantic partners.

Life-span development

Although a fully articulated life span model is beyond the scope of this review, key elements of our perspective are depicted in Figure 2 (see also [3••,16]). We acknowledge that all infants lack regulation strategies. However, some infants are also biologically and/or temperamentally vulnerable (e.g., trait impulsive) or difficult to sooth. These infant vulnerabilities interact with contextual stressors to shape ED. Because regulatory skills and strategies are socialized, problems within proximal attachment relationships are uniquely devastating. Over time, temperament–environment interactions alter underlying biology (e.g., fight-flight systems, parasympathetic regulation, functional connectivity of brain circuits, DNA methylation) via allostatic mechanisms. Poor self-regulation further affects parent–child, peer, and romantic relationships, which can lead to risky health behaviors, severe psychopathology, and physical illness by adulthood. Finally, stress and poor health alter biological systems among unborn offspring of vulnerable parents, increasing risk for intergenerational transmission of ED.

Figure 1



Heterotypic continuity from ADHD to internalizing and externalizing disorders.

Infancy and early childhood

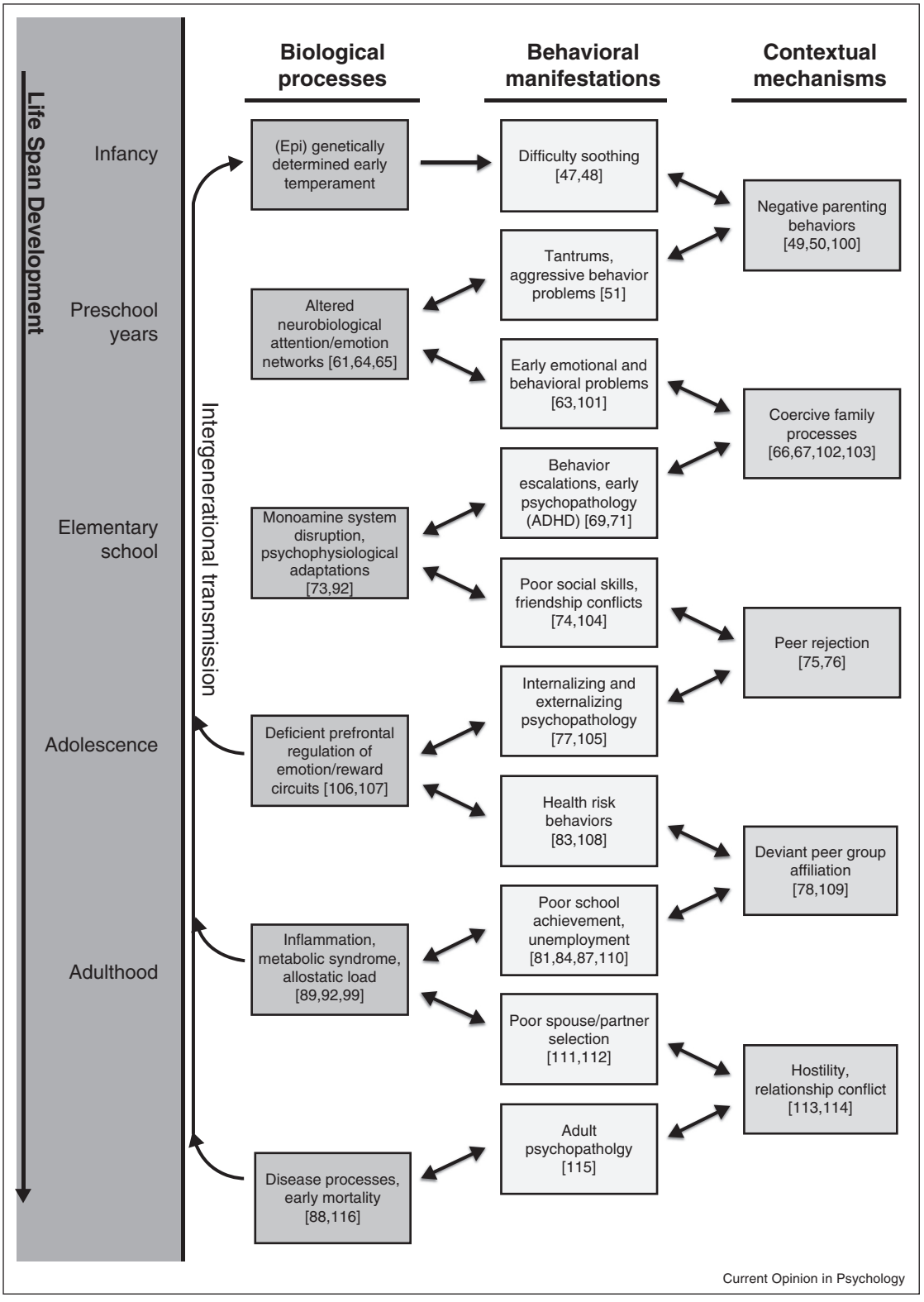
Timely acquisition of emotional control in infancy is associated with later psychosocial functioning [43,44•]. Infants possess relatively little ability to independently regulate emotions, depending upon external sources of co-regulation, especially parents [45]. Indeed, negative parenting behaviors and low sensitivity in infancy are associated with poor psychosocial outcomes throughout childhood [46]. Furthermore, babies who exhibit more frequent and intense negative emotions are more difficult to soothe [47,48], receive less sensitive parenting [49,50], and are more likely to develop behavior problems (e.g., tantrums) with unresponsive parenting [51•,52]. In the context of highly responsive parenting, however, emotionally reactive infants can develop better self-regulation [53].

Early caregiving experiences affect developing biological systems [54–56] and these differences persist into young adulthood [57–59]. In particular, unsupportive early environments affect neurobiological systems related to attention and self-regulation [60]. For example, parental responsiveness during infancy is associated with higher respiratory sinus arrhythmia (RSA) in childhood [61], a biological index of attention and emotion regulation capacity [11]. Low parental sensitivity in infancy is associated with lower RSA in childhood and less effective emotion-regulation [62]. Similarly, delays in executive control over attention are associated with regulatory problems later in childhood [63]. This is because executive attention abilities scaffold later behavioral, emotional, and cognitive regulation [64,65]. In other words, early experiences initiate a cascade of biological and social processes that shape ED.

Later childhood

Research in later childhood reveals that biology × environment interactions potentiate severe ED across development [54]. Moreover, dysregulated children can elicit caregiver reactions that are similarly problematic [66]. This results in coercive family processes, which have been linked to emergence and maintenance of ED [67]. Coercion is a process whereby parent and child use increasingly extreme displays of negative affect to get needs met [7,68]. Extreme behaviors are intermittently reinforced when one party relents, which increases the frequency of dysregulated conflict-resolution tactics. Complex transactions between early externalizing problems and parent–child conflict can lead to externalizing behaviors and the development of internalizing symptoms [69,70]. Other problematic parent–child conflict interactions (e.g., limited emotional variability [71,72]) are also associated with adolescent psychopathology.

Figure 2



Simplified life span developmental model of emotion dysregulation across biological, behavioral, and contextual domains (See refs. [47–51•,61,63–67,69,71,73–78,81,83,84,87–89•,92,99–116]).

Adolescence

The consequences of ED extend beyond home. Over time, responses to conflict become entrenched and are characterized by physiological dysregulation and labile emotions [73]. This affects social functioning and peer relationships. For example, ED mediates the relationship between adolescent ADHD and social/friendship problems [74]. Peer difficulties also increase risk for depression and anxiety [75,76]. Additionally, adolescents with ADHD who experience peer rejection are more likely to progress along externalizing risk trajectories, including tobacco use, conduct problems, and delinquency [77,78].

Adolescence is also a period of biological change in systems that underlie self-regulation, including improved prefrontal modulation of subcortical brain structures [79]. However, neuromaturational development of subcortical structures (e.g., the amygdala and ventral striatum) outpaces development of cortical regions involved in regulation (e.g., prefrontal cortex [80]). Vulnerable adolescents are also more likely to engage in high-reward risky behaviors (e.g., substance use, promiscuity), further disrupting neurodevelopment maturation [7]. During late adolescence and young adulthood, affiliation with deviant peer groups may mediate associations between ED and externalizing behaviors [78]. Deviancy training is a process by which deviant behaviors are modeled and reinforced by group members, leading to academic decline, psychopathology, and health-risk behaviors [81–83].

Adulthood

Dynamic associations between individual dysregulation and deviant peer groups increase risk into young adulthood via school drop-out [84], delinquency and incarceration [85,86], and limited prospects for employment [87]. Over time the effects of dysregulation can accumulate, resulting in immune deficiencies, cardiovascular disease, and early mortality [88]. Accumulating evidence suggests that ED affects inflammatory pathways [89•,90] via increased allostatic load [91,92]. Furthermore, dysregulated adults are more likely to experience social stressors in relationships and work [93,94], which place acute strain on physiological systems [95,96]. Psychopathology is also associated with obesity, metabolic syndrome, diabetes onset, and mortality through complex interactions between emotional, behavioral, and neuroendocrine systems [97–99].

Summary and future directions

The human tendency to catalog has produced numerous psychiatric and medical diagnoses. This obscures connections within and across disciplines, creating artificial boundaries between scholars. Child development researchers have argued that the origins of distress begin at conception and are exacerbated by social inequity, especially inadequate access to mental and physical health resources, discrimination, and poverty. Support for parents is especially limited (e.g., parental leave, high-quality daycare, affordable housing) and high-risk families are disproportionately affected. When parents are stressed, resources for socializing healthy emotion regulation are depleted and ED is more likely to be transmitted across generations.

In this review, we have highlighted evidence that ED is shaped and maintained through close relationships, leading to severe problems among those who are most vulnerable. Thus, ongoing interventions targeting healthy emotional development in children and families have potential to reduce risk, public health costs, and severe distress. Future research should continue to examine emotional underpinnings of physical health conditions, with the objective of preventing disease and speeding recovery among the afflicted. Additional research and resources should also be directed toward prevention and rapid intervention following childhood trauma, especially interpersonal traumas such as sexual or physical abuse by a caregiver. When physical and emotional health are conceptualized jointly, the public health implication are apparent. Early intervention and prevention have the potential to improve wellbeing and reduce burden on a taxed healthcare system.

References and recommended reading

Papers of particular interest, published within the period of review, have been highlighted as:

- • of special interest
- •• of outstanding interest

1. *Oxford Dictionary of English*. edn 3. Oxford University Press; 2010.
2. Duarte JO, Planeta CS, Crestani CC: **Immediate and long-term effects of psychological stress during adolescence in cardiovascular function: comparison of homotypic vs heterotypic stress regimens**. *Int J Dev Neurosci* 2015, **40**:52-59.
3. •• Beauchaine TP, McNulty T: **Comorbidities and continuities as ontogenic processes: toward a developmental spectrum model of externalizing psychopathology**. *Dev Psychopathol* 2013, **25**:1505-1528.

This review integrates findings from diverse literatures to exemplify how a transactional, life span perspective that cuts across traditional levels of analysis can improve our understanding of externalizing disorders and psychopathology. Authors emphasize that conceptualizing psychopathology in terms of developmental manifestations of trait vulnerabilities interacting with environmental risk factors will facilitate important cross-disciplinary connections.

4. American Psychiatric Association: *Diagnostic and Statistical Manual of Mental Disorders*. edn 5. 2013.
5. Krueger RF, Watson D, Barlow DH: **Introduction to the special section: toward a dimensionally based taxonomy of psychopathology**. *J Abnorm Psychol* 2005, **114**:491-493.
6. Beauchaine TP, Gatzke-Kopp LM: **Instantiating the multiple levels of analysis perspective in a program of study on externalizing behavior**. *Dev Psychopathol* 2012, **24**:1003-1018.
7. Beauchaine TP, Klein DN, Crowell SE, Derbidge C, Gatzke-Kopp LM: **Multifinality in the development of personality disorders: a biology × sex × environment interaction model of antisocial and borderline traits**. *Dev Psychopathol* 2009, **21**:735-770.
8. DeYoung CG: **Personality neuroscience and the biology of traits**. *Soc Pers Psychol Compass* 2010, **4**:1165-1180.

9. Kop WJ, Gottdiener JS: **The interaction between psychologic distress and biobehavioral processes in cardiovascular disease**. In *Psychiatry and Heart Disease: The Mind, Brain, and Heart.* Edited by Riba M, Wulsin L, Rubenfire M. John Wiley & Sons; 2012:1-17.

10. Serido J, Almeida DM, Wethington E: **Chronic stressors and daily hassles: unique and interactive relationships with psychological distress**. *J Health Soc Behav* 2004, **45**:17-33.

11. Beauchaine TP, Gatzke-Kopp L, Mead HK: **Polyvagal theory and developmental psychopathology: emotion dysregulation and conduct problems from preschool to adolescence**. *Biol Psychol* 2007, **74**:174-184.

12. Calkins SD, Dollar JM: **A biopsychosocial perspective on maternal psychopathology and the development of child emotion regulation**. *J Pers Disord* 2014, **28**:70-77.

13. Hoffmann SG, Sawyer AT, Fang A, Asnaani A: **Emotion dysregulation model of mood and anxiety disorders**. *Depress Anxiety* 2012, **29**:409-416.

14. Althoff RR, Verhulst FC, Rettew DC, Hudziak JJ, van der Ende J: **Adult outcomes of childhood dysregulation: a 14-year follow-up study**. *J Am Acad Child Adolesc Psychiatry* 2010, **49**:1105-1116.

15. Calkins S: **Origins and outcomes of individual differences in emotion regulation**. In *The Development of Emotion Regulation: Biological and Behavioral Considerations.* Edited by Fox NA. Monographs of the Society for Research in Child Development; 1994:53-72.

16. Crowell SE, Beauchaine TP, Linehan MM: **A biosocial developmental model of borderline personality: elaborating and extending Linehan's theory**. *Psychol Bull* 2009, **135**:495-510.

17. Gratz KL, Roemer L: **Multidimensional assessment of emotion regulation and dysregulation: development, factor structure, and initial validation of the difficulties in emotion regulation scale**. *J Psychopathol Behav Assess* 2004, **26**:41-54.

18. Folk JB, Zeman JL, Poon JA, Dallaire DH: **Longitudinal examination of emotion regulation: pathways to anxiety and depressive symptoms in urban minority youth**. *Child Adolesc Ment Health* 2014, **19**:243-250.

19. Ball TM, Ramsawh HJ, Campbell-Sills L, Paulus MP, Stein MB: **Prefrontal dysfunction during emotion regulation in generalized anxiety and panic disorders**. *Psychol Med* 2013, **43**:1475-1486.

20. Miranda R, Tsypes A, Gallagher M, Rajappa K: **Rumination and hopelessness as mediators of the relation between perceived emotion dysregulation and suicidal ideation**. *Cognit Ther Res* 2013, **37**:786-795.

21. Crowell SE, Beauchaine TP, McCauley E, Smith CJ, Stevens AL, Sylvers P: **Psychological, autonomic, and serotonergic correlates of parasuicide among adolescent girls**. *Dev Psychopathol* 2005, **17**:1105-1127.

22. Law KC, Khazem LR, Anestis MD: **The role of emotion dysregulation in suicide as considered through the ideation to action framework**. *Curr Opin Psychol* 2015 http://dx.doi.org/10.1016/j.copsyc.2015.01.014. (advance online publication).

23. McLaughlin KA, Hatzenbuehler ML, Mennin DS, Nolen-Hoeksema S: **Emotion dysregulation and adolescent psychopathology: a prospective study**. *Behav Res Ther* 2011, **49**:544-554.

24. Gratz KL: **Risk factors for and functions of deliberate self-harm: an empirical and conceptual review**. *Clin Psychol Sci Pract* 2003, **10**:192-205.

25. Linehan MM: *Cognitive-behavioral Treatment of Borderline Personality Disorder*. The Guilford Press; 1993.

26. Nock MK: **Why do people hurt themselves?** *Curr Dir Psychol Sci* 2009, **18**:78-83.

27. • Karalunas SL, Fair D, Musser ED, Kamari Aykes BS, Iyer SP, Nigg JT: **Subtyping attention-deficit/hyperactivity disorder using temperament dimensions: toward biologically based nosologic criteria**. *JAMA Psychiatry* 2014, **71**:1015-1024.
This study proposes the existence of three subtypes of ADHD, classified on the basis of associated dysregulation. Although classification was independent of ADHD symptom severity, concurrent findings indicate neural and physiological differences in children with ADHD and emotion dysregulation. Longitudinal findings indicate that those who had deficits regulating negative emotion had the worst clinical prognosis.

28. Martel MM: **Research review: a new perspective on attention-deficit/hyperactivity disorder: emotion dysregulation and trait models**. *J Child Psychol Psychiatry* 2009, **50**:1042-1051.

29. Herts KL, McLaughlin KA, Hatzenbuehler ML: **Emotion dysregulation as a mechanism linking stress exposure to adolescent aggressive behavior**. *J Abnorm Psychol* 2012, **40**:1111-1112.

30. Messman-Moore TL, Ward RM: **Emotion dysregulation and coping drinking motives in college women**. *Am J Health Behav* 2014, **38**:553-559.

31. Tull MT, Bardeen JR, DiLillo D, Messman-Moore T, Gratz KL: **A prospective investigation of emotion dysregulation as a moderator of the relation between posttraumatic stress symptoms and substance use severity**. *J Anxiety Disord* 2015, **29**:52-60.

32. Okado Y, Bierman KL: **Differential risk for late adolescent conduct problems and mood dysregulation among children with early eternalizing behavior problems**. *J Abnorm Child Psychol* 2014 http://dx.doi.org/10.1007/s10802-014-9931-4. (advance online publication).

33. Barbaresi WJ, Colligan RC, Weaver AL, Voigt RG, Killian JM, Katusic SK: **Mortality, ADHD, and psychosocial adversity in adults with childhood ADHD: a prospective study**. *Pediatrics* 2013, **131**:637-644.

34. Hinshaw SP, Owens EB, Zalecki C, Perrigue Huggins S, Montenegro-Nevado AJ, Schrodek E, Swanson EN: **Prospective follow-up of girls with attention-deficit/hyperactivity disorder into early adulthood: continuing impairment includes elevated risk for suicide attempts and self-injury**. *J Consult Clin Psychol* 2012, **80**:1041-1051.

35. Appleton AA, Buka SL, McCormick MC, Koenen KC, Loucks EB, Gilman SE, Kubzansky LD: **Emotional functioning at age 7 years is associated with C-reactive protein in middle adulthood**. *Psychosom Med* 2011, **73**:295-303.

36. Kiecolt-Glaser JK, McGuire L, Robles TF, Glaser R: **Emotions, morbidity, and mortality: new perspectives from psychoneuroimmunology**. *Annu Rev Psychol* 2002, **53**:83-107.

37. Tsypes A, Aldao A, Mennin DS: **Emotion dysregulation and sleep difficulties in generalized anxiety disorder**. *J Anxiety Disord* 2013, **27**:197-203.

38. Selby EA: **Chronic sleep disturbances and borderline personality disorder symptoms**. *J Consult Clin Psychol* 2013, **81**:941-947.

39. DeSteno D, Gross JJ, Kubzansky L: **Affective science and health: the importance of emotion and emotion regulation**. *Health Psychol* 2013, **32**:474-486.

40. Lam LL, Emberly E, Fraser HB, Neumann SM, Chen E, Miller GE, Kobor MS: **Factors underlying variable DNA methylation in a human community cohort**. *Proc Natl Acad Sci U S A* 2012, **109**:17253-17260.

41. Ouellet-Morin I, Wong CCY, Danese A, Pariante CM, Papadopoulos AS, Mill J, Arseneault L: **Increased serotonin transporter gene (SERT) DNA methylation is associated with bullying victimization and blunted cortisol response to stress in childhood: a longitudinal study of discordant monozygotic twins**. *Psychol Med* 2013, **43**:1813-1823.

42. Hughes AE, Crowell SE, Uyeji L, Coan JA: **A developmental neuroscience of borderline pathology: emotion dysregulation and social baseline theory**. *J Abnorm Child Psychol* 2012, **40**:21-33.

43. Hemmi MH, Wolke D, Schneider S: **Associations between problems with crying, sleeping, and/or feeding in infancy and**

long-term behavioural outcomes in childhood: a meta-analysis. *Arch Dis Child* 2011, **96**:622-629.

44. • Winsper C, Wolke D: **Infant and toddler crying, sleeping, and feeding problems and trajectories of dysregulated behavior across childhood**. *J Abnorm Child Psychol* 2014, **42**:831-843.
This longitudinal study addressed the stability of between early-life regulatory problems between infancy and later childhood. Although the manifestation of dysregulation changes across development, all early-life regulatory problems (e.g., excessive crying, sleep and feeding difficulties) were associated with later dysregulation (e.g., negative emotionality, conduct problems, hyperactivity). The presence of multiple regulatory problems in infancy was linked with particularly negative outcomes.

45. Kopp CB: **Regulation of distress and negative emotions: a developmental view**. *Dev Psychol* 1989, **25**:343.

46. Lahey BB, Van Hulle CA, Keenan K, Rathouz PJ, D'Onofrio BM, Rodgers JL, Waldman ID: **Temperament and parenting during the first year of life predict future child conduct problems**. *J Abnorm Child Psychol* 2008, **36**:1139-1158.

47. Crockenberg SC, Smith P: **Antecedents of mother–infant interaction and infant irritability in the first three months of life**. *Infant Behav Dev* 1982, **5**:105-119.

48. White BP, Gunnar MR, Larson MC, Donzzella B, Barr RG: **Behavioral and physiological responsivity, sleep, and patterns of daily cortisol production in infants with and without colic**. *Child Dev* 2000, **71**:862-877.

49. Planalp EM, Braungart-Rieker JM: **Temperamental precursors of infant attachment with mothers and fathers**. *Infant Behav Dev* 2013, **36**:796-808.

50. Ghera MM, Hane AA, Malesa EE, Fox NA: **The role of infant soothability in the relation between infant negativity and maternal sensitivity**. *Infant Behav Dev* 2006, **29**:289-293.

51. • Kochanska G, Kim S: **Difficult temperament moderates links between maternal responsiveness and children's compliance and behavior problems in low-income families**. *J Child Psychol Psychiatry* 2013, **54**:323-332.
This study demonstrates significant interactions between temperament and maternal responsiveness on externalizing problems in early childhood. Children classified as temperamentally difficult had greater levels of externalizing problems in the context of low maternal responsiveness, but lower levels in the context of highly responsive mothers. Maternal responsiveness was not related to externalizing outcomes for children with easy temperaments.

52. Halligan SL, Cooper PJ, Fearon P, Wheeler SL, Crosby M, Murray L: **The longitudinal development of emotion regulation capacities in children at risk for externalizing disorders**. *Dev Psychopathol* 2013, **25**:391-406.

53. Kim S, Kochanska G: **Child temperament moderates effects of parent–child mutuality on self-regulation: a relationship-based path for emotionally negative infants**. *Child Dev* 2012, **83**:1275-1289.

54. Humphreys KL, Zeanah CH: **Deviations from the expectable environment in early childhood and emerging psychopathology**. *Neuropsychopharmacology* 2015 http://dx.doi.org/10.1038/npp.2014.165. (advance online publication).

55. Martinez-Torteya C, Dayton C, Beeghly M, McGinnis E, Broderick A, Rosenblum KL, Muzik M: **Maternal parenting predicts infant biobehavioral regulation among women with a history of childhood maltreatment**. *Dev Psychopathol* 2014, **26**:379-392.

56. Qiu A, Rifkin-Graboi A, Chen H, Chong YS, Kewk K, Gluckman PD, Frotier MV, Meany MJ: **Maternal anxiety and infants' hippocampal development: timing matters**. *Transl Psychiatry* 2013, **3**:e306 http://dx.doi.org/10.1038/tp.2013.79.

57. Barry TJ, Murray L, Fearon RP, Moutsiana C, Cooper P, Goodyer IM, Halligan SL: **Maternal postnatal depression predicts altered offspring biological stress reactivity in adulthood**. *Psychoneuroendocrinology* 2015, **52**:251-260.

58. Moutsiana C, Fearon P, Murray L, Cooper P, Goodyer I, Johnstone T, Halligan S: **Making an effort to feel positive: insecure attachment in infancy predicts the neural underpinnings of emotion regulation in adulthood**. *J Child Psychol Psychiatry* 2014, **55**:999-1008.

59. Moutsiana C, Johnstone T, Murray L, Fearon P, Cooper P, Pliatsikas C, Halligan S: **Insecure infant attachment predicts greater amygdala volumes in early adulthood**. *J Child Psychol Psychiatry* 2014 http://dx.doi.org/10.1111/jcpp.1231.7. (advance online publication).

60. Rothbart MK, Sheese BE, Rueda MR, Posner MI: **Developing mechanisms of self-regulation in early life**. *Emot Rev* 2011, **3**:207-213.

61. Perry NB, Mackler JS, Calkins SD, Keane SP: **A transactional analysis of the relation between maternal sensitivity and child vagal regulation**. *Dev Psychol* 2014, **50**:784-793.

62. Williams SR, Woodruff-Borden J: **Parent emotion socialization practices and child self-regulation as predictors of child anxiety: the mediating role of cardiac variability**. *Child Psychiatry Hum Dev* 2014 http://dx.doi.org/10.1007/s10578-014-0492-0. (advance online publication).

63. Hughes C, Ensor R: **Individual differences in growth in executive function across the transition to school predict externalizing and internalizing behaviors and self-perceived academic success at 6 years of age**. *J Exp Child Psychol* 2011, **108**:663-676.

64. Ferrier DE, Bassett HH, Denham SA: **Relations between executive function and emotionality in preschoolers: exploring a transitive cognition–emotion linkage**. *Front Psychol* 2014, **5**:487 http://dx.doi.org/10.3389/fpsyg.2014.0048.7.

65. Posner MI, Rothbart MK, Sheese BE, Voelker P: **Developing attention: behavioral and brain mechanisms**. *Adv Neurosci* 2014, **2014**:1-9 http://dx.doi.org/10.1155/2014/4050.94.

66. Besnard T, Verlaan P, Davidson M, Vitaro F, Poulin F, Capuano F: **Bidirectional influences between maternal and paternal parenting and children's disruptive behaviour from kindergarten to grade 2**. *Early Child Dev Care* 2013, **183**:515-533.

67. Crowell SE, Yaptangco M, Turner SR: **Coercion, invalidation, and risk for self-injury and borderline personality traits**. In *Coercion Theory and the Development of Psychopathology.* Edited by Dishion T, Snyder J. Oxford; 2014.

68. Crowell SE, Baucom BR, McCauley E, Potapova NV, Fitelson M, Barth H, Smith CJ, Beauchaine TP: **Mechanisms of contextual risk for adolescent self-injury: invalidation and conflict escalation in mother–child interactions**. *J Clin Child Adolesc Psychol* 2013, **42**:467-480.

69. Hofer C, Eisenberg N, Spinrad TL, Morris AS, Gershoff E, Valiente C, Kupfer A, Eggum ND: **Mother–adolescent conflict: stability, change, and relations with externalizing and internalizing behavior problems**. *Soc Dev* 2013, **22**:259-279.

70. Yong M, Fleming CB, McCarty CA, Catalano RF: **Mediators of the association between externalizing behaviors and internalizing symptoms in late childhood and early adolescence**. *J Early Adolesc* 2014, **34**:967-1000.

71. Van der Giessen D, Branje S, Frijns T, Meeus W: **Dyadic variability in mother–adolescent interactions: developmental trajectories and associations with psychosocial functioning**. *J Youth Adolesc* 2013, **42**:96-108.

72. Van der Giessen D, Hollenstein T, Hale WW, Koot HM, Meeus W, Branje S: **Emotional variability in mother–adolescent conflict interactions and internalizing problems of mothers and adolescents: dyadic and individual processes**. *J Abnorm Child Psychol* 2015, **43**:339-353.

73. Beauchaine TP, Zalewski M:: **Physiological and developmental mechanisms of emotional lability in coercive relationships**. In *Oxford Handbook of Coercive Relationship Dynamics.* Edited by Dishion TJ, Snyder J. Oxford University Press; 2015. http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199324552.001.0001/oxfordhb-9780199324552-e-5 (advance online publication).

74. Zucchetti G, Ortega E, Scholte RH, Rabaglietti E: **The mediating role of aggressive behaviour, emotional and behavioural instability on the association between ADHD symptoms and**

best friend conflicts. *Curr Psychol* 2014 http://dx.doi.org/10.1007/s12144-014-9243-4. (advance online publication).

75. Humphreys KL, Katz SJ, Lee SS, Hammen C, Brennan PA, Najman JM: **The association of ADHD and depression: mediation by peer problems and parent–child difficulties in two complementary samples**. *J Abnorm Psychol* 2013, **122**:854-867.

76. Roy A, Hartman CA, Veenstra R, Oldehinkel AJ: **Peer dislike and victimisation in pathways from ADHD symptoms to depression**. *Eur Child Adolesc Psychiatry* 2014 http://dx.doi.org/10.1007/s00787-014-0633-9. (advance online publication).

77. Mrug S, Molina BS, Hoza B, Gerdes AC, Hinshaw SP, Hechtman L, Arnold LE: **Peer rejection and friendships in children with attention-deficit/hyperactivity disorder: contributions to long-term outcomes**. *J Abnorm Child Psychol* 2012, **40**:1013-1026.

78. Lansford JE, Malone PS, Dodge KA, Pettit GS, Bates JE: **Developmental cascades of peer rejection, social information processing biases, and aggression during middle childhood**. *Dev Psychopathol* 2010, **22**:593-602.

79. Gogtay N, Giedd JN, Lusk L, Hayashi KM, Greenstein D, Vaituzis AC, Nugent TF III, Herman DH, Clasen LS, Toga AW *et al.*: **Dynamic mapping of human cortical development during childhood through early adulthood**. *Proc Natl Acad Sci U S A* 2004, **101**:8174-8179.

80. Steinberg L: **Cognitive and affective development in adolescence**. *Trends Cogn Sci* 2005, **9**:69-74.

81. Brière FN, Fallu JS, Morizot J, Janosz M: **Adolescent illicit drug use and subsequent academic and psychosocial adjustment: an examination of socially-mediated pathways**. *Drug Alcohol Depend* 2014, **35**:45-61.

82. Klostermann S, Connell A, Stormshak EA: **Gender differences in the developmental links between conduct problems and depression across early adolescence**. *J Res Adolesc* 2014 http://dx.doi.org/10.1111/jora.12170. (advance online publication).

83. Lansford JE, Dodge KA, Fontaine RG, Bates JE, Pettit GS: **Peer rejection, affiliation with deviant peers, and risky sexual behavior**. *J Youth Adolesc* 2014, **43**:1742-1751.

84. Wang MT, Fredricks JA: **The reciprocal links between school engagement, youth problem behaviors, and school dropout during adolescence**. *Child Dev* 2014, **85**:722-737.

85. Vitaro F, Brendgen M, Lacourse E: **Peers and delinquency: a genetically informed, developmentally sensitive perspective**. In *The Development of Criminal and Antisocial Behavior.* Edited by Morizot J, Kazemian L. Springer; 2015:221-236.

86. Reingle JM, Jennings WG, Komro KG: **A case–control study of risk and protective factors for incarceration among urban youth**. *J Adolesc Health* 2013, **53**:471-477.

87. Trzesniewski KH, Donnellan BM, Moffitt TE, Robins RW, Poulton R, Caspi A: **Low self-esteem during adoescence predicts poor health, criminal behavior, and limited economic prospects during adulthood**. *Dev Psychol* 2006, **42**:381-390.

88. Kemp AH, Quintana DS: **The relationship between mental and physical health: insights from the study of heart rate variability**. *Int J Psychophysiol* 2013, **89**:288-296.

89. • Gianaros PJ, Marsland AL, Kuan DCH, Schirda BL, Jennings JR, Sheu LK, Hariri AR, Gross JJ, Manuck SB: **An inflammatory pathway links atherosclerotic cardiovascular disease risk to neural activity evoked by the cognitive regulation of emotion**. *Biol Psychiatry* 2014, **75**:738-745.
Authors demonstrated that cortical activation during a negative emotion regulation task predicted preclinical atherosclerosis, and that this association was mediated by levels of interleukin-6 in the bloodstream. Therefore, altered engagement of executive function circuitry be linked to inflammation-related neural alterations.

90. Harrison NA, Cooper E, Voon V, Miles K, Critchley HD: **Central autonomic network mediates cardiovascular responses to acute inflammation: relevance to increased cardiovascular risk in depression?** *Brain Behav Immun* 2013, **31**:186-196.

91. Chen E, Miller GE, Lachman ME, Gruenewald TL, Seeman TE: **Protective factors for adults from low childhood socioeconomic circumstances: the benefits of shift-and-persist for allostatic load**. *Psychosom Med* 2012, **74**:178-186.

92. Beauchaine TP, Neuhaus E, Zalewski M, Crowell SE, Potapova N: **The effects of allostatic load on neural systems subserving motivation, mood regulation, and social affiliation**. *Dev Psychopathol* 2011, **23**:975-999.

93. Diamond LM: **The biobehavioral legacy of early attachment relationships for adult emotional and interpersonal functioning**. In *Bases of Adult Attachment: Linking Brain, Mind and Behavior.* Edited by Zayaz V, Hazan C. Springer; 2015:79-106.

94. Scheibe S, Zacher H: **A lifespan perspective on emotion regulation, stress, and well-being in the workplace**. In *Research in Occupational Stress and Well-Being.* Edited by Perrewé PL, Rosen CC, Halbesleben JRB. Emerald Group Publishing Limited; 2013:167-197.

95. Hasselmo K, Sbarra DA, O'Connor MF, Moreno FA: **Psychological distress following marital separation interacts with a polymorphism in the serotonin transporter gene to predict cardiac vagal control in the laboratory**. *Psychophysiology* 2015 http://dx.doi.org/10.1111/psyp.12409. (advance online publication).

96. Wiernik E, Pannier B, Czernichow S, Nabi H, Hanon O, Simon T, Lemogne C: **Occupational status moderates the association between current perceived stress and high blood pressure evidence from the IPC Cohort Study**. *Hypertension* 2013, **61**:571-577.

97. de Jonge P, Alonso J, Stein DJ, Kiejna A, Aguilar-Gaxiola S, Viana MC, Zhaorui L, O'Neill S, Bruffaerts R, Caldas-de-Almeida JM *et al.*: **Associations between DSM-IV mental disorders and diabetes mellitus: a role for impulse control disorders and depression**. *Diabetologia* 2014, **5**:699-709.

98. Katon WJ, Rutter C, Simon G, Lin EH, Ludman E, Ciechanowski P, Kinder L, Young B, Von Korff M: **The association of comorbid depression with mortality in patients with type 2 diabetes**. *Diabetes Care* 2005, **28**:2668-62672.

99. Pervanidou P, Chrousos GP: **Metabolic consequences of stress during childhood and adolescence**. *Metabolism* 2012, **61**:611-619.

100. Kiff CJ, Lengya LJ, Zalewski M: **Nature and nurturing: parenting in the context of child temperament**. *Clin Child Fam Psychol Rev* 2011, **14**:251-301.

101. Andrews Espy K, Sheffield TD, Wiebe SA, Clark CAC, Moehr MJ: **Executive control and dimensions of problem behaviors in preschool children**. *J Child Psychol Psychiatry* 2011, **52**:33-46.

102. Boyle MH, Jenkins JM, Georgiades K, Cairney J, Duku E, Racine Y: **Differential maternal parenting behavior: estimating within- and between-family effects on children**. *Child Dev* 2004, **75**:1457-1476.

103. Clark LA, Kochanska G, Ready R: **Mothers' personality and its interaction with child temperament as predictors of parenting behavior**. *J Pers Soc Psychol* 2000, **79**:274-285.

104. Bunford N, Evans SW, Langberg JM: **Emotion dysregulation is associated with social impairment among young adolescents with ADHD**. *J Atten Disord* 2014 http://dx.doi.org/10.1177/1087054714527793. (advance online publication).

105. Vitulano ML, Fite PJ, Hopko DR, Lochman J, Wells K, Asif I: **Evaluation of underlying mechanisms in the link between childhood ADHD symptoms and risk for early initiation of substance use**. *Psychol Addict Behav* 2014, **28**:816.

106. Heatherton TF, Wagner DD: **Cognitive neuroscience of self-regulation failure**. *Trends Cogn Sci* 2011, **15**:132-139.

107. Volkow ND, Fowle JS, Wang GJ, Baler R, Telang F: **Imaging dopamine's role in drug abuse and addiction**. *Neuropharmacology* 2009, **56**:3-8.

108. Monahan KC, Rhew IC, Hawkins JD, Brown EC: **Adolescent pathways to co-occurring problem behavior: the effects of**

peer delinquency and peer substance use. *J Res Adolesc* 2014, **24**:630-645.

109. Snyder J, Schrepferman L, McEachern A, Barner S, Johnson K, Provines J: **Peer deviancy training and peer coercion: dual processes associated with early-onset conduct problems**. *Child Dev* 2008, **79**:252-268.

110. Zimmermann F, Schütte K, Taskinen P, Köller O: **Reciprocal effects between adolescent externalizing problems and measures of achievement**. *J Educ Psychol* 2013, **105**:747-761.

111. Meyler D, Stimpson JP, Peek MK: **Health concordance within couples: a systematic review**. *Soc Sci Med* 2007, **64**:2297-2310.

112. Rhule-Louie DM, McMahon RJ: **Problem behavior and romantic relationships: assortative mating, behavior contagion, and desistance**. *Clin Child Fam Psychol Rev* 2007, **10**:53-100.

113. Robles TF, Kane HS: **The attachment system and physiology in adulthood: normative processes, individual differences, and implications for health**. *J Pers* 2014, **82**:515-527.

114. Chen H, Cohen P, John JG, Kasen S, Sneed JR, Crawford TN: **Adolescent personality disorders and conflict with romantic partners during the transition to adulthood**. *J Pers Disord* 2004, **18**:507-525.

115. Butterworth P, Rodgers B: **Concordance in the mental health of spouses: analysis of a large national household panel survey**. *Psychol Med* 2006, **36**:686-697.

116. Kubzansky LD, Park N, Peterson C, Vokonas P, Sparrow D: **Healthy psychological functioning and incident coronary heart disease: the importance of self-regulation**. *Arch Gen Psychiatry* 2011, **68**:400-408.