Inter- and intra-individual variation in emotional complexity: methodological considerations and theoretical implications

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The degree of relationship between positive and negative emotional states or *emotional complexity* is a topic of ongoing debate. At issue is whether positive and negative emotions are opposite ends of a bipolar continuum or independent dimensions in a bivariate distribution. In this review, we summarize work suggesting that the distinction between positive and negative emotions varies both between and within individuals as a function of cognition and changes in informational demands, a perspective called the Dynamic Model of Affect (DMA). In addition to providing a theoretical model that specifies the conditions under which bivariate and bipolar models of affect may be valid, the DMA offers an integrative framework through which models of resilience and stress adaptation may be articulated.

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Introduction

There is tremendous variety in the emotional states that constitute everyday life. Some people have emotional experiences that are wide in range and well differentiated, while others experience emotions in a highly diffuse and global manner. In their influential work on mood variability, Wessman and Rick [1] coined the term 'affect complexity' to characterize the tremendous richness of individual emotional lives. Over the past four decades, disparate lines of research have tended to emphasize either a bipolar or bivariate approach to affect relationships [2••,3–5]. The bipolar approach contends that positive and negative affective states vary along a single continuum from high levels of positive affect (PA) at one end to high levels of negative affect (NA) at the opposite end [6,7]. In contrast, the bivariate approach posits that PA and NA are two distinct dimensions residing on separate measurement continua [8,9]. Although both approaches are useful in describing the everyday experiences of affect, neither approach has been able to adequately explain the well-documented inconsistency in affective reporting that tends to emerge in studies of across-person (nomothetic) and within-person (idiographic) associations [10,11].

In this review, we focus on methodological issues relevant to the conceptualization and measurement of emotional complexity. We appraise evidence for an integrative model, the Dynamic Model of Affect (DMA), that specifies the conditions under which emotional complexity varies both between and within individuals. Finally, we consider the theoretical implications of the DMA for understanding flexible adaptation to changing stressful circumstances and environmental demands.

Conceptualization and measurement of emotional complexity

While conceptualizations of emotional complexity have varied across studies, an emerging literature suggests that indices of complexity can be reliably grouped together according to the degree of *covariation* or *granularity* in the self-reported experience of emotion [12•,13••,14]. Measures of *emotional covariation* typically assess the degree of co-occurrence (*i.e.*, mixed emotions) or correlation (*i.e.*, emotional dialecticism) between PA and NA over time [15–17]. Greater dialectical and mixed emotional experience is associated with improved well-being and greater resilience [18–20], particularly among East Asians [21,22] and older adults [23–25], though there is evidence that these associations may be in part due to individual differences in the affective states people value and their dialectical beliefs about change and interdependence [26,16], as well as the amount of intra-individual variability in positive and negative emotional states [27,12•].

Another form of complexity is *emotional granularity* [13••,28] or the propensity to categorize and label emotional experiences in precise, discrete terms. More granular emotional experiences suggest a greater ability to make subtle distinctions among emotional states [*e.g.*, fear, sadness, anger; 29] as they are experienced. Estimates of between-person granularity generated from diary and ecological momentary assessment data show consistent relations between low emotional granularity (particularly of negative emotions) and a wide range of psychopathologies, including borderline personality, social anxiety, and major depressive disorder [30–32]. Other research has similarly established an association between high granularity in positive emotions and adaptive coping and adjustment [e.g., 33]. This work suggests that like negative emotions, positive emotional states that can be represented in discrete emotion terms may have greater 'informational value' than global affective states [34,35], presumably because representing affective information as qualitatively distinct events reduces the misattributions people likely make about their own affective reactions [36,37].

Despite growing scholarly interest in the measurement of emotional complexity, prior research indicates only modest congruence between indices of emotional covariation and emotional granularity [12•,7,38,39]. Russell and Carroll [7] concluded that the degree of relationship between PA and NA can vary depending upon the specific affect terms chosen, the time frame respondents use to judge affect, the specific response scales provided by the experimenter, and the degree of correlated measurement error across measures. Grühn *et al.* [12•] concluded that low variability can also restrict the range of correlation between positive and negative emotional states. Brose *et al.* [27] similarly cautioned against using measures of co-occurrence to index the relationship between PA and NA (*i.e.*, emotional complexity) and suggested that weak inter-affect correlations may simply reflect negligible amounts of intra-individual variance in NA rather than greater emotional complexity, *per se*. Finally, beyond statistical artifacts, differences in the contextual state of the person at the time of assessment influence the degree of correlation between PA and NA [40,41•,42].

The Dynamic Model of Affect
Zautra and colleagues proposed the Dynamic Model of Affect (DMA) to account for variability in the structure of affect over time and between persons. The model posits that the structure underlying affective experiences varies as a function of the degree of uncertainty [2••,43•]. Stressful conditions increase uncertainty, placing cognitive demands on information processing, and in so doing tax the capacities of neural information processing networks to retain complex associations. Consequently, the DMA predicts that under high stress, affect becomes bipolar. Typically, this is experienced as high levels of

NA accompanied by low levels of PA. As stress increases, attention is directed toward the most salient environmental stimulus, which in the context of stress is often of negative valence [44].

Empirical tests of the DMA have employed a wide range of participant samples and assessment techniques. Supportive evidence for the model comes from field and laboratory studies of daily [40,45•], acute [41•,46], and normative life stressors [*e.g.*, bereavement and disability; 47•,48,18,41•]. The seminal idiographic DMA studies employed 'microlongitudinal' techniques to assess affect along with stressful life events over the course of multiple time points [45•,2••,43•,41•]. This type of idiographic assessment allows one to observe the average association of PA and NA over time, as well as what happens to that association *when* a stressful or otherwise disruptive event occurs in the course of daily life. Even more, by repeatedly assessing these co-occuring experiences, one can determine whether the stressful event was of greater magnitude or occurred with greater frequency than the individual's average experience over time. To capture these deviations from an individual's mean, the independent variables are person-centered. A typical modeling strategy, then, may include person-centered NA as a predictor and estimate its association with PA over time in the context of a linear mixed model (the choice of which valence should be modeled as the independent versus dependent variable is arbitrary here, but may be guided by particular research questions). The resulting regression coefficient estimates the average amount of change in PA when NA increases by one unit, relative to an individual's mean. By additionally modeling person-centered stress as a predictor and the interaction between stress and NA, one can then evaluate the degree to which the association between NA and PA varies as a function of within-person (momentary, daily, weekly, *etc.*) deviations in stress. This modeling strategy permits an explicit evaluation of the DMA hypothesis that the structure of affect is bivariate when stress is low, and becomes increasingly bipolar as stress increases relative to an individual's average.

An extensive body of clinical data with patients challenged by chronic pain and mood disturbances provide further illustration of the dynamics that underlie affective relationships under stress [45•,49,2••,43•]. Chronic pain is a particularly informative context through which to observe the affective dynamics predicted by the DMA because pain is rarely static, and in many conditions presents in unpredictable flares of varying intensity and duration, thereby fostering a millieu of persistent uncertainty. Consistent with the DMA, Zautra *et al.* [44] reported that women with rheumatoid arthritis (RA) experienced greater bipolarity of daily affects on high- vs. low-stress days. Finan *et al.* [50] found the relationship between PA and NA varied across chronic pain disorders,

with osteoarthritis patients demonstrating greater emotional complexity than fibromyalgia patients, a group that experiences a high incidence of mental health comorbidities and reports substantial affective distress and unpredictability of daily pain [50,51]. Finally, an investigation by Williams *et al.* [52] suggested that the heightened apprehension and uncertainty characteristic of anxiety disorder contribute to a less complex, more unidimensional affect structure. In sum, data have accumulated across a variety of different stressful contexts in support of the DMA, suggesting that stressful experiences alter affective relationships, shifting individual appraisals toward simpler, less complex, processing of affective information.

Although much has been learned about the effects of stress on affective dynamics, people differ in emotional complexity [53–56], and a number of studies have focused on individual difference factors that are likely to be important in accounting for variability in the structure of affect over time. In particular, core deficits in informaton processing, including higher levels of cognitive simplicity [42,40], neuroticsm [25,23], hostility [45•] and lower levels of mood clarity [43•], trait PA [56], psychological resilience [47•], and subjective perceptions of approaching death [57] have all been implicated as factors that increase vulnerability to affective simplification during times of stress.

Overall, the available evidence suggests that individual differences, especially those that have relevance for differentiation of emotional experience, warrant further investigation as potential moderators of the interplay between PA and NA.

Implications

There are a number of theoretical implications of the DMA. Perhaps the most fundamental implication is the idea that a person's level of stress should not be ignored when assessing affective states [2••]. This implies that the degree of relationship between PA and NA (*i.e.*, emotional complexity) may vary depending upon information processing demands (*e.g.*, the degree of stress the individual is under at the time of assessment, as well cognitive and affective processing styles). A related implication is that at least two dimensions are needed to fully classify human emotions, one that assesses the level of NA and accompanying motivations and another that gauges the extent of PA and accompanying approach processes. Although including within- and between-person context effects will make analytic models of affective well-being more complicated, it seems clear that such sources of variance require greater empirical attention in future studies [44].

In line with the two-factor framework, the DMA may be expanded beyond the study of emotions and individual differences to incorporate social relationships and community well-being. The underlying premise is that social factors relevant to adaptive responding are separable into positive and negative domains and that similar to the experience of emotional complexity, the ability to sustain a complex view of social relationships during times of stress may be a key to resilience and optimal health [58–60]. Davis *et al.* [45•] reviewed evidence from a range of studies across different chronic pain populations and found support for a two-factor model of social complexity, suggesting that pain patients' perceptions of the positive and negative features of their social relationships become more simplified and inversely coupled during pain episodes. Likewise, emergent infrastructures (*e.g.*, the built and natural environment, social capital, civil governance) that foster and sustain a coherent sense of community, while also aiding in recovery from crisis and disaster may contribute to social and community resilience [60–62]. Finally, the capacity to sustain partial separation of positive and negative states while under stress may have major implications for psychosocial treatment of chronic stress and other health-related disorders. Zautra [63] cited evidence that mindfulness-based approaches to stress reduction may offer a means of broadening emotional awareness and thus help to sustain positive emotional engagement under stressful conditions. Consequently, psychological interventions that facilitate the processing of emotions and social relationships with greater complexity might foster adaptive coping and adjustment to chronic stress and illness [2••,45•].

Conclusion

In support of the DMA, the studies discussed in this review suggest that the relationship between PA and NA varies both within and between individuals. The DMA offers a set of testable hypotheses governing the conditions under which the two affects would be independent and conditions in which they are inversely coupled. Affective states appear to become less differentiated with increased stress and among individuals who show a propensity to process information in a less complex fashion. Conversely, the ability to maintain emotional complexity in the face of stress may represent a key pathway underling resilience and flexible adaptation. Efforts to target affective states in vulnerable populations should consider the social context, and future studies should continue to explore the range of stressful life experiences and individual differences that may have implications for emotional complexity and adaptive functioning.

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Conflict of interest

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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. Wessman AE, Ricks DF: *Mood and Personality*. Oxford: Holt, Rinehart, and Winston; 1966.

2. Reich JW, Zautra AJ, Davis MC: **Dimensions of affect**
•• **relationships: models and their integrative implications**. *Rev. Gen. Psychol.* 2003, **7**:66-83.
Comprehensive review of studies evaluating the Dynamic Model of Affect (DMA).

3. Bradburn NM: *The Structure of Psychological Well-being*. Chicago: Aldine; 1969.

4. Osgood CE, Suci GJ, Tannenbaum PH: *The Measurement of Meaning*. Urbana: University of Illinois Press; 1964.

5. Cacioppo JT, Gardner WL, Berntson GG: **The affect system has parallel and integrative processing components: form follows function**. *J. Pers. Soc. Psychol.* 1999, **76**:839-855.

6. Green DP, Salovey P, Truax KM: **Static, dynamic, and causative bipolarity of affect**. *J. Pers. Soc. Psychol.* 1999, **76**:856-867.

7. Russell JA, Carroll JM: **On the bipolarity of positive and negative affect**. *Psychol. Bull.* 1999, **125**:3-30.

8. Watson D, Clark LA: **Measurement and mismeasurement of mood: recurrent and emergent issues**. *J. Pers. Assess.* 1997, **68**:267-296.

9. Larsen JT, McGraw A, Cacioppo JT: **Can people feel happy and sad at the same time?** *J. Pers. Soc. Psychol.* 2001, **81**:684-696.

10. Tennen H, Affleck G: **Daily processes in coping with chronic pain: methods and analytic strategies**. In *Handbook of Coping: Theory, Research, Applications*. Edited by Endler NS, Zeidner M. Oxford: John Wiley & Sons; 1996:151-177.

11. Kenny DA, Kashy DA, Bolger N: **Data analysis in social psychology**. In *The Handbook of Social Psychology*. Edited by Fiske ST, Gilbert DT. New York: McGraw Hill; 1998:233-265.

12. Grühn D, Lumley MA, Diehl M, Labouvie-Vief G: **Time-based**
• **indicators of emotional complexity: interrelations and correlates**. *Emotion* 2013, **13**:226-237.
The study provides an empirical test of the degree of convergence in various time-based indicators of emotional complexity and their correlates to well-being.

13. Lindquist K, Barrett LF: **Emotional complexity**. In *The Handbook*
•• *of Emotion*. Edited by Lewis M, Haviland-Jones JM, Barrett LF. New York: Guilford Press; 2008:513-530.
A critical review of the literature on the complexity in self-reported experiences of emotion.

14. Hay EL, Diehl M: **Emotion complexity and emotion regulation across adulthood**. *Eur. J. Ageing* 2011, **8**:157-168.

15. Larsen JT, McGraw AP: **The case for mixed emotions**. *Soc. Pers. Psychol. Compass* 2014, **8**:263-274.

16. Grossmann I, Huynh AC, Ellsworth PC: **Emotional complexity: clarifying definitions and cultural correlates**. *J. Pers. Soc. Psychol.* 2016, **111**:895-916.

17. Ready RE, Carvalho JO, Weinberger MI: **Emotional complexity in younger, midlife, and older adults**. *Psychol. Aging* 2008, **23**:928-933.

18. Coifman KG, Bonanno GA, Rafaeli E: **Affect dynamics, bereavement and resilience to loss**. *J. Happiness Stud.* 2007, **8**:371-392.

19. Adler JM, Hershfield HE: **Mixed emotional experience is associated with and precedes improvements in psychological well-being**. *PLoS One* 2012, **7**:1-10.

20. Hershfield HE, Scheiber S, Sims TL, Carstensen LL: **When feeling bad can be good: mixed emotions benefit physical health across adulthood**. *Soc. Psychol. Pers. Sci.* 2013, **4**:54-61.

21. Miyamoto Y, Ryff CD: **Cultural differences in the dialectical and non-dialectical emotional styles and their implications for health**. *Cogn. Emot.* 2011, **25**:22-39.

22. Miyamoto Y, Uchida Y, Ellsworth PC: **Culture and mixed emotions: co-occurrence of positive and negative emotions in Japan and the United States**. *Emotion* 2010, **10**:404-415.

23. Carstensen LL, Pasupathi M, Mayr U, Nesselroade JR: **Emotional experience in everyday life across the adult life span**. *J. Pers. Soc. Psychol.* 2000, **79**:644-655.

24. Carstensen LL, Turan B, Scheibe S *et al.*: **Emotional experience improves with age: evidence based on over 10 years of experience sampling**. *Psychol. Aging* 2011, **26**:21-33.

25. Ong AD, Bergeman CS: **The complexity of emotions in later life**. *J. Gerontol. Series B Psychol. Sci. Soc. Sci.* 2004, **59B**:P117-P122.

26. Sims TL, Tsai JL, Jiang D *et al.*: **Wanting to maximize the positive and minimize the negative: implications for mixed affective experience in American and Chinese contexts**. *J. Pers. Soc. Psychol.* 2015, **109**:292-315.

27. Brose A, de Roover K, Ceulemans E, Kuppens P: **Older adults' affective experiences across 100 days are less variable and less complex than younger adults'**. *Psychol. Aging* 2015, **30**:194-208.

28. Barrett LF: **Solving the emotion paradox: categorization and the experience of emotion**. *Pers. Soc. Psychol. Rev.* 2006, **10**:20-46.

29. Barrett LF, Gross J, Christensen TC, Benvenuto M: **Knowing what you're feeling and knowing what to do about it: mapping the relation between emotion differentiation and emotion regulation**. *Cogn. Emot.* 2001, **15**:713-724.

30. Tomko RL, Lane SP, Pronove LM *et al.*: **Undifferentiated negative affect and impulsivity in borderline personality and depressive disorders: a momentary perspective**. *J. Abnorm. Psychol.* 2015, **124**:740-753.

31. Demiralp E, Thompson RJ, Mata J *et al.*: **Feeling blue or turquoise? Emotional differentiation in major depressive disorder**. *Psychol. Sci.* 2012, **23**:1410-1416.

32. Kashdan TB, Farmer AS: **Differentiating emotions across contexts: comparing adults with and without social anxiety disorder using random, social interaction, and daily experience sampling**. *Emotion* 2014, **14**:629-638.

33. Tugade MM, Fredrickson BL, Feldman-Barrett L: **Psychological resilience and positive emotional granularity: examining the benefits of positive emotions on coping and health**. *J. Pers. Soc. Psychol.* 2004, **72**:1161-1190.

34. Barrett LF, Mesquita B, Ochsner KN, Gross JJ: **The experience of emotion**. *Annu. Rev. Psychol.* 2007, **58**:373-403.

35. Barrett LF: **Discrete emotions or dimensions? The role of valence focus and arousal focus**. *Cogn. Emot.* 1998, **12**:579-599.

36. Schwarz N, Clore GL: **Mood, misattribution, and judgments of well-being: informative and directive functions of affective states**. *J. Pers. Soc. Psychol.* 1983, **45**:513-523.

37. Schwarz N: **Feelings as information: informational and motivational functions of affective states**. In *Handbook of Motivation and Cognition: Foundations of Social Behavior*, vol. 2.

Edited by Sorrentino RM, Higgins ET . New York: Guilford Press; 1990:527-561.

38. Schimmack U: **Pleasure, displeasure, and mixed feelings: are semantic opposites mutually exclusive?** *Cogn. Emot.* 2001, **15**:81-97.

39. Diener E, Iran Nejad E: **The relationship in experience between various types of affect**. *J. Pers. Soc. Psychol.* 1986, **50**:1031-1038.

40. Potter PT, Zautra AJ, Reich JW: **Stressful events and information processing dispositions moderate the relationship between positive and negative affect: implications for pain patients**. *Ann. Behav. Med.* 2000, **22**:191-198.

41. Zautra AJ, Reich JW, Davis MC, Potter PT, Nicolson NA: **The role**
• **of stressful events in the relationship between positive and negative affects: evidence from field and experimental studies**. *J. Pers.* 2000, **68**:927-951.
This study is the first to present data from two experimental studies designed to evaluate the Dynamic Model of Affect (DMA).

42. Reich JW, Zautra AJ, Potter PT: **Cognitive structure and the independence of positive and negative affect**. *J. Soc. Clin. Psychol.* 2001, **20**:99-115.

43. Zautra A, Smith B, Affleck G, Tennen H: **Examinations of chronic**
• **pain and affect relationships: applications of a dynamic model of affect**. *J. Consult. Clin. Psychol.* 2001, **69**:786-795.
This study is the first to provide empirical support for the Dynamic Model of Affect (DMA) in chronic pain populations.

44. Zautra AJ, Affleck GG, Tennen H, Reich JW, Davis MC: **Dynamic approaches to emotions and stress in everyday life: Bolger and Zuckerman reloaded with positive as well as negative affects**. *J. Pers.* 2005, **73**:1511-1538.

45. Davis MC, Zautra AJ, Smith BW: **Chronic pain, stress, and the**
• **dynamics of affective differentiation**. *J. Pers.* 2004, **72**:1133-1159.
A review of empirical and intervention studies that examine the evidence for the Dynamic Model of of Affect (DMA) in chronic pain populations.

46. Finan PH, Quartana PJ, Smith MT: **Positive and negative affect dimensions in chronic knee osteoarthritis: effects on clinical and laboratory pain**. *Psychosom. Med.* 2013, **75**:463-470.

47. Ong AD, Bergeman CS, Bisconti TL, Wallace KA: **Psychological**
• **resilience, positive emotions, and successful adaptation to stress in later life**. *J. Pers. Soc. Psychol.* 2006, **91**:730-749.
This study provides evidence for the Dynamic Model of Affect (DMA), finding that the distinction between positive and negative emotions varies both between individuals and within individuals over time as a function of individual differences in psychological resilience and changes in daily stress.

48. Ong AD, Bergeman CS, Bisconti TL: **The role of daily positive emotions during conjugal bereavement**. *J. Gerontol. Psychol. Sci. Soc. Sci.* 2004, **59B**:P168-P176.

49. Finan PH, Zautra AJ, Davis MC: **Daily affect relations in fibromyalgia patients reveal positive affective disturbance**. *Psychosom. Med.* 2009, **71**:474-482.

50. Martinez-Lavin M: **Biology and therapy of fibromyalgia. Stress, the stress response system, and fibromyalgia**. *Arthritis Res. Ther.* 2007, **9**:1-7.

51. Thieme K, Turk DC, Flor H: **Comorbid depression and anxiety in fibromyalgia syndrome: relationship to somatic and psychosocial variables**. *Psychosom. Med.* 2004, **66**:837-844.

52. Williams J, Peeters F, Zautra A: **Differential affect structure in depressive and anxiety disorders**. *Anxiety Stress Coping Int. J.* 2004, **17**:321-330.

53. Kang SM, Shaver PR: **Individual differences in emotional complexity: their psychological implications**. *J. Pers.* 2004, **72**:687-726.

54. Terracciano A, McCrae RR, Hagemann D, Costa PT Jr: **Individual difference variables, affective differentiation, and the structures of affect**. *J. Pers.* 2003, **71**:669-703.

55. Lane RD, Pollermann BZ: **Complexity of emotion representations**. In *The Wisdom in Feeling: Psychological Processes in Emotional Intelligence.* Edited by Salovey P, Barrett LF. New York: Guilford Press; 2002:271-293.

56. Zautra AJ, Johnson LM, Davis MC: **Positive affect as a source of resilience for women in chronic pain**. *J. Consult. Clin. Psychol.* 2005, **73**:212-220.

57. Palgi Y, Shrira A, Ben-Ezra M *et al.*: **Age-related and death-related differences in emotional complexity**. *Psychol. Aging* 2014, **29**:284-296.

58. Smith BW, Zautra AJ: **Vulnerability and resilience in women with arthritis: test of a two- factor model**. *J. Consult. Clin. Psychol.* 2008, **76**:799-810.

59. Zautra AJ, Reich JW: **Life events and perceptions of life quality: developments in a two-factor approach**. *J. Community Psychol.* 1983, **11**:121-132.

60. Cacioppo JT, Reis HT, Zautra AJ: **Social resilience: the value of social fitness with an application to the military**. *Am. Psychol.* 2011, **66**:43-51.

61. Zautra AJ, Arewasikporn A, Davis MC: **Resilience: promoting well-being through recovery, sustainability, and growth**. *Res. Hum. Dev.* 2010, **7**:221-238.

62. Hall JH, Zautra AJ: **Indicators of community resilience: what are they, why bother?** In *Handbook of Adult Resilience.* Edited by Reich JW, Zautra AJ, Hall JS. New York: Guilford Press; 2010350-375.

63. Zautra AJ: *Emotions, Stress and Health*. London: Oxford University Press; 2003.