

What develops during emotional development? A component process approach to identifying sources of psychopathology risk in adolescence

Katie A. McLaughlin, PhD; Megan C. Garrad, BA; Leah H. Somerville, PhD



Introduction

Adolescence is a phase of the lifespan associated with widespread changes in emotional behavior thought to reflect both changing environments and stressors, and psychological and neurobiological development. However, emotions themselves are complex phenomena that are composed of multiple subprocesses. In this paper, we argue that examining emotional development from a process-level perspective facilitates important insights into the mechanisms that underlie adolescents' shifting emotions and intensified risk for psychopathology. Contrasting the developmental progressions for the antecedents to emotion, physiological reactivity to emotion, emotional regulation capacity, and motivation to experience particular affective states reveals complex trajectories that intersect in a unique way during adolescence. We consider the implications of these intersecting trajectories for negative outcomes such as psychopathology, as well as positive outcomes for adolescent social bonds.

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Adolescence is a phase of the lifespan that begins around the onset of physical puberty and ends with the assumption of adult roles. This phase of the lifespan is associated with changes across widespread biological and psychological domains, including physical, social, cognitive, and emotional. In the emotional domain, although a typical adolescent is overall more happy than unhappy,¹ evidence does suggest that adolescents experience frequent and intense emotions that accompany a marked increase in their risk for mental disorders characterized by problems with emotion regulation. Here, we take a process-level perspective to evaluate why emotions differ from childhood and adulthood in this particular way.

Emotions comprise responses to environmental stimuli (termed antecedents) that manifest at multiple levels (eg, ref 2). Responses to antecedents occur at the subjective level (one's own evaluation of their emotional state or *affect*), at the physiological level (arousal and stress responses via the peripheral nervous system), and at the regulatory level (motivation to, and success in, altering

Author affiliations: Department of Psychology, University of Washington, Seattle, Washington, USA (Katie A. McLaughlin); Department of Psychology, Harvard University, Cambridge, Massachusetts, USA (Megan C. Garrad, Leah H. Somerville)

Address for correspondence: Leah H. Somerville, 52 Oxford Street, Room 290, Cambridge MA 02138, USA
(email: somerville@fas.harvard.edu)

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Clinical research

emotional experiences), among others. Here we consider how these emotional subprocesses develop from childhood to adulthood with a particular focus on changes that accompany the transition to adolescence. Specifically, we examine how exposure to emotional antecedents changes during adolescence, whether adolescents have a biological propensity to experience particularly intense emotional responses, and, finally, whether emotion regulation strategies are different during adolescence as compared with other developmental stages. Incorporating what is known about the fundamental tenets of pubertal and adolescent development, we consider putative mechanisms that underlie developmental shifts in emotional subprocesses. Finally, we explore the positive and negative consequences of these patterns of emotional development during the transition to adolescence.

Adolescents' daily emotional experiences

Developmental studies that assess variance, valence, and intensity of daily, self-reported mood suggest that adolescence reflects a change in daily affective experience. A longitudinal study of 220 youth revealed that average emotional states became progressively more negative from early to middle adolescence.¹ Subsequent studies have documented a similar overall effect in mid-to-late adolescence, and further specified that these mood shifts are attributable to a continual deterioration of daily positive affect (as opposed to an increase in negative affect).³ In terms of clinical symptoms, adolescent girls endorse higher levels of depressed mood than boys.^{3,4} Changes in daily mood can also relate to shifts in adolescents' quality of life. Flook⁵ found that in adolescent girls, negative mood predicted more negative interpersonal events and fewer positive interpersonal events, while a positive mood predicted fewer negative interpersonal events.

Compared with children and adults, adolescents also experience more intense emotions in both positive and negative domains. In experience-sampling studies, adolescents have been observed to transition through emotional states more rapidly and are more likely to react to situations with a mix of positive and negative affect compared with children.^{1,6} Additionally, stressors elicit stronger negative affect among adolescents than children,⁷ suggesting that adolescents experience stronger associations between stressful events and the emergence of negative affect.

Endogenous and exogenous emotional triggers during adolescence

Emotional antecedents

Given the minefield of major life changes that adolescents face, it is perhaps no surprise that adolescents experience less positive and more variable mood states than at other points in development. During adolescence, individuals' social groups grow, become more complex, and individuals experience more frequent fluctuations in affiliation and status⁸ while concerns of social evaluation increase.⁹ As adolescents transition from childhood, they begin to spend less time with their parents and more time with peers.^{10,11} Adolescents also begin to make increasingly independent decisions about how to navigate the world based on a very limited experience base. This combination of independence and inexperience can feel particularly weighty to adolescents as their decisions can have life-altering consequences for their proximal educational and occupational goals.¹² Adolescence is also characterized by dramatic shifts in physical state such as growth spurts, pubertal hormonal surges,^{13,14} and shifts in sleep patterns that conflict with the demands of modern society.¹⁵ Models of adolescent development refer to these concurrent shifts as a "pile-up" of emotional stressors,¹⁶ highlighting the challenges faced by adolescents as they attempt to understand and manage their changing bodies, relationships, and responsibilities.

A critical issue worth considering is whether variation in daily affective states during adolescence compared with other developmental periods is simply the result of the intense, stressful, and uncertain environments they live in and their affective motivations, rather than an underlying developing process. If the marked differences in adolescents' emotional reactivity was solely due to the introduction of new and unique life stressors, laboratory tests with strictly controlled environmental conditions would yield no differences in affect among children, adolescents, and adults. However, these differences continue to be observed, suggesting that unique emotional subprocesses are at work during adolescence that contribute to distinct patterns of emotional reactivity.

Motivation to achieve emotional states

Motivational factors can contribute to emotional experiences, in that an individual could choose to "seek

out” preferred emotional states. The concept of *ideal affect* has been examined extensively in cross-cultural studies,¹⁷ but much less more frequently in developmental studies. However, available evidence suggests that, unlike adults, adolescents endorse a desire to seek out and maintain negative emotions at the expense of positive emotions. A study by Riediger and colleagues⁶ used experience sampling to collect information about daily affect in tandem with the degree of motivation to maintain or even enhance that affective state. Results showed that, relative to adults, adolescents endorse a greater desire to enhance their negative affect and reduce their positive affect in daily life, a phenomenon termed counter-hedonic motivation. This suggests that in addition to the stressful, uncertain environments adolescents face in daily life, affective responses to these environments might actually be consistent with adolescents’ desire to achieve and maintain particular emotional states.

What qualities of emotional reactions change during adolescence?

Physiological reactivity

One dimension of emotional reactivity involves physiological responses to emotional antecedents. This includes activation of the sympathetic division of the autonomic nervous system (ANS) and the hypothalamic-pituitary-adrenal (HPA) axis. Evidence from both animal and human studies indicates that adolescence is characterized by heightened physiological reactivity to environmental stimuli, including reactions to experiences of stress. Rodent models have revealed key linkages between the systemic hormonal changes that are a hallmark of puberty on one hand, and physiological reactivity in the ANS and HPA axis on the other.¹⁴

In humans, adolescents exhibit amplified physiological reactivity to social evaluation and to performance-related stressors as compared with children.^{18,19} Similar patterns of heightened physiological reactivity in response to social rejection among adolescents relative to children have been observed in other markers, such as pupil dilation.²⁰ Other work suggests that even situations involving the possibility of social evaluation, such as being observed on a video camera by a peer, generate greater autonomic arousal and embarrassment in adolescents as compared with children and adults.²¹

This is consistent with a broad set of findings indicating that adolescents exhibit unique patterns of neural activation when thinking about the cognitive and emotional states of other people as compared with children or adults,²² which may ultimately contribute to their distinct profiles of emotional responses in social situations. The transition to adolescence is thus accompanied by stronger physiological responses across multiple regulatory systems to environmental antecedents and to social and evaluative situations in particular. Adolescents’ increased physiological sensitivity to social and emotional provocation likely has widespread influences on social behavior, decision-making, and mental health.

Subjective affect

Although the heightened physiological reactivity of adolescence is consistent with “storm and stress” models of adolescence, it is important to acknowledge that adolescence does not constitute a period of consistently elevated reactivity. Studies assessing self-reported affect in children, adolescents, and adults while viewing aversive pictures²³ have demonstrated that self-report measures of emotional intensity do not differ much among children, adolescents, and adults.^{24,25} However, these findings contrast with findings that suggest developmental variation in emotional reactivity specifically within the social context.²⁶ In laboratory experiments designed to deliver genuine social acceptance and rejection cues, adolescents experience stronger reductions in self-reported mood and more dramatic increases in anxiety than adults when excluded from a virtual ball-tossing game with a supposed peer²⁷; similarly, adolescents report greater increases in positive mood when receiving socially accepting feedback from a desirable peer than adults.²⁸ Available evidence thus suggests that developmental variation in emotional reactivity is highly dependent on the type of provocation and that heightened physiological and subjective responses to emotional provocation during adolescence might emerge only in response to situations involving self-relevant social information.

Emotional regulation

Once an emotional response has been generated, regulatory processes can be deployed to alter the intensity and valence of the affective experience. Despite their

Clinical research

relative emotional volatility, adolescents generally exhibit improvements in emotion regulation abilities compared with children. As cognitive control increases progressively from childhood through adolescence and adulthood,²⁹⁻³¹ enhancements in cognitive control efficiency might contribute to enhanced ability to regulate emotions, particularly through effortful strategies like cognitive reappraisal.

Cognitive reappraisal is a form of emotion regulation whereby an individual attempts to alter the meaning of an emotional cue through cognitive reinterpretation. In a developmental study of cognitive reappraisal in response to negative situations, robust age-related increases were observed in the efficacy of reappraisal in reducing negative affect.²⁵ However, reappraisal efficacy was significantly worse in adolescents compared with children and adults when the stimuli depicted negative social interactions or social suffering,²⁵ suggesting important contextual variation in regulatory abilities during adolescence. This pattern provides additional evidence that changes in emotional processing during adolescence are most apparent in situations with high social salience. These are also the contexts in which the emotion regulation capacity of adolescents is particularly taxed.

Motivation to regulate emotions also differs in key ways among adolescents compared with adults. Although adolescents engage in reappraisal strategies more effectively than children,³² they still use reappraisal less frequently in daily life than adults do.³³ Furthermore, adolescents are less likely to try to distract themselves in order to avoid an emotionally distressing cue and are more likely to ruminate in response to stress relative to children.³⁴ Although these interesting findings point to potential motivational mechanisms for emotion regulation, more research is needed to disentangle the developmental course of regulatory abilities from regulatory motivations, and the impact of each on emotional functioning.

Neurodevelopmental mechanisms of emotional change

How does the developing brain contribute to shifts in emotional behavior through adolescence? Although this is an active area of research, many fundamental, unanswered questions remain. For one, to understand the neurodevelopmental shifts in emotional behavior,

one must first understand what neural circuitry is involved in emotional processing. In contrast with models that take a “locationist” perspective attributing particular emotions to particular brain regions, recent meta-analytic efforts have shown that a diverse array of brain regions interact to dynamically represent emotional information.^{35,36} These new insights have provoked new research directions that expands the neural “search space” for emotional development.³⁷

Research to date has focused on a circumscribed set of brain regions have revealed that components of emotion processing circuitry have distinct developmental trajectories that could contribute to changes in emotional behavior.³⁸ One emotion processing center is the amygdala, a structure in the medial temporal lobe that detects important information in the environment and through dense modulatory projections, orchestrates learning and physiological reactions to threats and other salient information.³⁹ Studies focusing on the functioning of the amygdala have found either exaggerated reactivity patterns in adolescents compared with earlier or later ages,^{40,41} or alternatively maximal activity in young children that diminishes through adolescence into early adulthood.⁴² Conversely, the prefrontal cortex—which plays a central role in the effortful emotion regulation—shows continued development through adolescence, and could constrain the efficiency of emotion regulation.^{24,43} Finally, the interactions within cortical-subcortical circuitries that process emotion show late-developing trajectories which shift in their interaction profiles through adolescence.⁴² To summarize, dynamic neurodevelopmental changes in emotion processing circuitry could contribute to the intensity of emotions experienced during adolescence.

Consequences of developmental shifts in emotional responding

The developmental shifts in antecedents, motivations, emotional responses, and regulation strategies that occur in adolescence have important implications for the development of psychopathology during this period. Adolescence is characterized by particularly high risk for the onset of many common forms of psychopathology, including major depression, eating disorders, substance use disorders, and some anxiety disorders.⁴⁴⁻⁴⁷ Indeed, the median age of onset for many mental disorders occurs during adolescence.⁴⁷ It is likely that this

risk is driven, at least in part, by developmental changes in multiple emotional processes occurring during adolescence.

First, developmental changes in emotional antecedents almost certainly contribute to heightened risk for psychopathology among adolescents. Exposure to stressors are potent risk factors for many forms of psychopathology,⁴⁸⁻⁵² and perceptions of stress and daily hassles increase during adolescence as compared with childhood.^{7,53,54} The changing social dynamics of adolescence present innumerable challenges for adolescents to navigate. These include higher levels of conflict with parents and disappointments and frustrations in achievement-related domains. Changes in peer and romantic relationships create greater opportunities for social evaluation as well as increased greater opportunities for adolescents' own behaviors to play a role in generating stressors in their interpersonal relationships.^{49,55} Each of these emotional antecedents have been associated with risk for psychopathology in previous research.⁵⁵⁻⁵⁷

Second, the elevations in emotional and physiological reactivity and greater emotional lability that are characteristic of adolescence also contribute to psychopathology risk during this developmental period. In studies using a wide range of methodologies, heightened emotional intensity and reactivity to environmental cues are consistently associated with higher levels of internalizing psychopathology—including anxiety and depression. This pattern has been observed in laboratory-based studies examining self-reported emotional and physiological responses to emotionally provocative stimuli,⁵⁸⁻⁶² fMRI studies examining neural response to facial emotion,⁶³⁻⁶⁶ and experience sampling studies that measure emotional responses in real-world situations.^{67,68} Together, these studies provide clear evidence that the developmental shifts in the magnitude of emotional responses to socially relevant stimuli are powerful factors underlying the increased risk for depression and anxiety that occurs during adolescence.

Finally, developmental variation in the utilization of emotion regulation strategies may additionally contribute to increased vulnerability for psychopathology during adolescence. For example, adolescents engage in rumination in response to distress more frequently than children.³⁴ Habitual rumination has consistently been associated with increased risk for anxiety, depression, substance use problems, and eating pathology in

prospective studies.⁶⁹⁻⁷² Adolescents are also less likely than adults to use some effective and adaptive emotion regulation strategies, like cognitive reappraisal.⁷³ In turn, low use of cognitive reappraisal to modulate to negative emotions has been observed in multiple forms of psychopathology.^{58,74-76}

Even for adolescents who utilize adaptive regulation strategies, the confluence of increased exposure and perception of emotional antecedents and the elevated subjective and physiological responses to those antecedents that occur may overwhelm the ability to effectively regulate emotional responses. Indeed, the interpersonal stressors that occur with greater frequency during this period are associated with disruptions in adolescents' ability to effectively regulate their emotions. Interpersonal stressors are associated with subsequent changes in emotional responses (eg, maladaptive expression of sadness and anger), poor emotional awareness, and engagement in maladaptive emotion regulation strategies like rumination.⁷⁷⁻⁷⁹ Adolescents who exhibit these types of emotional responses and habitually use maladaptive emotion regulation strategies are more likely to develop anxiety, depression, aggressive behavior, substance use problems, and eating pathology over time than adolescents who express and regulate emotions more adaptively.^{67,70,72,77-81}

Summary and conclusions

Although more research is needed that takes a process-level approach to understanding emotional development, particularly in diverse cultural contexts, initial findings suggest that the subprocesses involved in adolescents' increasingly complex emotional life follow a number of distinct trajectories. Some aspects of complex emotional behavior seem to develop along a linear trajectory (such as progressive improvements in reappraisal capacity) whereas other subcomponents of complex emotion change in a nonlinear fashion (adolescent peaks in daily stressors, physiological reactions, and risk for psychopathology). If we were to view only the range on these trajectories that encompasses adolescence, we would surmise that adolescents experience mixed affect, of varying extremes, while they are living in a naturally stressful phase of the lifespan. We could also deduce that their capacity to regulate emotions is robust but still developing, and they are less motivated to regulate negative emotions than adults are. This pic-

Clinical research

ture of adolescence allows us to take a process-level approach to understanding adolescents' emotional behavior that will not only provide fundamental theoretical insights into how the mind gives rise to emotion, it could also lead to more precise, developmentally tailored approaches to treating psychopathology.

Advantages of emotions “running hot” in adolescence

The long-held stereotype of adolescents as ill-tempered, unpredictable, and intense promotes the idea that adolescents exhibit dysfunctional emotional behavior. However, the same processes that make adolescents more vulnerable to developing risk for psychopathology can also be viewed as critical to healthy social and emotional development. For instance, emotion regulation strategies typically thought of as maladaptive in children and adults have can be highly beneficial to adolescents in other domains of their lives. One example is corumination, defined as excessive discussion of personal problems with friends.⁸² Use of this emotion regulation strategy is associated with increased friend-

ship quality in both cross-sectional and longitudinal studies^{82,83}; however, greater corumination also predicts higher levels of anxiety and depression over time in girls but not boys.⁸³ Although the specific factors that contribute to this sex difference are unknown, it is consistent with extensive evidence for sex differences in peer relationships processes during adolescence.⁸⁴ This finding leads to the surprising conclusion that negative emotions might help adolescents connect with their peers, rather than alienating them from the group. The increased closeness that adolescents feel with friends while “chewing on” negative emotions together may be a potent reason for adolescents' contra-hedonic motivation to experience negative affect. Indeed, the intense and precipitate nature of adolescents' emotions may help facilitate important benchmarks of development such as establishing autonomy from parents, independent self-exploration and learning, and forming close relationships with peers. The turbulent emotional life of adolescents could therefore be viewed as indispensable in initiating the final stages of psychological and neurobiological development. □

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¿Qué se desarrolla durante el desarrollo emocional? Un enfoque para el procedimiento de identificación de las fuentes de riesgo de psicopatología en la adolescencia

La adolescencia es una fase de la vida que se asocia con cambios generalizados en la conducta emocional, lo que se piensa refleja tanto cambios ambientales y de estresores, como desarrollo psicológico y neurobiológico. Sin embargo, las emociones en sí mismas son fenómenos complejos que están compuestos por múltiples subprocesos. En este artículo se postula que el examen del desarrollo emocional desde una perspectiva a nivel de procesos facilita importantes conocimientos acerca de los mecanismos que subyacen a las emociones cambiantes de los adolescentes y al aumento del riesgo de psicopatología. En contraste con el progreso del desarrollo, los antecedentes de la emoción, la reactividad fisiológica a la emoción, la capacidad de regulación emocional y la motivación para experimentar determinados estados afectivos revelan complejas trayectorias que se intersectan de manera singular durante la adolescencia. Se consideran las implicancias de estas intersecciones, tanto en términos de consecuencias negativas como la psicopatología, así como de resultados positivos para los vínculos sociales de los adolescentes.

Que se passe-t-il au cours du développement émotionnel ? Un modèle par processus composants pour identifier les origines du risque psychopathologique à l'adolescence

L'adolescence est un moment de la vie associé à des changements amples du comportement émotionnel, supposés refléter des modifications de l'environnement et des facteurs de stress ainsi que le développement psychologique et neurobiologique. Les émotions elles-mêmes sont cependant des phénomènes complexes composés de sous-processus multiples. Dans cet article, nous pensons que l'examen du développement émotionnel par niveau du processus permet d'avoir une meilleure idée des mécanismes sous-tendant les changements d'émotion des adolescents et intensifiant le risque d'apparition d'une psychopathologie. Opposer les progressions du développement pour les antécédents émotionnels, la réactivité physiologique à l'émotion, la capacité de régulation émotionnelle et la motivation à expérimenter des états affectifs particuliers révèle des trajectoires complexes qui se croisent de façon unique à l'adolescence. Nous analysons les implications de ces trajectoires croisées pour des résultats négatifs comme une psychopathologie, ainsi que pour des résultats positifs comme les liens sociaux à l'adolescence.

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