

Adolescence as a pivotal period for emotion regulation development

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Abstract

Adolescence is a dynamic period for the development of emotion regulation. For many individuals, emotion regulation skills improve dramatically during adolescence. However, for some youth adolescence marks the beginning or worsening of psychopathology characterized by difficulties with emotion regulation. In the present review, I describe evidence that caregiving experiences play an outsized role in shaping interindividual variability in emotion regulation during adolescence. After describing work demonstrating links between caregiving – with an emphasis on parental socialization practices – and emotion regulation outcomes, I characterize our current understanding of how behavioral and neurobiological indices of emotion regulation develop normatively across adolescence. Using cognitive reappraisal as an exemplar emotion regulation strategy, I outline ways that caregiving might impact interindividual variability in emotion regulation neurodevelopment. I conclude by identifying two key future directions for adolescent emotion regulation research.

1. Introduction

Adolescence is a dynamic period for the development of emotion regulation (ER), a collection of implicit and explicit skills that can be used to monitor, evaluate, and modify emotional responses in accordance with one's goals [1–4]. Key developmental tasks in adolescence – including achieving greater independence from caregivers who scaffold ER in childhood, and navigating significant social, cognitive and biological changes – pose significant self-regulatory challenges. Many individuals respond to these challenges by strengthening and refining their ER skills, but for some, adolescence is marked by emergent or worsening difficulties with ER and associated psychopathology. What factors contribute to normative improvements in ER during adolescence? Likewise, what explains phenotypic heterogeneity in ER during this period? Here, I submit that caregivers socialize ER practices, which contributes to ER development in adolescence. Next, I will suggest that adolescence is a period wherein ER strategies – with a focus on cognitive reappraisal, which involves thinking about emotional stimuli differently so as to change their affective import, as an exemplar strategy – are honed in accordance with socialization experiences as well as intrinsic factors. Finally, I will conclude by outlining future directions for the field.

2. Caregivers shape emotion regulation processes across development

Influential theoretical models posit that parents influence emotion in general and ER in particular across multiple mechanisms and timescales [5–7]. Cumulatively, this work has revealed that mere parental presence can powerfully regulate children's emotional behavior, physiology and neurobiology [8–11]. Beyond simply being present, parents also actively engage in “emotion socialization behaviors” (ESBs) that include modeling and coaching their children's emotional behavior, as well as setting the emotional tone for their family context [6,7]. Unsurprisingly, a parent's own ER skills, their parenting behaviors and the broader emotional context in which a child is raised tend to be highly intercorrelated. As such, a key theme in contemporary parent-child ER research is to formally parse the contributions of various environmental inputs on child ER. One impressive example of this comes from a recent study that sought to decompose the relative influence of parent ER and child adversity exposure on child ER [12]. Strikingly, Milojevic and colleagues found that parent ER continued to predict child ER after controlling for adversity exposure, but not the other way around. This finding, together with work linking parent ER skills to optimal caregiving [13], suggest that improving parent ER skills could be an indirect but powerful mechanisms for promoting positive ER development in youth, and particularly in youth at risk for ER difficulties due to adversity exposure [14–16]. One way that parent ER skills can impact children's ER development is through the ESBs they use [17–19]. Cross-sectional data has shown that “positive” parental ESBs (i.e., caregiver warmth and emotional sensitivity) are associated with better ER outcomes in youth (see [7] for a review), ranging from more frequent use of reappraisal in early-middle childhood [20], to better psychosocial adjustment in adolescence [21]. More recently, longitudinal studies have built upon this knowledge base to demonstrate that positive parent ESBs (typically assessed in childhood or early adolescence) confer better ER and psychosocial outcomes in both typically developing youth as well as youth with psychiatric diagnoses [17,21–24]. For example, one recent study found that positive parental ESBs at age 5 predicted better socioemotional adjustment at age 15, and notably, that this relationship was explained by enhanced ER at age 10 [25]. The temporal sequencing of this study suggests that parental ESBs are *causing* improvements in child ER, and that childhood caregiving practices continue to impact wellbeing into adolescence. Relatedly, a

new line of research suggests that parental ESBs exert differential effects on child ER depending on developmental stage. For example, one recent study found that while general forms of parental emotional support (displaying warmth and acceptance) was associated with better ER in both older and younger adolescents, hands-on parental support (e.g., emotional coaching) benefited only younger adolescents [26]. These results suggest that more active forms of parental support are beneficial at earlier stages of development but likely offer diminishing returns as children seek out more emotional autonomy in adolescence.

Complementing the aforementioned developmental analyses on parental ESBs are a growing number of studies using neuroimaging methods to uncover how parental ESBs impact specific features of ER neurodevelopment in adolescence. Both extreme forms of caregiving adversity (e.g., deprivation) and normative variations in caregiving experiences (e.g., different parent-child attachment styles) influence development of prefrontal-amygdala circuitry [27,28]. Given that prefrontal-amygdala circuitry is critical for supporting ER in adults, such findings suggest that caregivers externally scaffold ER development and sculpt ER circuitry in childhood until individuals are neurodevelopmentally mature enough to self-regulate in adolescence [29]. At present, very few neuroimaging studies have specifically examined the effects of parental ESBs on ER neurodevelopment. However, preliminary evidence suggests that exposure to negative parental ESBs in early childhood presages negative medial prefrontal (mPFC)-amygdala connectivity (a more “adult-like” neurophenotype) in response to emotional stimuli in late childhood and adolescence [30,31]. These findings together with work in youth exposed to caregiving adversity, suggest that caregiving experiences dynamically adjust the developmental pacing of mPFC-amygdala circuitry involved in implicit ER processes (e.g., extinction learning) [27]. Given theoretical and empirical evidence that neural circuits supporting implicit ER develop prior to those underlying explicit ER (e.g., cognitive reappraisal), this could suggest that parents scaffold implicit ER development in childhood, which in turn supports the development of explicit ER in adolescence [4,32].

3. Neurodevelopment of ER in adolescence

While children rely heavily on caregivers to regulate their emotions, adolescents are increasingly likely to turn to friends or themselves to regulate emotion. As adolescents change in their propensity to self-regulate, so too does the way that adolescents self-regulate change. Consistent with characterizations of adolescence as a critical period for the development of higher-order cognitive processes [33], adolescents use cognitive self-regulatory strategies a higher proportion of the time than children and are more flexible at switching between different cognitive strategies as well [34,35]. Age-related differences are apparent not only in terms of how adolescents use classes of ER strategies (e.g., cognitive strategies), but also specific strategies (e.g., cognitive reappraisal). Here, I focus on the strategy cognitive reappraisal because its is associated with mental health [36], is modifiable by intervention [37], and has been studied in developmental populations using multiple modalities [4]. Reappraisal capacity (i.e., the ability to reappraise effectively) and the tendency to use reappraisal to regulate emotion in everyday life are relatively independent of one another and are often assessed using different methods [38]. While cross-sectional studies have yielded mixed age results regarding reappraisal tendency in adolescence, longitudinal data suggest that age does not predict intra-individual changes in the tendency to use reappraisal [39–41]. By contrast, studies examining reappraisal capacity demonstrate steep age-related improvements from childhood through mid-adolescence that plateau during late

adolescence (though notably, no published longitudinal studies of reappraisal capacity exist) [32,42,43]. Together, these findings suggest that individuals hone their reappraisal skills in adolescence but do not necessarily use said skills more frequently.

Neuroimaging research can provide a useful mechanistic perspective on how and when adolescents acquire the ability to reappraise [44]. Prior research in adults has suggested that reappraisal is instantiated by robust recruitment of dorsal and lateral prefrontal regions known to support cognitive control processes (dorsomedial, dorsolateral and ventrolateral prefrontal cortex), and that this prefrontal engagement in turn attenuates amygdala responses to affective stimuli [45]. In childhood, however, reappraisal appears to *increase*, rather than decrease, amygdala activity [32,46]. These findings suggest that reappraisal might be counterproductive for children – though some preliminary evidence suggests that children can reappraise more effectively when assisted by their parent [10]. In adolescence, reappraisal begins to attenuate amygdala responses with continued linear age-related decreases in amygdala responses observed until young adulthood [32,47,48]. Such findings dovetail nicely with behavioral evidence that reappraisal buffers against negative mental health outcomes in adolescence, but not necessarily childhood [34]. The emergence of reappraisal as an effective strategy in adolescence appears linked to the fact that adolescents recruit dorsal and lateral prefrontal regions to support reappraisal [32,48–50], though said prefrontal recruitment continues to increase with age across adolescence [32,50]. One recent study suggests that the overall magnitude of activation of lateral prefrontal cortex may be just one feature of reappraisal-related neurodevelopment, and that the extent to which specific subregions of ventrolateral prefrontal cortex are selectively activated may be particularly predictive of reappraisal skill [51]. These findings cumulatively suggest that reappraisal skills may promote mental health – but only once the neural machinery needed to support such skills is in place – and that functional specialization in ventrolateral prefrontal cortex may be a key neurodevelopmental ingredient in supporting reappraisal skill acquisition.

At present, it is relatively unknown what experiential factors contribute to behavioral and neural markers of reappraisal ability in adolescence. However, one intriguing possibility is that parent ESBs (e.g., caregivers regularly modeling reappraisal use) provide adolescents with rich ER experiences across development, that directly or indirectly tune lateral prefrontal development and associated reappraisal skills. While no work has explicitly tested this hypothesis, there is evidence that parent ER skills positively predict child ER skills via prefrontal synchrony [52], and also that negative parental ESBs predict less engagement of lateral prefrontal regulatory regions [28,53], thus supporting the notion that parental inputs modify lateral prefrontal function involved in ER. There are also data from adults suggesting that repeated exposure to reappraisal elicits more constrained and specific patterns of ventrolateral recruitment in adults [54], underscoring the fact that repeated exposure to an ER strategy can sculpt associated regulatory circuitry. Together, these datapoints imply that caregiving practices shape a youth's ER context and that this may in turn tune lateral prefrontal circuitry involved in reappraisal. Among other things, this suggests that one reason youth who have experienced caregiving adversity (i.e., abuse, neglect or institutional caregiving) are at risk for ER difficulties is because they lack the means of learning ER strategies from a caregiver. This together with evidence that youth who acquire reappraisal skills in spite of their caregiving adversity history are more likely to be resilient again psychopathology than those who do not [55,56], suggests that training adolescents

exposed to caregiving adversity to use strategies like reappraisal might be a particularly effective means of buffering against mental health symptoms.

4. Conclusions and future directions for research on adolescent ER development

In the first section of this review, I described how caregiving experiences and specifically parental ESBs, tune ER development. I subsequently summarized behavioral and neuroscientific evidence about how ER ability, with an emphasis on reappraisal, develops across adolescence but also differs substantially between individuals. In this final section, I will briefly outline two key future directions for research on adolescent ER development. The first future direction for the field will be to more carefully consider the social context when investigating adolescent ER. This is critical not only because social situations are particularly evocative for adolescents [42], but also because social ties may represent a relatively untapped resource for improving ER skills in adolescence. A rich body of literature examining caregiver interventions in young children [57], as well as emerging work examining friendships in young adults [58], suggest that close relationships can be capitalized on to teach and enhance ER skills – including reappraisal. Despite the fact that adolescents are highly sensitive to social influences (particularly from peers), far less research has sought to understand or improve adolescent ER through a social lens. Future basic research might benefit from carefully examining how parents and friends differentially modulate ER processes as individuals progress from childhood to adolescence to adulthood. At the same time, translational research might test whether adolescents show greater gains in ER if interventions are delivered directly, or through friends or caregivers. A second future direction will be to leverage longitudinal neuroimaging studies to characterize developmental mechanisms underlying ER development. Longitudinal questionnaire and behavioral research have significantly informed our understanding of ER development [7], but there remains a scarcity of longitudinal neuroimaging research examining ER. It will be critical to fill this knowledge gap to better characterize normative developmental change as well as how caregiving and other contextual factors mechanistically shape divergent ER trajectories. For example, longitudinal designs could be leveraged to test which specific dimensions of caregiving in childhood predict neural markers of ER skill in adolescence. Such work has the capacity to not only inform our scientific understanding of adolescent ER, but also to optimize interventions during a pivotal period for mental health and wellbeing.

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References

- [1] J.J. Gross, Emotion Regulation: Past, Present, Future, *Cognition & Emotion*. 13 (1999) 551–573. <https://doi.org/10.1080/026999399379186>.
- [2] R.A. Thompson, EMOTION REGULATION: A THEME IN SEARCH OF DEFINITION, *Monographs of the Society for Research in Child Development*. 59 (1994) 25–52. <https://doi.org/10.1111/j.1540-5834.1994.tb01276.x>.
- [3] L.M. Braunstein, J.J. Gross, K.N. Ochsner, Explicit and implicit emotion regulation: a multi-level framework, *Social Cognitive and Affective Neuroscience*. 12 (2017) 1545–1557. <https://doi.org/10.1093/scan/nsx096>.
- [4] J.A. Silvers, Extinction Learning and Cognitive Reappraisal: Windows Into the Neurodevelopment of Emotion Regulation, *Child Dev Perspect*. 14 (2020) 178–184. <https://doi.org/10.1111/cdep.12372>.
- [5] N. Eisenberg, A. Cumberland, T.L. Spinrad, Parental Socialization of Emotion, *Psychol Inq*. 9 (1998) 241–273. https://doi.org/10.1207/s15327965pli0904_1.
- [6] A.S. Morris, J.S. Silk, L. Steinberg, S.S. Myers, L.R. Robinson, The Role of the Family Context in the Development of Emotion Regulation, *Social Development*. 16 (2007) 361–388. <https://doi.org/10.1111/j.1467-9507.2007.00389.x>.
- [7] A.S. Morris, M.M. Criss, J.S. Silk, B.J. Houlberg, The Impact of Parenting on Emotion Regulation During Childhood and Adolescence, *Child Dev Perspect*. 11 (2017) 233–238. <https://doi.org/10.1111/cdep.12238>.
- **This review provides a current and comprehensive framework for how caregiving influences emotion regulation development across childhood and adolescence.
- [8] D.G. Gee, L. Gabard-Durnam, E.H. Telzer, K.L. Humphreys, B. Goff, M. Shapiro, J. Flannery, D.S. Lumian, D.S. Fareri, C. Caldera, N. Tottenham, Maternal Buffering of Human Amygdala-Prefrontal Circuitry During Childhood but Not During Adolescence, *Psychol Sci*. 25 (2014) 2067–2078. <https://doi.org/10.1177/0956797614550878>.
- [9] C.E. Hostinar, A.E. Johnson, M.R. Gunnar, Parent support is less effective in buffering cortisol stress reactivity for adolescents compared to children, *Dev Sci*. 18 (2015) 281–297. <https://doi.org/10.1111/desc.12195>.
- [10] S. Myruski, T. Dennis-Tiwary, Biological signatures of emotion regulation flexibility in children: Parenting context and links with child adjustment, *Cogn Affect Behav Neurosci*. (2021). <https://doi.org/10.3758/s13415-021-00888-8>.
- [11] N. Tottenham, M. Shapiro, J. Flannery, C. Caldera, R.M. Sullivan, Parental presence switches avoidance to attraction learning in children, *Nat Hum Behav*. 3 (2019) 1070–1077. <https://doi.org/10.1038/s41562-019-0656-9>.
- [12] H.M. Milojevich, L. Machlin, M.A. Sheridan, Early adversity and children's emotion regulation: Differential roles of parent emotion regulation and adversity exposure, *Dev Psychopathol*. 32 (2020) 1788–1798. <https://doi.org/10.1017/S0954579420001273>.
- *This study demonstrates that parent emotion regulation can exert greater influences on child emotion regulation than early adversity.
- [13] A. Crandall, K. Deater-Deckard, A.W. Riley, Maternal emotion and cognitive control capacities and parenting: A conceptual framework, *Developmental Review*. 36 (2015) 105–126. <https://doi.org/10.1016/j.dr.2015.01.004>.

- [14] N.J. Hajal, B. Paley, Parental emotion and emotion regulation: A critical target of study for research and intervention to promote child emotion socialization., *Developmental Psychology*. 56 (2020) 403–417. <https://doi.org/10.1037/dev0000864>.
- [15] A.S. Méndez Leal, J.A. Silvers, Neurobiological Markers of Resilience to Early-Life Adversity During Adolescence, *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*. (2020) S2451902220302391. <https://doi.org/10.1016/j.bpsc.2020.08.004>.
- [16] J.A. Seddon, R. Abdel-Baki, S. Feige, K. Thomassin, The Cascade Effect of Parent Dysfunction: An Emotion Socialization Transmission Framework, *Front. Psychol.* 11 (2020) 579519. <https://doi.org/10.3389/fpsyg.2020.579519>.
- [17] L.J. Boldt, K.C. Goffin, G. Kochanska, The significance of early parent-child attachment for emerging regulation: A longitudinal investigation of processes and mechanisms from toddler age to preadolescence., *Developmental Psychology*. 56 (2020) 431–443. <https://doi.org/10.1037/dev0000862>.
- [18] J.E. Cooke, L.B. Kochendorfer, K.L. Stuart-Parrigon, A.J. Koehn, K.A. Kerns, Parent–child attachment and children’s experience and regulation of emotion: A meta-analytic review., *Emotion*. 19 (2019) 1103–1126. <https://doi.org/10.1037/emo0000504>.
- [19] S. Meyer, H.A. Raikes, E.A. Virmani, S. Waters, R.A. Thompson, Parent emotion representations and the socialization of emotion regulation in the family, *International Journal of Behavioral Development*. 38 (2014) 164–173. <https://doi.org/10.1177/0165025413519014>.
- [20] C. Gunzenhauser, A. Fäsche, W. Friedlmeier, A. von Suchodoletz, Face it or hide it: parental socialization of reappraisal and response suppression, *Front. Psychol.* 4 (2014). <https://doi.org/10.3389/fpsyg.2013.00992>.
- [21] L. Cui, M.M. Criss, E. Ratliff, Z. Wu, B.J. Houlberg, J.S. Silk, A.S. Morris, Longitudinal links between maternal and peer emotion socialization and adolescent girls’ socioemotional adjustment., *Developmental Psychology*. 56 (2020) 595–607. <https://doi.org/10.1037/dev0000861>.
- [22] R.P. Breaux, J.D. McQuade, E.A. Harvey, R.J. Zakarian, Longitudinal Associations of Parental Emotion Socialization and Children’s Emotion Regulation: The Moderating Role of ADHD Symptomatology, *J Abnorm Child Psychol.* 46 (2018) 671–683. <https://doi.org/10.1007/s10802-017-0327-0>.
- [23] S.F. Thompson, M. Zalewski, C.J. Kiff, L. Moran, R. Cortes, L.J. Lengua, An empirical test of the model of socialization of emotion: Maternal and child contributors to preschoolers’ emotion knowledge and adjustment., *Developmental Psychology*. 56 (2020) 418–430. <https://doi.org/10.1037/dev0000860>.
- [24] X. Zhang, L.M. Gatzke-Kopp, G.M. Fosco, K.L. Bierman, Parental support of self-regulation among children at risk for externalizing symptoms: Developmental trajectories of physiological regulation and behavioral adjustment., *Developmental Psychology*. 56 (2020) 528–540. <https://doi.org/10.1037/dev0000794>.
- [25] N.B. Perry, J.M. Dollar, S.D. Calkins, S.P. Keane, L. Shanahan, Maternal socialization of child emotion and adolescent adjustment: Indirect effects through emotion regulation., *Developmental Psychology*. 56 (2020) 541–552. <https://doi.org/10.1037/dev0000815>.

*This longitudinal study demonstrates that maternal socialization of emotion in childhood influences adolescent wellbeing by way of emotion regulation gains in late childhood.

- [26] M.M. Criss, A.S. Morris, E. Ponce-Garcia, L. Cui, J.S. Silk, Pathways to Adaptive Emotion Regulation Among Adolescents from Low-Income Families, *Fam Relat.* 65 (2016) 517–529. <https://doi.org/10.1111/fare.12202>.
- [27] B.L. Callaghan, N. Tottenham, The Neuro-Environmental Loop of Plasticity: A Cross-Species Analysis of Parental Effects on Emotion Circuitry Development Following Typical and Adverse Caregiving, *Neuropsychopharmacol.* 41 (2016) 163–176. <https://doi.org/10.1038/npp.2015.204>.
- [28] K.L. Kerr, E.L. Ratliff, K.T. Cosgrove, J. Bodurka, A.S. Morris, W. Kyle Simmons, Parental influences on neural mechanisms underlying emotion regulation, *Trends Neurosci Educ.* 16 (2019) 100118. <https://doi.org/10.1016/j.tine.2019.100118>.
- [29] P.Z. Tan, C.W. Oppenheimer, C.D. Ladouceur, R.D. Butterfield, J.S. Silk, A review of associations between parental emotion socialization behaviors and the neural substrates of emotional reactivity and regulation in youth., *Developmental Psychology.* 56 (2020) 516–527. <https://doi.org/10.1037/dev0000893>.
- [30] X. Chen, E.M. McCormick, N. Ravindran, N.L. McElwain, E.H. Telzer, Maternal emotion socialization in early childhood predicts adolescents' amygdala-vmPFC functional connectivity to emotion faces., *Developmental Psychology.* 56 (2020) 503–515. <https://doi.org/10.1037/dev0000852>.
- **This is one of the first studies to examine how parental socialization of emotion influences adolescent brain development.
- [31] D.C. Kopala-Sibley, M. Cyr, M.C. Finsaas, J. Orawe, A. Huang, N. Tottenham, D.N. Klein, Early Childhood Parenting Predicts Late Childhood Brain Functional Connectivity During Emotion Perception and Reward Processing, *Child Dev.* 91 (2020) 110–128. <https://doi.org/10.1111/cdev.13126>.
- [32] J.A. Silvers, C. Insel, A. Powers, P. Franz, C. Helion, R.E. Martin, J. Weber, W. Mischel, B.J. Casey, K.N. Ochsner, vPFC–vmPFC–Amygdala Interactions Underlie Age-Related Differences in Cognitive Regulation of Emotion, *Cereb. Cortex.* (2016) bhw073. <https://doi.org/10.1093/cercor/bhw073>.
- [33] B. Larsen, B. Luna, Adolescence as a neurobiological critical period for the development of higher-order cognition, *Neuroscience & Biobehavioral Reviews.* 94 (2018) 179–195. <https://doi.org/10.1016/j.neubiorev.2018.09.005>.
- [34] B.E. Compas, S.S. Jaser, A.H. Bettis, K.H. Watson, M.A. Gruhn, J.P. Dunbar, E. Williams, J.C. Thigpen, Coping, emotion regulation, and psychopathology in childhood and adolescence: A meta-analysis and narrative review., *Psychological Bulletin.* 143 (2017) 939–991. <https://doi.org/10.1037/bul0000110>.
- **This meta-analysis provides a contemporary assessment of the state of the science on emotion regulation and coping development, providing insights such as the fact that links between cognitive reappraisal and mental health are moderated by age.
- [35] L. Fields, R.J. Prinz, Coping and adjustment during childhood and adolescence, *Clinical Psychology Review.* 17 (1997) 937–976. [https://doi.org/10.1016/S0272-7358\(97\)00033-0](https://doi.org/10.1016/S0272-7358(97)00033-0).
- [36] A. Aldao, S. Nolen-Hoeksema, S. Schweizer, Emotion-regulation strategies across psychopathology: A meta-analytic review, *Clinical Psychology Review.* 30 (2010) 217–237. <https://doi.org/10.1016/j.cpr.2009.11.004>.
- [37] B.T. Denny, Getting better over time: A framework for examining the impact of emotion regulation training., *Emotion.* 20 (2020) 110–114. <https://doi.org/10.1037/emo0000641>.

- [38] J.A. Silvers, J.F. Guassi Moreira, Capacity and tendency: A neuroscientific framework for the study of emotion regulation, *Neuroscience Letters*. 693 (2019) 35–39. <https://doi.org/10.1016/j.neulet.2017.09.017>.
 - [39] E. Chervonsky, C. Hunt, Emotion regulation, mental health, and social wellbeing in a young adolescent sample: A concurrent and longitudinal investigation., *Emotion*. 19 (2019) 270–282. <https://doi.org/10.1037/emo0000432>.
 - [40] E. Gullone, E.K. Hughes, N.J. King, B. Tonge, The normative development of emotion regulation strategy use in children and adolescents: a 2-year follow-up study: A longitudinal study of two specific emotion regulation strategies, *Journal of Child Psychology and Psychiatry*. 51 (2010) 567–574. <https://doi.org/10.1111/j.1469-7610.2009.02183.x>.
 - [41] E. Gullone, J. Taffe, The Emotion Regulation Questionnaire for Children and Adolescents (ERQ–CA): A psychometric evaluation., *Psychological Assessment*. 24 (2012) 409–417. <https://doi.org/10.1037/a0025777>.
 - [42] J.A. Silvers, K. McRae, J.D.E. Gabrieli, J.J. Gross, K.A. Remy, K.N. Ochsner, Age-related differences in emotional reactivity, regulation, and rejection sensitivity in adolescence., *Emotion*. 12 (2012) 1235–1247. <https://doi.org/10.1037/a0028297>.
 - [43] A. Theurel, E. Gentaz, The regulation of emotions in adolescents: Age differences and emotion-specific patterns, *PLoS ONE*. 13 (2018) e0195501. <https://doi.org/10.1371/journal.pone.0195501>.
 - [44] E. Pozzi, N. Vijayakumar, D. Rakesh, S. Whittle, Neural Correlates of Emotion Regulation in Adolescents and Emerging Adults: A Meta-analytic Study, *Biological Psychiatry*. 89 (2021) 194–204. <https://doi.org/10.1016/j.biopsych.2020.08.006>.
- *This meta-analysis provides a comprehensive characterization of the neurobiology of emotion regulation networks in adolescence and young adulthood.
- [45] J.T. Buhle, J.A. Silvers, T.D. Wager, R. Lopez, C. Onyemekwu, H. Kober, J. Weber, K.N. Ochsner, Cognitive Reappraisal of Emotion: A Meta-Analysis of Human Neuroimaging Studies, *Cerebral Cortex*. 24 (2014) 2981–2990. <https://doi.org/10.1093/cercor/bht154>.
 - [46] L.R. Dougherty, S.L. Blankenship, P.A. Spechler, S. Padmala, L. Pessoa, An fMRI Pilot Study of Cognitive Reappraisal in Children: Divergent Effects on Brain and Behavior, *J Psychopathol Behav Assess*. 37 (2015) 634–644. <https://doi.org/10.1007/s10862-015-9492-z>.
 - [47] A.C. Belden, J.L. Luby, D. Pagliaccio, D.M. Barch, Neural activation associated with the cognitive emotion regulation of sadness in healthy children, *Developmental Cognitive Neuroscience*. 9 (2014) 136–147. <https://doi.org/10.1016/j.dcn.2014.02.003>.
 - [48] K. Stephanou, C.G. Davey, R. Kerestes, S. Whittle, J. Pujol, M. Yücel, A. Fornito, M. López-Solà, B.J. Harrison, Brain functional correlates of emotion regulation across adolescence and young adulthood: Development of Emotion Regulation, *Hum. Brain Mapp*. 37 (2016) 7–19. <https://doi.org/10.1002/hbm.22905>.
 - [49] K. McRae, J.J. Gross, J. Weber, E.R. Robertson, P. Sokol-Hessner, R.D. Ray, J.D.E. Gabrieli, K.N. Ochsner, The development of emotion regulation: an fMRI study of cognitive reappraisal in children, adolescents and young adults, *Social Cognitive and Affective Neuroscience*. 7 (2012) 11–22. <https://doi.org/10.1093/scan/nsr093>.
 - [50] J.A. Silvers, J. Shu, A.D. Hubbard, J. Weber, K.N. Ochsner, Concurrent and lasting effects of emotion regulation on amygdala response in adolescence and young adulthood, *Dev Sci*. 18 (2015) 771–784. <https://doi.org/10.1111/desc.12260>.

- [51] J.F. Guassi Moreira, K.A. McLaughlin, J.A. Silvers, Spatial and temporal cortical variability track with age and affective experience during emotion regulation in youth., *Developmental Psychology*. 55 (2019) 1921–1937. <https://doi.org/10.1037/dev0000687>.
- *This study reveals that selective recruitment of ventrolateral prefrontal cortex is associated with enhanced emotion regulation ability in late childhood and adolescence.
- [52] V. Reindl, C. Gerloff, W. Scharke, K. Konrad, Brain-to-brain synchrony in parent-child dyads and the relationship with emotion regulation revealed by fNIRS-based hyperscanning, *NeuroImage*. 178 (2018) 493–502. <https://doi.org/10.1016/j.neuroimage.2018.05.060>.
- [53] K.H. Lee, G.J. Siegle, R.E. Dahl, J.M. Hooley, J.S. Silk, Neural responses to maternal criticism in healthy youth, *Social Cognitive and Affective Neuroscience*. 10 (2015) 902–912. <https://doi.org/10.1093/scan/nsu133>.
- [54] B.T. Denny, M.C. Inhoff, N. Zerubavel, L. Davachi, K.N. Ochsner, Getting Over It: Long-Lasting Effects of Emotion Regulation on Amygdala Response, *Psychol Sci*. 26 (2015) 1377–1388. <https://doi.org/10.1177/0956797615578863>.
- [55] D.G. Weissman, D. Bitran, A.B. Miller, J.D. Schaefer, M.A. Sheridan, K.A. McLaughlin, Difficulties with emotion regulation as a transdiagnostic mechanism linking child maltreatment with the emergence of psychopathology, *Dev Psychopathol*. 31 (2019) 899–915. <https://doi.org/10.1017/S0954579419000348>.
- [56] A.M. Rodman, J.L. Jenness, D.G. Weissman, D.S. Pine, K.A. McLaughlin, Neurobiological Markers of Resilience to Depression Following Childhood Maltreatment: The Role of Neural Circuits Supporting the Cognitive Control of Emotion, *Biological Psychiatry*. 86 (2019) 464–473. <https://doi.org/10.1016/j.biopsych.2019.04.033>.
- [57] G. England-Mason, A. Gonzalez, Intervening to shape children’s emotion regulation: A review of emotion socialization parenting programs for young children., *Emotion*. 20 (2020) 98–104. <https://doi.org/10.1037/emo0000638>.
- [58] R.S. Sahi, E. Ninova, J.A. Silvers, With a little help from my friends: Selective social potentiation of emotion regulation., *Journal of Experimental Psychology: General*. (2020). <https://doi.org/10.1037/xge0000853>.

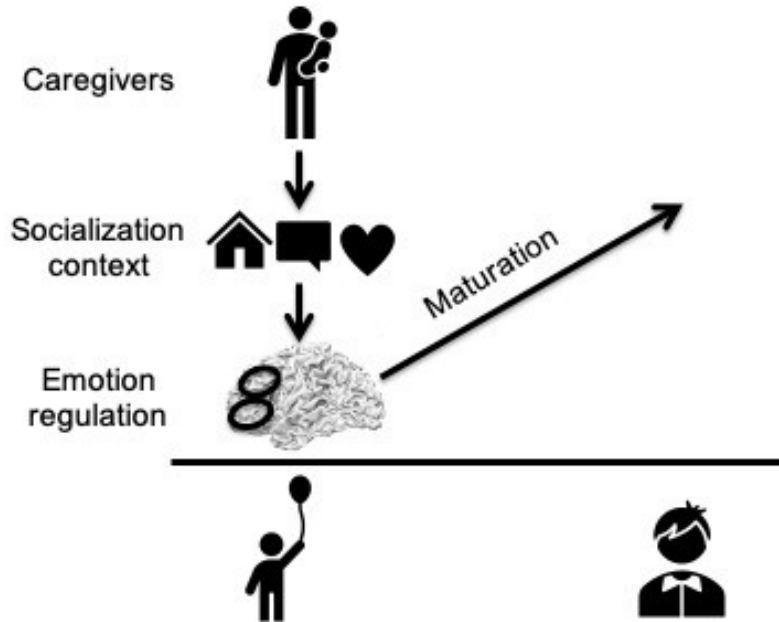


Figure 1. Caregiving influences on emotion regulation neurodevelopment from childhood to adolescence. Age is depicted left to right, with lateral prefrontal maturation depicted in the same scale. During childhood, caregivers lay the groundwork for future self-regulatory efforts by socializing emotion regulation both directly and indirectly.