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Recent advances in the genetics of emotion regulation: a review

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Recent attention has been given to the role of emotion regulation in the development and maintenance of psychopathology, and the psychosocial literature on emotion regulation has been growing rapidly over the past decade. However, knowledge about the genetic etiology of emotion regulation facets has been slower to develop. The present paper aims to briefly introduce the various constructs that fall under the umbrella of emotion regulation; provide an overview of behavioral genetic methods; summarize the empirical studies of emotion regulation twin studies; introduce molecular genetic methods; review the recent molecular genetic studies on emotion regulation; and provide future directions for research.

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Emotions are a key aspect of the human experience and they can influence behavior. It is theorized that emotions have been shaped by evolutionary mechanisms to promote behaviors associated with survival such as socializing/communicating with others, avoiding danger, and seeking needed resources [1]. Generating effective responses to emotion requires the ability to regulate the experience and expression of emotions, as well as the sequence in which emotions occur [2,3]. Regulation of emotion is important for mental health. In fact, over 50% of Axis I disorders and 100% of Axis II disorders implicate emotion regulation deficiencies [4]. Thus, developing a clear understanding of influences on emotion regulation is of high relevance to the characterization and treatment of psychopathological conditions.

Emotion regulation has been conceptualized as a set of strategies employed by individuals to influence the experience of, and behavioral response to, emotion. These strategies, which may be adaptive or maladaptive, include both explicit regulation processes that require conscious effort/control and implicit regulation processes that are unconscious and automatic [5•,6,7]. Given that emotions develop temporally, there are opportunities for modification at both the antecedent and response level [8•,9]. Emotion regulation is a widely studied and broadly defined construct, thus it is not surprising that several different constructs fall under the umbrella of emotion regulation including distress tolerance [10] and attention bias [11]. Diverse methods have also been used to measure these constructs, ranging from self-report measures of emotion-regulation effectiveness and strategies [12,13], to behavioral tasks [10], to fMRI paradigms [14].

Although the psychosocial literature on emotion regulation has developed greatly in the last two decades, the examination of the biological underpinnings is less developed. Increased understanding of the etiologic mechanisms underlying emotion regulation/dysregulation is needed to help elucidate the relationship between emotion regulation and psychopathology [15]. A paper by Canli and colleagues [8•] reviews the genetics of emotion regulation, and the current paper provides an updated review of recent studies, with a focus on the past three years of research, investigating the genetics of emotion regulation, including behavioral genetic studies (i.e. twin studies) and molecular genetic studies.

Behavioral genetic studies. Twin studies provide a means of examining the etiology of emotion regulation by quantifying both genetic (i.e. heritable) and environmental contributions. These models compare the similarity between monozygotic (MZ) twins, which share 100% of their genes, and dizygotic (DZ) twins, which share 50% of their genes, on a particular observable characteristic (phenotype). Variation existing within a phenotype can be decomposed into additive genetic factors which contribute twice as much to the correlation between MZ twins as they do for DZ twins, common environmental factors that are shared and contribute equally to the correlation between MZ and DZ twins (e.g. economic disadvantage), and specific environmental sources which encompasses unique experiences that are not shared among twins and measurement error.

Table 1

Recent twin studies of emotion regulation.

Author information	Population (*N*, ethnic breakdown, age, gender)	ER measurement	Major finding
Wang *et al.* (2014)	*N* = 304 same-sex twin pairs (140 MZ and 164 DZ) -Mean age of 2.99 years (SD = .08) - Ethnicity: 85.4% Caucasian, 3.2% Black, 2% Asian, 7.3% Mixed, 2.2% Other	Behavior Rating Scale (BRS) of the Bayley Scale of Infant Development-II	The results demonstrate a significant influence from genetic factors (43%) and from nonshared environmental factors (48%) on individual differences in emotion regulation. Shared effects contributed 9% (not significant).
Coccoro *et al.* (2012)	*N* = 301 (182 MZ and 119 DZ) twin pairs from the Vietnam Era Twin (VET) Registry - Mean age of 44.1 (SD = 2.9) - Caucasian (94.1%)	Affect Liability Scale (ALS) and Affect Intensity Measure (AIM)	ALS Depression and ALS Anger mood shift scores suggest a significant nonadditive genetic influence (29% and 27%, respectively). ALS Anxiety mood shift and AIM scores also showed a significant pattern of additive genetic influence (25% and 40%, respectively).
Kanakam *et al.* (2013)	*N* = 70 - 51 twins with an eating disorder diagnosis - 19 of unaffected co-twins - 16 concordant pairs (14 MZ and 2 DZ pairs) - 19 discordant pairs (11 MZ and 8 DZ pairs)	Difficulties in Emotion Regulation Scale; Reading the Mind in the Eyes test; Emotional Stroop task	For emotion recognition and social attentional bias, MZ twins had significant within-pair similarity in comparison to DZ twins suggesting a genetic influence to these particular processes underlying emotion regulation.
Weinberg *et al.* (2014)	*N* = 479 (244 MZ, 235 DZ) - Mean age of 29.39 (SD = 4.84) - 242 males - 237 females - Ethnicitiy: Caucasian, 96.5%; African American, 0.6%; Hispanic, 0.4%; Native American, 0.8%; mixed race, 0.8%; other/missing, 1.3%	Viewing 90 pictures (30 pleasant, 30 neutral and 30 unpleasant) from the International Affective Picture System	MZ twin correlations were significantly greater than DZ twin correlations for all picture type s within the centroparietal P300 observed between 300 and 600 ms and genetic influence accounted for 45–55% of the variance.

There have been few twin studies on emotion regulation ([8•], Table 1 for past studies conducted since 2011), and within this literature the means of emotion regulation assessment and specific facets of the construct under examination vary greatly (e.g. different forms of self-report and behavioral measures). Most prior twin studies in this area have focused on associated traits (e.g. personality characteristics [16]) and self-report emotion regulation difficulties [17] with less emphasis on certain emotion regulation strategies [8•]. However, a growing developmental literature exists regarding individual differences in emotion regulation and temperament among infants and children that additionally suggest that the processes underlying emotion regulation are moderately heritability [18]. Overall, the literature consistently suggests a moderate degree of heritability to the processes associated with emotion regulation across the lifespan (~25–55%; [8•]). This mild to moderate heritability estimate is comparable to that found for most internalizing disorders [19].

Recent twin studies of emotion regulation have yielded heritability estimates comparable to those reviewed by Canli and colleagues [8•]. In a twin study of toddlers, genetic factors contributed 43% to individual differences in emotion regulation as identified by a self-report measure [20]. Similarly, in a study conducted among adult twins, heritability estimates of ~40% were found to influence affect liability and intensity of emotional experiences, specifically, anger and anxiety [21]. Furthermore, brain activity occurring during periods of time where emotion regulation is believed to be actively occurring (i.e. viewing of images) appears to be moderately heritable (45–55% [22]). Although genetic influences appear to play a significant role in emotion regulation, each of the aforementioned studies also suggests a strong influence from nonshared environmental effects (e.g. occurrences that one twin may experience yet the other does not, for example, trauma exposure). In contrast, the contribution affiliated with shared or common environmental factors appears to be more limited in nature, thereby suggesting that experiences between twins (e.g. reared in same family) may have less of an impact on similarities identified between the pairs. Given the moderate heritability of emotion regulation, increased interest has been placed in identifying specific genes that may contribute to the processes associated with the particular construct.

Molecular genetic studies. Whereas twin studies yield an estimate of the magnitude of latent genetic effects on