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Brief Report

Counterfactually mediated emotions: A developmental study of regret and relief in a probabilistic gambling task

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ABSTRACT

Regret and relief are related to counterfactual thinking and rely on comparison processes between what has been and what might have been. In this article, we study the development of regret and relief from late childhood to adulthood (11.2–20.2 years), and we examine how these two emotions affect individuals' willingness to retrospectively reconsider their choice in a computerized monetary gambling task. We asked participants to choose between two "wheels of fortune" that differed in the amount of gain and loss expected and the probability of winning. We manipulated the outcome of the wheel of fortune that was not selected by participants to induce regret or relief. For each trial, participants rated how they felt about the outcome and their willingness to modify their choice. Participants' ratings suggest that regret and relief are stronger in adults than in children and adolescents. Regret affects participants' willingness to modify their initial choice, but this desire is stronger for adults than for children. In children, the experience of regret seems to be dissociated from the willingness to reconsider a choice. This study provides the first evidence that the ability to experience counterfactually mediated emotions, such as regret and relief, and the ability to take them into consideration continue to develop during late childhood and adolescence.

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Introduction

Psychology and neuroscience studies have provided converging evidence that emotion plays a crucial role in adaptive decision making (Cassotti et al., in press; Loewenstein, Rick, & Cohen, 2008). As suggested by Zinck and Newen (2007) (see also Power, 2010), emotions can be classified into basic and nonbasic emotions. During emotional development, basic emotions (e.g., fear, anger, joy, sadness) are differentiated into more complex cognitive emotions. Among these cognitive emotions, some emotions (e.g., regret, relief) are related to counterfactual thinking (Ritov, 1996). Specifically, these emotions rely on comparison processes between what has been and what might have been (Byrne, 2002). An individual experiences regret (upward counterfactual thinking) when the actual outcome of his or her choice is worse than the outcome of the rejected alternative, whereas the individual experiences relief (downward counterfactual thinking) in the opposite situation. Counterfactually mediated emotions result directly from an individual's decision (Mellers, Schwartz, & Ritov, 1999; Weisberg & Beck, in press) and, thus, are necessarily associated with a high feeling of responsibility.

Regret and relief are emotions that have a significant impact on everyday life. They can explain, among other things, irrational decision making such as the appetence for games (Zeelenberg & Pieters, 2004). However, few studies have examined the development of such counterfactually mediated emotions. This is particularly true for adolescence, even though adolescence is known to be a critical period for risk taking (Steinberg, 2008). Consequently, the goal of this study was to uncover the development of regret and relief from late childhood to adulthood and to examine how these two emotions modulate the willingness to reconsider an individual's choice.

To date, developmental psychology has focused mainly on the development of counterfactually mediated emotions in young children. For example, in Weisberg and Beck's (2010) paradigm, 5- to 8-year-olds were asked to choose between two boxes before the outcome obtained on the selected box and the unobtained outcome (on the unselected box) was revealed. By a manipulation of the unobtained outcome, researchers induced regret (when the unobtained outcome was better than the obtained outcome) or relief (in the opposite case). Finally, the children rated how they felt on a 5-point "emotional" Likert scale. Analysis of the ratings revealed that the acquisition of regret and relief occurs at different ages; the experience of regret develops at around 5 years of age, whereas the experience of relief does not develop before 7 years of age (Ferrell, Guttentag, & Gredlein, 2009; Guttentag & Ferrell, 2008; O'Connor, McCormack, & Feeney, 2012). According to Weisberg and Beck (2010), the fact that relief is experienced later than regret could reflect a bias of children's counterfactual thinking; adults show a greater tendency to think counterfactually when the outcome obtained is negative. Nevertheless, the authors noted that their task might not have led to "genuine relief" because the children were never confronted with an alternative negative outcome.

Recently, the development of regret and relief during adolescence and the impact of these emotions on decision making were investigated in a probabilistic gambling task with both positive and negative outcomes (Burnett, Bault, Coricelli, & Blakemore, 2010). Regret and relief were induced in the same way as in Weisberg and Beck's (2010) paradigm, using a manipulation of the unobtained outcome relative to the obtained outcome. Participants' emotional ratings revealed that relief, but not regret, develops during adolescence. The lack of development of regret during adolescence is surprising given what is known about the maturation of the brain areas involved in regret. Indeed, increasing feelings of regret are positively correlated with enhanced activity in the orbitofrontal cortex (OFC), an area that continues to mature until late adolescence (Camille et al., 2004; Chua, Gonzalez, Taylor, Welsh, & Liberzon, 2009; Coricelli, Dolan, & Sirigu, 2007).

A possible explanation of the lack of evidence for the development of regret during adolescence might relate to the nature of the dependent variables used to study regret. Studies have focused primarily on emotional ratings. Given that counterfactually mediated emotions are closely related to the alternative chosen by participants, it is necessary to also consider the degree to which participants are willing to modify their initial choice after experiencing regret (see Chua et al., 2009). Thus, the choice rating could be a complementary measure of counterfactual thinking. Interestingly, neuroimaging investigation of regret and relief has recently confirmed the complementarity of both scales (Chua et al., 2009). The data revealed positive correlations between the desire to change an initial