How does social comparison affect regret and relief in children, adolescents and adults?

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Abstract

Apprehending the development of complex emotions is crucial to understand the development of decision-making. Regret and relief are complex counterfactual emotions, which can arise in private or in social contexts. The aims of the present study were (i) to uncover the development of regret and relief and (ii) to explore the development of a social form of regret and relief in a context of competition. The first experiment provides evidence that the ability to experience regret and relief continues to develop until adolescence, consistent with the implication of the orbitofrontal cortex in their experience. In a context of competition, we observed that adolescents were less able to experience social regret compared to children and adults, whereas their feeling of social relief was reinforced. Besides, adolescents failed to question the appropriateness of their initial decision. This result could provide an explanation for adolescents' enhanced propensity to engage in risky behaviours.

Keywords: Regret; Relief: Counterfactual thinking, Social context; Decision making; Development.

Introduction

Psychology and neuroscience studies have provided converging evidence that emotions play a crucial role in adaptive decision-making (Loewenstein, Rick & Cohen, 2008). Thus apprehending the development of basic and complex emotions is crucial to fully understand the development of decision-making. Among these emotions, counterfactually mediated emotions – like regret and relief – are related to counterfactual thinking and rely on comparison processes. In a private context, these processes rely on a comparison between what has happened and what could have happened if the subject had made another choice (Ritov, 1996). The counterfactual comparison has an informative function, as it enables to determine a reference point according to which the obtained outcome will be evaluated. This process can also be motivated by the social context. It will then rely on a comparison between what has happened to the subject and what has happened to another person, like a competitor, who made a different choice (Bault, Coricelli & Rustichini, 2008).

To date, developmental psychology has mainly focused on the development of counterfactually mediated emotions in young children (Weisberg & Beck, 2010) showing that the experience of regret develops around 5 years of age, whereas the experience of relief develops around 7 years of age. Recently, the development of regret and relief in adolescence has been investigated in a probabilistic gambling task (Burnett, Bault, Coricelli & Blakemore, 2010). Participants' emotional ratings revealed that relief, but not regret, develops during adolescence. The lack of development of regret in adolescence is surprising given that increasing feelings of regret and relief are positively correlated with enhanced activity in the orbitofrontal cortex (OFC) that continues to mature until late adolescence (Camille et al., 2004; Gogtay et al., 2004).

A possible explanation of the lack of evidence for the development of regret in adolescence might relate to the nature of the variables used to study this emotion. Previous studies have focused primarily on emotional ratings. Knowing that counterfactually mediated emotions are related to participants' decision and in order to fully

apprehend these emotions, it was necessary to consider the degree to which participants are willing to reconsider their initial choice after experiencing regret (Chua, Gonzalez, Taylor, Welsh, & Liberzon, 2009).

Experiment 1 – Private context

Aims and Hypotheses. Thus, the aim of the first experiment was to uncover the development of regret and relief in late childhood, adolescence and adulthood.

In order to do so, participants performed a child friendly gambling task adapted from Camille et al. (2004). 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 the participants to induce either regret or relief. For each trial, participants rated how they felt about the outcome and their willingness to modify their choice, on a classical likert-type scale.

As the OFC has a fundamental role in the experience of regret, and given the late maturation of this brain area, we expect to observe a progressive development of the emotional experience of counterfactually mediated emotions from childhood to adulthood, in the private context. Besides, the choice rating could be a more sensitive measure in order to study the developmental trajectories and understand the complexity of regret and relief.

Method

Participants. In this private context, we recruited 53 volunteers: 19 children (mean age = 11.2 years, SD = 0.66), 17 adolescents (mean age = 14.5 years, SD = 0.40) and 17 university psychology students (mean age = 20.2 years, SD = 1.48).

Written parental consent was obtained for children and adolescents prior to the assessment session. Participants were tested in accordance with international norms governing the use of human research participants.

Experimental Procedure. Participants performed 36 trials of a child friendly gambling task (cf. fig. 1). For each trial, participants chose between two wheels of fortune, an advantageous wheel (with a positive expected value) and an attractive but disadvantageous wheel (with a negative expected value). Then, two feedbacks, *partial* and *complete feedbacks*, were successively provided to participants.

For the partial feedback, the outcome obtained on the selected wheel was displayed on the screen for 4 s (fig. 1.c.). Thus, the partial feedback induced either disappointment (in the case of losses) or elation (in the case of gains). For the complete feedback, participants were informed of the outcome of the alternative wheel for 4 s (fig. 1.f). They could thus compare the obtained outcome to the counterfactual outcome. The complete feedback was designed to induce either regret (when the comparison between the outcomes was unfavourable to the participant) or relief (in the opposite case).

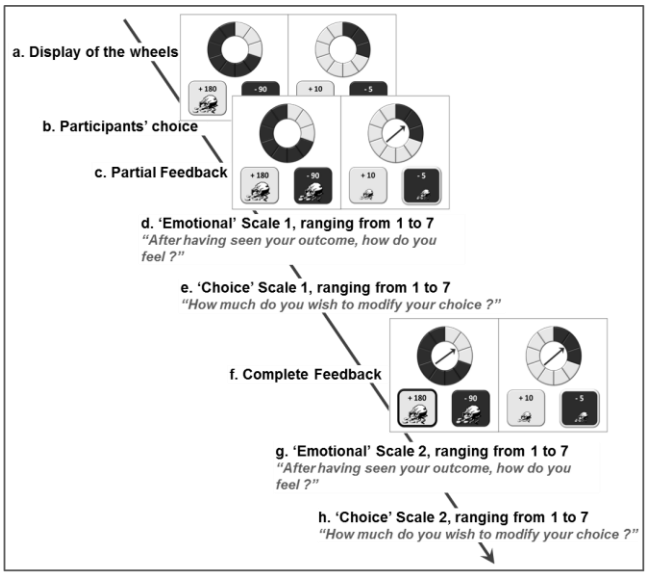

Figure 1: Experimental design of a trial inducing regret. Two 'wheels of fortune' were displayed on the computer screen (1.a.). After the participant's choice (1.b.), participants were informed of obtained outcome (*partial feedback* – 1.c.). Then the participant must rate an 'emotional' scale (1.d.) and a 'choice' scale (1.e.). Finally, participants were informed of the *complete feedback* (1.f.) and had to rate again an 'emotional' scale (1.g.) and a 'choice' scale (1.h.).

After each feedback, participants rated a 7-point 'emotional' scale (fig. 1.d. and 1.g.), ranging from 1 (I am unhappy) to 7 (I am happy). Participants then rated a 7-point 'choice' scale (fig. 1.e. and 1.f.), ranging from 1 (I wish to modify my choice) to 7 (I do not wish to modify my choice), on which they indicated how much they wished to reconsider their choice.

Results

Participants' ratings were analysed in four outcome conditions: (a) low loss vs. high loss condition, which should induce *minimal relief*; (b) low win vs. high win condition, inducing *minimal regret*; (c) low win vs. high loss condition, inducing *maximal relief*; and (d) low loss vs. high win condition, inducing *maximal regret*.

For the 'emotional' and 'choice' ratings analyses, we computed difference scores (see Weisberg & Beck, 2010). Ratings on the *partial feedback* were subtracted from ratings on the *complete feedback*. Thus, the *emotional* and *choice* scores ranged between -6 and +6. We carried out one-sample t-tests to determine whether both scores differed from zero. A negative *emotional* score would suggest that participants experienced regret whereas a positive emotional score would suggest that participants experienced relief. A

negative *choice* score would suggest that participants wanted to modify their initial choice whereas positive choice score would suggest that participants want to maintain their initial choice.

A 3 (age: children vs. adolescents vs. adults) x 4 (outcomes: maximal regret, minimal regret, maximal relief, minimal relief) mixed-design ANOVA on the 'emotional' scores revealed that these scores differed between the three groups of participants, $F(2,50) = 3.24$, $p < .05$, $\eta_p^2 = .12$, and between the type of outcomes, $F(3,50) = 57.95$, $p < .001$, $\eta_p^2 = .54$. The age of the participants affected the emotional scores differently in the four types of outcomes, $F(6,150) = 2.73$, $p < .05$, $\eta_p^2 = .10$. In the minimal regret condition, children and adolescents' average emotional scores were lower than adult scores, $t(34) = -1.60$, $p = .056$, $d = .72$ for children and $t(32) = -1.59$, $p = .052$, $d = .72$ for adolescents. Similarly, in the maximal regret condition, children and adolescents' emotional scores were lower than adult scores, $t(34) = -2.41$, $p < .01$, $d = .70$ for children and $t(32) = -3.47$, $p < .001$, $d = 1.75$ for adolescents (cf. fig. 2). No other differences were significant.

To sum up, all participants experienced regret in the conditions designed to induce this emotion, but children and adolescents' subjective experience of regret was reduced compared to adults. Besides, although all groups reported relief in the condition designed to induce maximal relief, children and adolescents did not experience relief when they lost a small amount of money but avoided losing a higher amount, $t(18) < 1$ and $t(16) = 2,39$, $p = .09$ respectively.

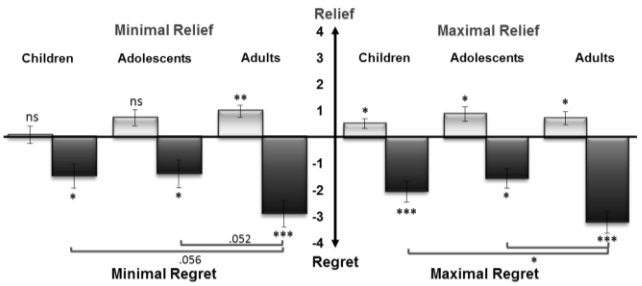

Figure 2: 'Emotional' ratings for the private context – mean scores (*partial feedback* ratings subtracted from *complete feedback* ratings) for regret and relief trials. Ratings were analysed according to four types of outcome (minimal relief, minimal regret, maximal relief and maximal regret). We compared regret and relief scores to zero (one-sample t-tests with zero as the test value, Bonferroni-corrected, *p < .05, ** p < .005, ***p < .001).

The 3 (age) x 4 (type of outcome) mixed-design ANOVA on the 'choice' scores revealed a main effect of the type of outcome, $F(3,150) = 36.7$, $p < .001$, $\eta_p^2 = .42$, but no main effect of age, $F(2,50) = 2.87$, $p = .07$. Interestingly, the interaction between age and outcome was significant, $F(6,150) = 2.54$, $p < .05$, $\eta_p^2 = .09$. Planned comparisons of the 'choice scores' revealed that children were less willing to modify their initial choice than were adolescents, $t(34) = -2.41$, $p < .01$, $d = .66$, and adults, $t(34) = -3.00$, $p < .005$, $d = 1.23$, in the minimal regret (win-win) condition. Similarly, in the maximal regret (loss-win) condition, children were less willing to modify their initial choice than were adults, $t(34) = -1.70$, $p < .05$, $d = .61$. No other differences were significant.

As expected, adults wished to modify their initial choice in the conditions inducing regret, $t(16) = -5.43$, $p < .001$ in the minimal regret condition and, $t(16) = -4.55$, $p < .001$ in the maximal regret condition. On the contrary, they wished to maintain their initial choice in the conditions inducing relief, $t(16) = 4.23$, $p < .005$ in the minimal relief condition and, $t(16) = 4.74$ $p < .001$ in the maximal relief condition. As opposed to adults, children did not wish to modify their choice in the minimal regret condition, $t(18) = 1.03$, $p > .1$, even if they experienced a significant feeling of regret.

Discussion

Analyses of the 'emotional' scores revealed developmental differences for both types of counterfactually mediated emotions (regret and relief). All participants experienced regret in the two outcome conditions designed to induce this emotion, but children and adolescents' subjective experience of regret was reduced compared to adults.

Our results are consistent with the ones reported in a recent study (Rafetseder & Perner, 2012) showing that regret develops progressively from childhood to adulthood and reaches its maximum level in the adult group.

The fact that children experienced relief after a small gain (maximal relief condition) but not after a small loss (minimal relief condition) might suggest that this group has difficulties distinguishing between two outcomes that both lead to a loss and thus might focus more on the loss they obtained rather than on the high loss they avoided (see Weisberg & Beck, 2012 for similar results).

Moreover, analyses of the 'choice' scores demonstrate that regret affects the participant's willingness to reconsider their initial choice in adults, whereas it does not systematically lead to a reconsideration of the initial choice in children.

Adults wished to modify their initial choice in the conditions inducing regret but wished to maintain their initial choice in the conditions inducing relief. As opposed to adults, children and adolescents expressed no preference about modifying their choice in the condition inducing minimised relief.

Finally, we identified a dissociation in children between the experience of regret and the willingness to reconsider an initial choice, in the minimal regret condition (low win vs. high win condition) specifically. In this condition, the salience of the counterfactual alternative might be reduced as participants have already won on the selected wheel. When the obtained outcome is already good for them, it seems difficult for children to think counterfactually, to take in account the alternative win and then expressing their wish to modify their choice.

Experiment 2 – Social context

Our first experiment provided evidence that the ability to experience regret and relief continues to develop during late childhood and adolescence.

As little is known about adolescents' sensibility to complex negative emotions, we were particularly interested in the emotional experience of regret in adolescents. It has actually been demonstrated that the anticipation of complex negative emotions – such as regret – can significantly contribute to decrease risky behaviours in adolescents (Conner, Sandberg, McMillan, & Higgins, 2006; Richard, Van Der Pligt, & De Vries, 1996). Indeed, studies focusing on the role of anticipated regret in risky decision making have revealed that inciting adolescents to anticipate the regret they could experience after a risky behaviour can significantly decrease the intentions to engage in this behaviour.

In order to apprehend risky decision making in adolescence, neurobiological models have postulated the existence of two distinct brain systems involved in decision making: a cognitive control system - supporting goal-directed decisions through the ability to inhibit impulsive behaviour - and a socio-emotional system - based on the valuation and prediction of potential rewards, that can bias decision (Chein, Albert, O'Brien, Uckert, & Steinberg, 2011; Sommerville, Jones & Casey, 2010). These models posit an imbalance between the maturity of adolescents' socio-emotional system and the relative immaturity of the cognitive control system (Sommerville, et al., 2010). Due to this imbalance, adolescents are hypersensitive to rewards, particularly in salient socio-emotional contexts (Chein et al., 2011; Ernst et al., 2005). This kind of context selectively increases adolescents' sensitivity to potential rewards, which could explain why adolescence corresponds to a period of greater risk seeking in everyday life (Chein et al., 2011).

However, to our knowledge, no study has examined the impact of a salient socio-emotional context on adolescents' experience of regret and relief. Yet, in everyday life, adolescents not only experience these emotions alone but also in social contexts – e.g., in school, when they compare their achievements with those of their schoolmates.

Aims and Hypotheses. Thus, the aim of this second experiment was to explore the development of a social form of regret and relief in adolescents, compared to children and adults. Social regret was defined as the negative emotion that one feels when he has missed an opportunity while another person has seized it and social relief as the opposite feeling.

In the socio-emotional context condition, participants were additionally informed that they would be playing against a schoolmate and that their results would be compared to those of the other player throughout the game.

We hypothesized that adolescents should be more influenced by the social context of competition than children and adults (Chein et al., 2011). If adolescents are hypersensitive to the emotional context, compared to adults and children, they should demonstrate a heightened sensitivity to the gains they obtain and their evaluation of social relief should be biased. Therefore, adolescents should experience an enhanced feeling of social relief. In addition, if the social context also influences negative complex emotions, they should experience a decreased feeling of social regret compared to children and adults. Thus, their willingness to reconsider an initial choice should be attenuated compared to the other groups.

Method

Participants. In the social context, we recruited 54 volunteers: 18 children (mean age = 11.8 years, SD = 0.43), 18 adolescents (mean age = 14.5 years, SD = 0.40) and 18 university students (mean age = 20.2 years, SD = 1.48).

Written parental consent was obtained for children and adolescents prior to the assessment session. Participants were tested in accordance with international norms governing the use of human research participants.

Experimental Procedure. Participants performed 36 trials of the computerized child friendly gambling task used in experiment 1. The procedure and the stimuli of the gambling task were the same as in experiment 1.

However, in order to induce social regret and social relief, children and adolescents were informed that that they would be playing against a schoolmate and adults were told that they will be playing against another student of the same age and the same institute. We additionally informed participants that all of their choices would be compared to those of their competitor. Thus, the complete feedback informed the participants about the outcome obtained by their competitor, so that they could compare it to their own outcome.

Results

Participants' ratings were again analysed according to four outcome conditions: (a) low loss vs. high loss condition, which should induce *minimal relief*; (b) low win vs. high win condition, inducing *minimal regret*; (c) low win vs. high loss condition, inducing *maximal relief*; and (d) low loss vs. high win condition, inducing *maximal regret*. Besides, we computed difference scores for the 'emotional' and 'choice' ratings analyses (cf. experiment 1).

A 3 (age) x 4 (outcome conditions) mixed-design ANOVA conducted on 'emotional' scores revealed a main effect of age, $F(2,51) = 12.64$, $p < .001$, $\eta_p^2 = .33$, a main effect of outcome condition, $F(3,153) = 51.01$, $p < .001$, $\eta_p^2 = .50$, and a significant interaction between age and outcome condition, $F(6,153) = 2.36$, $p < .05$, $\eta_p^2 = .08$. Planned comparisons revealed that in the minimal social relief condition, adolescents' social relief was higher than that expressed by children, $F(1,51) = 12.98$, $p < .001$, $d = 1.19$ (cf. fig. 3). No other differences were significant.

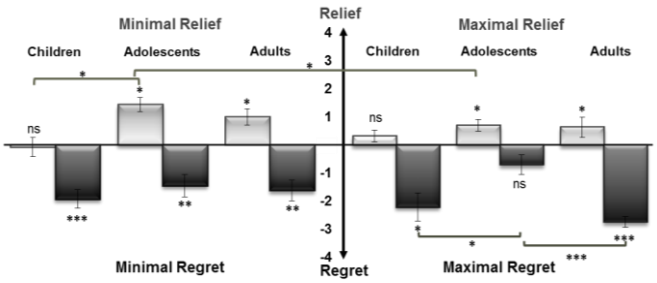

Figure 3: 'Emotional' ratings for the social context – mean scores on regret and relief conditions. Ratings were analysed according to four types of outcome (minimal relief, minimal regret, maximal relief and maximal regret). We compared regret and relief scores to zero (one-sample t-tests with zero as the test value, Bonferroni-corrected, * $p < .05$, ** $p < .005$, *** $p < .001$).

Notably, adolescents expressed lower social relief in the maximal relief condition compared to the minimal social relief condition, $F(1,51) = 6.18$, $p < .05$, $d = 0.71$. In the maximal social regret condition, adolescents expressed less regret than children, $t(51) = 2.60$, $p < .05$, $d = 0.82$, and adults, $t(51) = 3.51$, $p < .001$, $d = 1.34$. Beside, planned comparisons in this condition also revealed a significant quadratic trend between age and the expression of regret, revealing a U-shaped developmental pattern, $F(1,51) = 12.46$, $p < .001$, and no significant linear trend, $F < 1$. These results suggest that adolescents experience less social regret than children and adults in the maximal social regret condition.

A 3 (age) x 4 (outcomes) mixed-design ANOVA conducted on 'choice' scores revealed that these scores differed between the type of outcome, $F(3,153) = 22.21$, $p < .001$, $\eta_p^2 = .30$, but not between the three age groups, $F(2,51) = 1.13$, $p = .33$. Interestingly, the age of the participants affected the choice scores differently in the four outcome conditions, $F(6,153) = 2.67$, $p < .05$, $\eta_p^2 = .09$.

The willingness to maintain the initial choice was lower in the maximal social relief condition compared to the minimal social relief condition for adolescents and adults, $t(51) = 2.12$, $p < .05$, $d = 0.63$ and $t(51) = 3.51$, $p < .005$, $d = 0.83$, respectively. Adolescents were less willing to modify their choice in the maximal social regret condition than in the minimal social regret condition, $F(1,51) = 9.52$, $p < .01$, $d = 0.67$, and than adults, $F(1,51) = 5.33$, $p < .05$, $d = 0.83$.

Discussion

The results of this experiment evidenced that a salient socio-emotional context of competition impacts the feeling of regret and relief, specifically in adolescents. Critically, when adolescents obtained an initial negative outcome, their feeling of social relief was reinforced, compared to children and adults. Adolescents were actually far more relieved after obtaining an initial loss (minimal social relief) than after obtaining an initial win (maximal social relief). Given that the only difference between the minimal and maximal social relief conditions was the presence of an initial loss in the minimal social relief condition, this result may suggest that a salient context of social competition has a direct impact on adolescents' sensitivity to losses, increasing the feeling of relief when the competitor obtained a greater loss.

On the other hand, adolescents' feeling of social regret was considerably attenuated compared to children and adults. Theoretically, the condition of maximal social regret should have the greatest effect on participants' self-esteem. However, even if adolescents are able to experience regret (cf. experiment 1 and Burnett et al., 2010), they did not express a significant feeling of regret in the maximal regret condition. Thus, we argue that this specific lack of social regret in adolescents may be a consequence of a heightened sensitivity to negative outcomes in a social context. Interestingly, this weaker tolerance to losses leads adolescents to down-regulate their feeling of social regret and their willingness to reconsider their choice. As such, when adolescents obtain a negative outcome, they fail to question the appropriateness of their initial decision. This result is in line with studies that revealed a relative deficit in adolescents' ability to tolerate and to learn from negative outcomes compared to adults (Aïte, et al., 2012; Cassotti, Houdé & Moutier, 2011).

Our findings indicate that adolescents are not only hypersensitive to rewards but also to losses in salient socio-emotional contexts by demonstrating that the socio-emotional context of competition significantly impacts their feeling of social regret and of social relief after an initial loss. These results are in line with the proposition of an imbalance between the socio-emotional system and the cognitive control system in adolescence (Chein et al., 2011; Sommerville et al., 2010).

General Discussion

The aims of this paper were to (i) to examine the development of regret and relief from childhood to adulthood and (ii) to explore the development of the ability to experience social regret and social relief in adolescents compared to children and adults in a context of social competition.

The results of the first experiment provide evidence that the ability to experience counterfactually mediated emotions – regret and relief – is attenuated in children and adolescents compared to adults. This result is consistent with the implication of the OFC in the experience of regret and relief (Camille et al., 2004).

Moreover, we observed that regret affects the participant's willingness to reconsider their initial choice in adults, whereas it does not systematically lead to the same reconsideration in children. We actually identified that the experience of regret and the willingness to reconsider an initial choice can be dissociated in children. This result may indicate a developmental dissociation between feeling and doing that has previously been observed among participants of the same age range (Cassotti et al., 2011).

The results from the choice scale reveal the importance of using both 'emotional' and 'choice' ratings to study the precise development of counterfactually mediated emotions such as regret and relief.

The results of the second experiment is the first to evidence that a salient socio-emotional context of competition impacts the feeling of counterfactually mediated emotions – regret and relief – specifically in adolescents. Critically, when adolescents obtained an initial negative outcome, their feeling of social regret was considerably attenuated compared to children and adults, whereas their feeling of social relief was reinforced. The present results suggest that in a social comparison context, adolescents are less able to experience social regret and fail to question the appropriateness of their initial decision, particularly when another person (a competitor) has obtained a higher outcome by choosing differently.

Conclusion

In conclusion, the present paper evidenced that the ability to experience regret and relief continues to develop in late childhood and adolescence.

This paper is also the first to evidence that a salient socio-emotional context of competition can impact the feeling of regret and relief, specifically in adolescents.

Finally, the present results suggest that in a social comparison context, adolescents are less able to experience social regret and fail to question the appropriateness of their initial decision. Thus, this result could provide an explanation for adolescents' enhanced propensity to engage in risky behaviours in everyday life.

Acknowledgments

We thank the participants of the study and the teacher teams of the Saint Pierre Institute (Brunoy, France) and Guillaume de Normandie Junior High School (Caen, France).

References

Aïte, A., Cassotti, M., Rossi, S., Poirel, N., Lubin, A., Houdé, O., & Moutier, S. (2012). Is human decision-making under ambiguity guided by loss frequency regardless of the costs? A developmental study using the Soochow Gambling Task. *Journal of Experimental Child Psychology*, *112*(2), 286-294.

Bault, N., Coricelli, G., & Rustichini, A. (2008). Interdependent Utilities: How Social Ranking Affects Choice Behavior. *PLoS ONE*, *3*(10), e3477.

Burnett, S., Bault, N., Coricelli, G., & Blakemore, S.-J. (2010). Adolescents' heightened risk-seeking in a probabilistic gambling task. *Cognitive Development*, *25*(2), 183-196.

Camille, N., Coricelli, G., Sallet, J., Pradat-Diehl, P., Duhamel, J.-R., & Sirigu, A. (2004). The Involvement of the Orbitofrontal Cortex in the Experience of Regret. *Science*, *304*(5674), 1167-1170.

Cassotti, M., Houdé, O., & Moutier, S. (2011). Developmental changes of win-stay and loss-shift strategies in decision making. *Child Neuropsychology*, *17*(4), 400-411.

Chein, J., Albert, D., O'Brien, L., Uckert, K., & Steinberg, L. (2011). Peers increase adolescent risk taking by enhancing activity in the brain's reward circuitry. *Developmental Science*, *14*(2), F1-F10.

Chua, H. F., Gonzalez, R., Taylor, S. F., Welsh, R. C., & Liberzon, I. (2009). Decision-related loss: Regret and disappointment. *NeuroImage*, *47*(4), 2031-2040.

Conner, M., Sandberg, T., McMillan, B., & Higgins, A. (2006). Role of anticipated regret, intentions and intention stability in adolescent smoking initiation. *British Journal of Health Psychology*, *11*(1), 85-101.

Ernst, M., Nelson, E. E., Jazbec, S., McClure, E. B., Monk, C. S., Leibenluft, E., Blair, J., et al. (2005). Amygdala and nucleus accumbens in responses to receipt and omission of gains in adults and adolescents. *NeuroImage*, *25*(4), 1279-1291.

Gogtay, N., Giedd, J. N., Lusk, L., Hayashi, K. M., Greenstein, D., Vaituzis, A. C., Nugent, T. F., et al. (2004). Dynamic mapping of human cortical development during childhood through early adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, *101*(21), 8174 -8179.

Loewenstein, G., Rick, S., & Cohen, J. D. (2008). Neuroeconomics. *Annual Review of Psychology*, *59*(1), 647-672.

Rafetseder, E., & Perner, J. (2012). When the alternative would have been better: Counterfactual reasoning and the emergence of regret. *Cognition & Emotion*, *26*(5), 800-19.

Richard, R., Van Der Pligt, J., & De Vries, N. (1996). Anticipated Regret and Time Perspective: Changing Sexual Risk-taking Behavior. *Journal of Behavioral Decision Making*, *9*(3), 185-199.

Ritov (1996). *Organizational Behavior and Human Decision Processes*, *66*(2), 228-236.

Sommerville, L.H., Jones, R.M., Casey, B.J. (2010). A time of change: Behavioral and neural correlates of adolescent sensitivity to appetitive and aversive environmental cues. *Brain and Cognition*, *72*, 124-133.

Weisberg, D. P., & Beck, S. R. (2010). Children's thinking about their own and others' regret and relief. *Journal of Experimental Child Psychology*, *106*(2-3), 184-191.

Weisberg, D. P., & Beck, S. R. (2012). The development of children's regret and relief. *Cognition & Emotion*, *26*(5), 820-35.