UNIVERSITY OF TRENTO

DOCTORAL SCHOOL of

Cognitive Sciences and Education

THE ONTOGENESIS OF COUNTERFACTUAL EMOTIONS: *Regret* AND *Relief*

A dissertation presented by *Rossella Guerini*,

XXVI cycle

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN THE SUBJECT OF

DEVELOPMENTAL PSYCHOLOGY

Advisor: prof. *Giorgio Coricelli*

University of Trento, Italy

December 2013

Abstract

The aim of the present work is to investigate the development of *counterfactual emotions* in children aged 3 to 10. More specifically, this work deals with the development of the emotions of *regret* and *relief*. Five studies were conducted to determine at which age children start to understand, to feel and to attribute to others counterfactual emotions, as well as to experience the comparison with others during a choice. Study 1 aims to replicate Weisberg and Beck's paradigm, developed in 2010; and its results point out that children are able to feel regret at 5 years of age and relief at 7. Study 2 introduces some methodological changes and shows that children are able to report regret and relief starting at 6. The importance of the responsibility for the choice in the experience of regret is supported by the results concerning the manipulation of sense of agency (Study 3), with an effect on the experience of counterfactual emotions starting at 6 years old. To investigate the relationship between the ability to attribute to others emotions and to feel an emotion, study 4 aims to test whether children attribute to others regret and relief before experiencing them. The last study (Study 5: participants aged 3-11) concerns the development of social comparison and the experience of envy or gloating compared with the experience of regret and relief. The results reveal an effect of social comparison that precedes the effects of the two counterfactual emotions.

Acknowledgements

I need to really thank my supervisor, prof. Giorgio Coricelli, who has encouraged me and supported for the realization of the whole project. Prof. Paola Paladino provided me with suggestions and so I need to thank her for the support.

All the experiments would not have been possible without the patience and the kindly cooperation of the schools and kindergartens in and in which take part into the project: the kindergartens of , , , , , , , and the primary school .

My doctoral school and my supervisor gave me the opportunity to visit the "Laboratoire de Neurosciences Cognitives" at the "École Normale Supérieure" in Paris and this was really a great opportunity. During my stay in Paris I met dr. Sarah Beck from the University of Birmingham, who visited the lab. We have talked at length of counterfactuals and about my work. Sarah provided me with important feedbacks and a very positive evaluation. They were really important days and I need to thank her and my supervisor, prof. Giorgio Coricelli, again.

Contents

CHAPTER I

1.GENERAL INTRODUCTION

We term "counterfactual" those emotions that are closely linked to counterfactual thinking. These are *complex* emotions, i.e. emotions that, unlike "basic" emotions (like fear or anger), are highly sensitive to cognitive and cultural influences (e.g., guilt, envy, shame, jealousy, loyalty, etc.).

More precisely, counterfactual emotions are those emotions one usually feels when realizing that the outcome of a choice would have been different if an alternative decision was taken. Every day we happen to come into contact with counterfactual thinking in many of its forms: for example, if we lose a train, if we are late for an appointment or when we simply do what we after realize to be «a wrong choice». What is common to all these situations is the negative emotion that goes with it, or the positive emotion that we feel when we avoid a negative outcome. Counterfactual thinking underlies all these cases, as it is to think of imaginary alternatives. Specifically, if we feel regret, we contemplate alternative circumstances that are evaluatively better than actuality (=*upwards counterfactual thinking*); whereas if the simulated alternatives are evaluatively worse than actuality, the emotion will be the relief (=*downwards counterfactual thinking*) (Kasimatis & Wells, 1995; Markman, Gavanski, Sherman & McMullen, 1993).

For a long time decision theorists had been primarily focused and interested in the creation of normative models of choice, or the development of principles that allow to make rational decisions, such as the *maximization of the expected utility* (e.g. Edwards *et al.*, 1984). In more recent times, with the emergence of descriptive models of choice aimed to identify the psychological mechanisms responsible for decision-making processes, rather than to provide the principles for the behavior of an ideal decision maker, the study of emotions related to decision-making processes had an increased importance as the necessity to create models in order to accurately predict actual choices made by "real" people. In my work I followed the latter (positive) approach on the study of decision making.

1.1 The counterfactual emotion of «Regret»

There's not still today a universally accepted definition of regret: researchers have proposed different definitions and sometimes they disagree within the same field of studies. The lack of a formal definition makes inevitably difficult interpreting and comparing results of different researches. As I mentioned before, feeling regret implies realizing the importance of making a different choice, instead of the one made, and it is a negative emotion that results from the comparison between what happened and what could have happened.

For some economists (e.g., Loomes and Sugden, 1982; Bell, 1982), the knowledge of alternative outcomes is critical for the onset of regret, which is defined as the difference in value between the results obtained and the best of the alternative outcomes: the greater is this difference, the greater is the regret.

By contrast, research in psychology has suggested that the knowledge of a better outcome is not necessary; rather it is sufficient to imagine a better result. This type of comparison between the reality and alternative possibilities that could have been realized is a cognitive process that is commonly defined as *counterfactual thinking*.

Since the past cannot be changed, the main question is why we feel such a painful emotion. One suggestion is that regret may have a functional role for adaptive behavior.

Thus, for example, Roese (1997) suggests that *upward counterfactuals* could have an adaptive function: producing useful causal inferences they would have an effect on the agent's intentions to perform success-facilitating behaviors in the future. If a similar situation occurs again, the person will be ready to deal with it in a more suitable way.

In this perspective, the experience of regret, even if painful, is viewed as a functional and adaptive capacity, which can help us to learn from our mistakes in order to avoid committing them in the future (Zeelenberg, 1999a).

These suggestions were generalized into a *functional* perspective on counterfactual thinking (Epstude & Roese, 2008). This perspective ascribes a beneficial role to counterfactual thoughts (construed as top-down rather than bottom-up processes) in order to regulate behavior. This marks a departure from Kahneman and Miller's (1986) "norm theory" (the earliest theoretical tradition to explain counterfactual thinking) that sees counterfactual thoughts as a source of biases.

Another important function of counterfactual thinking seems to be the regulation of affect (cf. e.g. Roese & Olson, 1997; Johnson & Sherman, 1990). For example, generating downward counterfactuals seems to have a strategic function for mood regulation, so people can feel better after the generation of downward counterfactuals. Moreover, some experimental evidences have shown that people are able to recognize the benefits of regret, and this is evaluated more favourably than other negative emotions (e.g. Saffrey, Summerville and Roese, 2008).

The possibility to experience regret depends on the construction of counterfactual thoughts; and the intensity of the experience of regret is in relation to the availability of various counterfactual alternatives. Many researches showed a tendency to stronger emotional reaction for events for which is easier to imagine an alternative outcome. This phenomenon is known as *emotional amplification* (Kahneman & Miller, 1986).

Among the factors leading to the onset of regret it is important to mention the *closeness of the alternative outcome*, the *action-non action* factor, and the *perception of responsibility* (Arkes *et al.*, 2002; Byrne & McEleney, 2000; Feeney & Handley, 2006; Frijda *et al.*, 1989; Landman,1987; N'gbala & Branscombe, 1997; Zeelenberg *et al*., 2002).

Another important parameter linked to regret is the proximity in time of the events. People are much more willing to change causes that are proximal in time to the event than causes distal in time; and they are also more willing to change things under their control than thinks which they can't control (Girotto *et al.* 1991; Roese & Olson, 1995).

Note that regret is an emotion shaped by specific counterfactual thoughts, different from those who shape another emotion known as “disappointment”. As we are going to see in the next section, we can say that «regret is shaped by the generation of behavior-focused counterfactuals, whereas disappointment is shaped by the generation of situation-focused counterfactuals» (Zeelenberg *et al.* 1998).

1.2 Regret and disappointment

Regret and disappointment are both negative emotions but -- as we have just said -- they can be distinguished from the nature of counterfactuals from which they derive. The emotion of Regret emerges as a result of counterfactuals in which we imagine to change our actions. The emotion of Disappointment arises when we imagine to change the events of the world, and hence when a negative outcome doesn’t depend on our choice but it depends on chance.

Some researchers have argued that the two emotions can be differentiated on the basis of appraisals (e.g. Frijda *et al.*, 1989) and phenomenologies (e.g. Roseman *et al.*, 1994).

According to the theorists of appraisal any emotion is related to a specific pattern of evaluation of events (Lazarus). Zeelenberg *et al.* (1998) asked participants to describe situations in which they felt regret or disappointment, and then they assessed their appraisals. They used eight appraisal dimensions (*unexpectedness, motivational state, situational state, probability, control potential, legitimacy, problem source, and agency*). Agency was composed by *self-agency*, *other-person-agency* and *circumstances agency* measures. Their study showed higher evaluations for disappointment in *unexpectedness, wanting*

something pleasurable, *thinking that one was morally right*, and *causation by circumstances beyond anyone's control* measures. For Regret they obtained higher evaluations for *thinking that one could do something about the event*, and *self-causation* measures.

As regards the phenomenological experience of the two emotions the researchers asked participants to evoke moments in which they felt an intense regret or disappointment and then to report feelings, thoughts, action tendencies, actions and motivations. Consistently with Roseman *et al.* (1994), their results showed significant differences between regret and disappointment for each dimension.

All these studies suggest that regret and disappointment need to be differentiated. Regret implies thinking about own mistakes, the desire to go back and undo our action or decision. Disappointment implies a sense of inaction and a lack of power to change reality.

A different perception of responsibility and agency also differentiates regret from disappointment. So, perceiving self as an agent and highly responsible are closely related to regret, while perceiving others as agents and not responsible are closely linked to disappointment (cf. e.g. Frijda *et al.* 1989).

1.3 The Neural Basis of Regret

Neuroscience studies have investigated which are the brain structures involved in decision-making and emotions associated with them. Several experimental evidences pointed at the orbitofrontal cortex as a crucial structure for decision-making. The orbitofrontal cortex is activated in the evaluation and comparison of

outcomes and is connected with the dorsolateral prefrontal regions, active in reasoning and planning, and with limbic areas crucial for emotions, such as amygdala. Patients with focal lesions in the ventromedial prefrontal cortex, while keeping intact memory and reasoning, show reduced ability to make decisions, for example perseverating in losing financial investments, and in the social domain, being unable to maintain stable social relationships (Bechara *et al.*, 2000). Damasio and colleagues attribute this deficit to the inability to generate somatic markers, or visceral sensations that "mark" positively or negatively the alternatives of a choice, that allow to anticipate the emotional consequences (Bechara *et al.*, 1997). This hypothesis has been explored by the IOWA gambling task. In this game participants are presented with four decks of cards (two decks are "good" and two "bad"). Each deck contains cards that represent a win or a loss. In the "good" bunches winnings are low but it's the same for losses. In the "bad" bunches winnings are high but losses are higher than winnings. Participants are given an initial amount of money and they receive instruction in order to play maximizing the winnings. After a few hands, healthy subjects show the ability to make the choice that involves less risky and more winnings in the long term: they tend to draw cards from the "good" deck. In contrast, subjects with lesion to the ventromedial prefrontal cortex, do not show this pattern, continuing to choose indifferently from both decks. Their neurological deficit affect the ability to learn from past mistakes and affects their behavior in the game. For this reason, patients with ventromedial prefrontal cortex lesions, although equipped with standard cognitive and intellectual abilities, have a great difficulty in making decisions in

real-life situations. The somatic marker hypothesis showed a bottom-up influence on decision-making processes.

Coricelli *et al.* (2005) claimed that, thanks to counterfactual reasoning, orbitofrontal cortex shows a top-down modulation of emotions. This happens after a particular decision followed by feedbacks about the obtained results. After the outcome of a particular choice, the comparison between the obtained result and the result of potential alternatives is made and this cognitive process (counterfactual comparison) represents a top-down modulation. According to the authors, the orbitofrontal cortex is supposed to be the brain area involved in the integration of cognitive and emotional components of the decision making processes. So, orbitofrontal cortex appears to have a fundamental role for regret and brain damages in that area determine an impairment in the feeling of counterfactual emotions such as regret (Camille *et al*., 2004; Coricelli *et al*., 2005).

Camille *et al.* (2004) asked participants to make choices between two lotteries with different potential winnings. There were two conditions, "partial feedback" and "complete feedback" conditions. In the "partial feedback" condition participants received only information on the chosen lottery (see *fig*. 1.1) and in the "complete feedback" condition they were presented with results of both lotteries (see *fig.* 1.2). At the end of the game, for each task, subject were asked to evaluate their emotional state. Healthy subjects reported emotional evaluations consistent with a counterfactual comparisons between the obtained and the unobtained outcomes (see *fig.* 1.3).

For example a payout of 50 € when the alternative choice would have been 200 €, generated an extremely negative emotional response. On the other hand, a win of 50 euros when the alternative would have been a loss of 200 euros generated a counterfactual emotion of relief, a positive response to the outcome. So, the experience of regret generates choices characterized by an attempt to avoid other future regrets. Patients with selective lesions to orbitofrontal cortex don't report regret and they don't anticipate the negative consequences of their actions. Orbitofrontal patients (and not subject with other brain lesions) persist in the choices which healthy subject avoid after regret, because they are not able to anticipate and avoid a future negative counterfactual emotion.

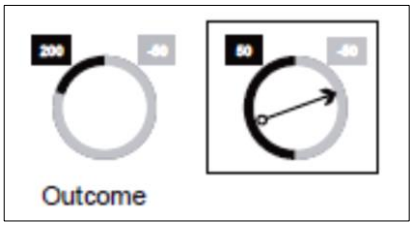

Fig.1.1 partial feedback condition (from Camille *et al.* 2004)

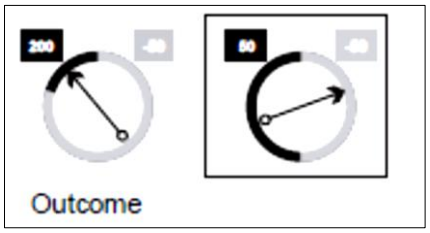

Fig.1.2 complete feedback condition (from Camille *et al.* 2004)

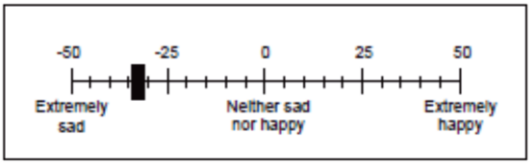

Fig. 1.3 emotional evaluation (from Camille *et al.* 2004)

Coricelli *et al.* (2005) reported an increase of brain activity in the orbitofrontal cortex during the experience of regret and during the anticipation of this emotion at the time of choice in a fMRI study with healthy participants.

Another important result concerns a greater involvement of cognitive components in future choices. Indeed, in the choices that follow an obtaining negative result, they observed an increase in brain activity for the inferior parietal lobe, the dorsolateral prefrontal cortex and right lateral orbitofrontal cortex. The negative emotional experience induces the intervention of areas involved in cognitive control and then the comparison between the obtained outcome and what we could have obtained with another choice.

1.4. The role of Orbitofrontal Cortex in decision making

The Orbitofrontal cortex (OFC) is a portion of the prefrontal cortex involved in decision making processes. Some portions of the OFC are Brodmann areas 10, 11 and 47.

OFC gets its name from the position immediately above the orbits. It's involved in sensory integration, representing the affective value of reinforcers and in decision-making. Particularly, the OFC seems to be involved in expected rewards or punishment, thus making the OFC critical for adaptive learning. It has been less studied than other prefrontal cortex areas. This happened only in recent years with evidences from neuropsychology and neuroimaging. All these evidences provided information about the role and functions played by OFC. It links sensory integration function with the modulation of autonomic reactions and learning, prediction and decision making. OFC is part of the frontostriatal circuit with strong connections to the limbic system. For this reason it's a region that

integrates affective and not affective information and which regulates the appetitive responses.

The role of OFC in decision making processes was first understood in 1848 thanks to the case of Phineas Gage, whose orbitofrontal cortex was penetrated by a metal rod. Phineas Gage survived but he completely changed personality. In recent years neuropsychology provided results concerning orbitofrontal cortex damage, reporting problems with decision making, lack of affect and social inappropriateness (Blair & Cipolotti, 2000).

1.4.1 The development of Orbitofrontal Cortex

During childhood and adolescence many changes occur with a growth and modifications in myelination and synaptic density in the brain. Among the prefrontal structures some studies report that OFC develops earlier than dorsolateral prefrontal cortex (e.g. Orzhekhovskaya, 1981).

Recent evidences suggest that orbitofrontal structures continue to develop into adulthood, but that they first emerge during development, around the end of the first year of life; this is in contradiction to what was previously believed, that is: a prefrontal cortex functionality starting from 4-7 years old (Luria, 1973), or even starting from 12-15 years old (Golden, 1981).

Gogtay *et al* (2004) (see *fig.* 1.4) found an early increase of gray matter volume, followed by sustained loss at puberty. According to the researchers the process of gray matter maturation (and loss at puberty) begins in dorsal parietal cortices, goes on in the frontal, parietal, occipital ones, and ends in the temporal

cortex. Only in a final stage of maturation the dorsolateral prefrontal cortex is involved, which starts to lose gray matter only at the end of adolescence.

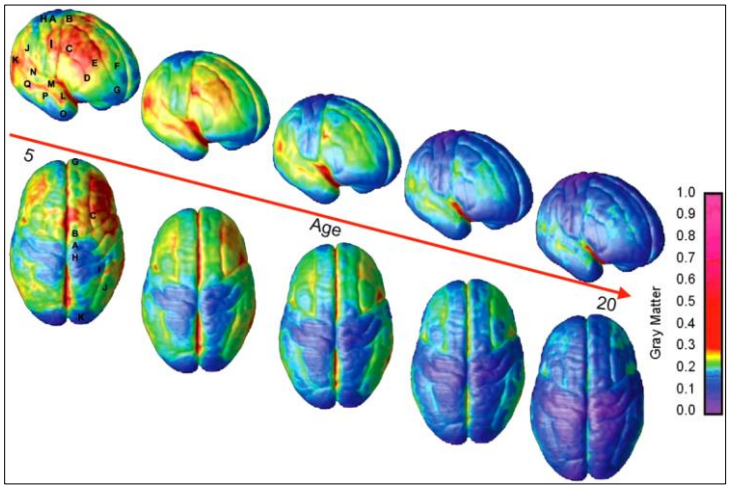

Fig. 1.4 (Source: Gogtay *et al.*, 2004)

In the second year of life children become more able to inhibit their answers during the Piagetian A-not-B search task (Piaget, 1954). Furthermore, some studies (Overman *et al.*, 1996) demonstrated an improvement in young children's performance in a task known as *object reversal*.[1] Bell & Fox (1992) found also a correlation between frontal/parietal EEG coherence and the ability to tolerate delays of gratification. In order to measure the delays of gratification in young children, Thompson *et al.* (1997) employed a modified choice task. The

[1] *Reversal Learning* is a task in which participants are asked to give different responses according to the two conditions of reward and punishment. So they have to learn to change their answers in the game according to conditions in which previously rewarded stimuli are no longer rewarded and so on.

researchers found that 4 to 5 years old children in a task in which they are asked to choose between a small reward now or a larger after a delay of time, and in a task in which they had to choose between a reward for self now or for self and other after a delay of time, show altruistic behavior and ability to delay the gratification compared with 3-year-old children. Moore *et al.* (1998) found also a correlation between altruism and theory of mind (Premack &Woodruff, 1978). According to Happaney *et al.* (2004) OFC plays a role also in affective decision making. Kerr and Zelazo (2004) found that in the *Iowa Gambling Task* 3-year-old children performed in a disadvantageous way compared to 4-year-old children. And a better performance by 6 years olds compared with 3 and 4 year olds was shown in Garon and Moore's (2004) experiment. Note that the relationships among delay of gratification, Theory of Mind abilities, Decision Making and Attachment have been investigated by Marchetti & Castelli (2012).

Finally, Blair *et al.* (2001) investigated advantageous choice and correlation with age in a sample of participants aged from 9 to 17. They found an inverse correlation between the two variables, which shows a development across age of the ability to make advantageous choice, and hence the development of OFC.

The functions of OFC consist in an inhibitory role but also in a coordination of components of cognitive, emotional and behavioral regulation. This involves the evaluation of motivational signals, the ability to learn appropriate responses to rewarding and aversive stimuli, the registration and regulation of emotional states and the switch of behavior and responses. OFC plays a role also in working memory (e.g., Schoenbaum & Setlow, 2001).

The best way to classify OFC's regions is to divide them into the medial and lateral ones. The medial region is mainly involved in motivation (e.g. reward evaluation), being highly connected with limbic structures. The more anterior region is involved in behavioral inhibition and selection of responses (e.g. Bokura *et al.*, 2001). This anterior region is more connected with the dorsolateral prefrontal cortex (DLPFC). Both regions are connected with the anterior cingulate cortex (ACC), another very important region for executive functions, more involved in self-monitoring and error detection (e.g. Carter *et al.*, 2000).

For many researchers the development of executive functions occurs at around the age of 3-4, with the development of self-control and perspective taking. According some authors (e.g., Derryberry & Reed, 1996) self-control also allows an early development of responsibility for actions.

1.5 Counterfactual thinking in children

Harris (1989) specifically claimed to consider the emotional development in close relationship to cognitive development. But given the strong dependence of counterfactual emotions from counterfactual thinking, children are able to experience these emotions only if they first have developed the skills in this type of thinking.

There are conflicting ideas in the literature about when during child development counterfactual thinking emerges. Harris *et al.* (1996) and Riggs *et al.* (1998) claimed that children are able to think counterfactually when they are around 3 or 4 years old. In a typical experimental task children are asked what would have happened if things would have been different. For example, they see a

dirty floor and a doll with dirty shoes. So they are asked how is the floor now and whether it was dirty before the doll's arrival. Then they are asked whether the floor would have been dirty if the doll would have removed her shoes.

Some authors described *implicit* counterfactuals (Perner *et al.*, 2004), referring to Gergely *et al.* (2002). But I agree with Beck, Riggs and Burns (2011), claiming that it makes sense to refer to counterfactual thinking only as an *explicit* process. Beck *et al.* (2011) described four types of counterfactuals. These counterfactuals are: *generating alternative worlds, representing falsity as if it were true, representing multiple possibilities* and *comparing multiple possibilities* (p. 111).

So it initially appeared that three years old children would be able to reason counterfactually, as long as relying on short chains of action. However, this hypothesis has given way to the idea that this was the result of false positives. Children are based in fact, not so much on their ability to reason counterfactually but on their general knowledge of the world. Beck *et al.* (2010) attempted to check this hypothesis by reading to children some stories similar to those of German & Nichols (2003) in which a main character is initially presented as happy and then, running into bad luck, becomes sad. They do not replicate their results. Questions regarding short chains of events were not for children easier than those involving long chains of events.

In a second experiment, Beck *et al.* (2010) found that short questions were for children more difficult than longer questions and short questions about emotions. This leads us to think that actually they base their answer on their general knowledge of the world, however in case of questions of long chains of

causal action their performance are not due to skills they possess. Beck *et al.* (2010) do not, however, report sufficient evidence in favour of any specific hypothesis.

The authors claimed the children were not able to reason counterfactually not because of the length of chains of events but rather because of the development of language skills.

Robinson & Beck (2000) argue that for the emergence of counterfactual thinking is also necessary to have a sufficiently developed inhibitory control system. This is because counterfactual reasoning implies to resist in considering the reality and to rely on what might happen. Children make mistakes due to the fact that they refer to reality instead of chance. So they can't inhibit the answer concerning reality instead of the answer concerning what might happen.

Beck *et al.* (2009) report that children who are not yet able to represent counterfactual thinking as a "double chance" didn't experience it. This concept of "double possibility" refers to a certain point in time where it is not yet clear the result of a decision and any outcome can possibly occur: one of these possibilities will then become reality while the alternative one doesn't manifest. According to Beck *et al.* (2006) it's only from the age of six that children are able to imagine counterfactual thinking as a "double chance". According to Rafetseder *et al.* (2010), children up to five / six years old do not think in a counterfactual way but adopt other strategies such as conditional or logical reasoning.

1.6 The Development of the emotions of regret and relief

Once children are able to think counterfactually and have an adequately developed inhibitory control, they should be able to understand and report counterfactual emotions. Between three and six years of age children develop the skills required for the emergence of regret and relief. It's important to underlie that counterfactual thinking is a necessary condition but not sufficient for the development of counterfactual emotions.

As I mentioned before, the experience of regret may have an adaptive function and so may have a role of "learning from the experience". If the actions of an individual lead to undesirable results, it is assumed that the same individual will no longer act in that way, in similar conditions.

Amsel and Smalley (2000) investigated for the first time the age at which a child begins to understand that an agent feels the emotion of regret or to feel himself this emotion. The investigation of counterfactual reasoning in child development has been generally conducted in literature using story telling in which children are asked to judge an event as the actual target that would have been different changing his antecedent (*forward counterfactual reasoning*) or its subsequent (*backward counterfactual reasoning*). The distinction between representing and reasoning about counterfactual states and the way in which this distinction has an influence on counterfactual thinking and the emotional evaluation is really crucial to assess the impact of counterfactual thinking on emotional evaluation.

The four studies designed by Amsel *et al.* (2003) investigate regret, but also relief (defined by the authors as elation, but see chapter 2 for a distinction). In

each of them children are given an initial question concerning the emotion of an agent (both in *Self* and in *Other* condition) as a result of a choice between two options. Subsequently, the alternative choice is revealed, and then the question about how the agent feels now about the outcome of the un-chosen option is asked.

Evidence of child ability to represent and reason about a possible state of things is obtained through the difference between the first question and the last question (counterfactual). Specifically, children must demonstrate an ability to judge the agent happier or sadder with an undesirable or a desirable outcome with respect to an undesirable or not selected one. In order to claim that preschoolers are able to manage counterfactual emotions the authors support the hypothesis that they have to feel differently in response to the original question with respect to the final one.

1.6.1 *The role of the alternative outcomes for the emergence of regret*

The aim of Amsel *et al.* (2003) was to investigate when children judge the counterfactual-based emotion of regret in others and when they themselves experience it. In each of four studies, participants were asked an Initial Question about the happiness of an agent (*self* or *other*) regarding the consequence of having selected one of two options. For example, in Studies 1 and 2, agents selected and opened only one of two boxes and in Studies 3 and 4, agents turned over one of two face-down cards in a card game against a rival who had been dealt a face-up card. Then, the unselected option (gift box or card) was revealed

and it was shown that it would have produced a more or less desired consequence than the selected option.

In *Self* conditions the experimenter introduced two dolls representing two agents of the same sex of the participants. Close to the dolls were placed two boxes. They were said to be gift boxes. They contained a plastic figurine for children and $ 5 for adults. The evaluation of the agent's happiness in relation to the choice consists of a 4-point scale represented by 4 smileys: not at all happy, a little happy, pretty happy or very happy. After the presentation of the scale they were asked the first question: "How happy is (name of the doll) with the gift received?". So the alternative outcome was revealed and they were asked to report how happy is the doll again. The participants were randomly assigned to two conditions. One was the condition with the alternative outcome as a better gift than received and the other one was the condition with a worse alternative outcome compared with the gift received. The evaluation of the feelings of the agent was asked after revealing the content of the not chosen box and the counterfactual question was asked: "How much would have been happy (name of) if he/she had chosen the other box?". This was followed by a final question: "How happy is now (name of) with the gift received?". It would be a repetition of the initial question, but after knowing the alternatives.

The authors examined the differences in the answers to the initial question and the counterfactual question in order to examine if the participants gave different judgments before and after discovering the contents of the not chosen box. Their results revealed a significant effect of the alternative outcome: if it was positive, the main character was judged happier than the protagonist getting a

negative alternative result, all in relation to the given answers in response to the counterfactual question compared to the original question. This effect was seen in all the age groups.

The qualitative analysis suggests to authors that pre-school children as well as adults judged the feelings of the protagonist on possible states of things. A second analysis assesses the differences in the initial and final answer to the question, and so the judgments about the feelings of the protagonists in relation to the fact that it was revealed the contents of the not selected box. Through the results of this study they assumed that young children represent themselves and think like adults with regard to the feelings of the protagonists in relation to states of things that could have happened. Counterfactual thinking, therefore, is thought to be possessed even by very young children.

Other researchers have also become interested in the emergence of counterfactual thinking in preschool children, claiming that the visible change at 4/5 years regarding the counterfactual reasoning is due to several factors: (i) an increase in the mental capacity of children to represent explicitly and reason about real alternatives, (ii) the acquisition of the ability to imagine alternatives to reality, besides those involving only negative outcomes, (iii) the acquisition of the ability to think about alternative states of affairs.

The idea to test is the possibility that children think about an alternative world but not in connection with the real one, and that they actually give a judgment on the amount of gift received instead of reporting a counterfactual emotion. In order to test this hypothesis, Amsel *et al.* (2003) ran another experiment, with the presence of detail information about the agent.

1.6.2 *The effect of providing additional information about the agent*

This study examines the influence of the factual and counterfactual outcomes on the opinions of children about the happiness of the protagonists. The procedure is similar to the study 1, but the content of the two boxes changes, which is now the same for children and for adults. In addition, once selected the box, participants are given details about the protagonist of the choice.

This information corresponds to counterfactual information concerning a gift that is worth more or less than the one that the protagonist could have received; factual information concerning the level of satisfaction of the protagonist in relation to the gift received (in this case, for example, how recently the protagonist had eaten if the box contained a dessert, or played if the box contained a figurine).

This new information is used to influence the opinions of the participants on the protagonist's feelings about a state of affairs that has no direct reference to mental or psychological states of the characters. This allows a fair comparison between the factual and counterfactual account in making emotional judgments.

Amsel *et al.* (2003) expected that college students but not pre-school children would have modified their initial judgments about the happiness of the protagonist after receiving the gift (sweet or present) if they were given additional counterfactual information and that the initial judgments for both the age groups were affected by additional factual information concerning the level of satisfaction of the protagonist.

The procedure consisted in presenting one at the time four dolls of the same sex of the participant to whom was given the opportunity to choose between two boxes. Then the experimenter explained to participants that they had to judge the feelings of the dolls about the gifts received (initial question). After evaluating the emotion of the protagonist, participants were given, at the same time, the factual or the counterfactual information.

The factual information was positive for half of the protagonists, then the prize received was very appreciated because in this case the dolls had not eaten / played recently, but for the other half the factual information was negative.

After giving the new information, they were asked a question about the feelings of the protagonists in the light of the acquired information and lastly the final question, a repetition of the initial one. So there were eight groups of participants who received respectively: a) factual or counterfactual information; b) a sweet or a present shown first; c) initial positive or negative information.

This study replicated the results of the study 1 showing the lack of effect of counterfactual information on children's judgment about the happiness of a protagonist. This cannot be said about the new factual information, who had an effect on judgments both for children and adults about the happiness of the protagonist, although in different sizes.

The different influence of factual or counterfactual information allows us to conclude that children in this second study are unwilling to change their judgments about the level of happiness of a protagonist in the light of new information. The results, however, leave open the question of why the counterfactual information has not an effect in both first and second study of

Amsel *et al.* (2003). One possibility is that children do not make judgments about their feelings, but they judge those of another protagonist.

1.6.3 *Making judgment about own feelings*

In light of the results of the study 2, Amsel *et al.* (2003) asked children to make a judgment of regret and elation in a card game in which they won some stickers. Participants played against the experimenter with cards ranging from 0 to 5 points. Participants were given two faced down cards while the experimenter had one card faced up. Who had the card with the highest score was the winner. One of the two cards of the participants had always the same score of the experimenter, while the other card was higher or lower. The counterfactual question was asked after seeing the not selected card.

The differences from previous studies in the evaluation of the emotions was that the scale included a neutral smiley. In addition, before starting the experiment, there was a training game consisting of three hands, one in which participants win, one in which the experimenter is the winner and one in which cards are the same, to test the understanding of the game, in which the simple question: "Who wins?" is asked. Participants were excluded from the study if they answered incorrectly to more than one question. In two hands the alternative card was the better choice.

The initial question was "How do you feel about the card that you chose? Happy, sad or neither sad nor happy?". Then the non-chosen card was turned and the counterfactual question was asked: "How would you have felt if you had chosen the not selected card?". This was followed by the final question: "How do

you feel now about the card you chose?". This last question was slightly different from the initial one, introducing the adverb "now" with the dual purpose of asking a different questions in order to eliminate the reluctance of participants to change their response and emphasize the word "now", allowing participants to change their answer. At the end of the game participants were asked to say the number of the selected card.

What emerges from this third study is that children are influenced in their judgments about their current emotions by understanding quickly the information on alternative states of affairs. Methodological artefacts are excluded and they assumed that the emergence of regret and elation attributed to themselves or others occur simultaneously. Moreover, preschoolers are unable or ignore the value of taking into account an alternative state of affairs in their judgments of actual emotional states.

1.6.4 *Other- and self-attribution of counterfactual emotions: which come first?*

In their last study Amsel *et al.* (2003) asked participants to judge their level of happiness and the level of happiness of another agent in a task similar to study 3. The purpose is to determine whether the capacity to self-attribute counterfactual emotions emerges in development in advance of the capacity to attribute them to others, or if there is no self/other asymmetry in development.

The agent is Billie, a plush character with no facial expression, who played against participants instead of the experimenter. There are eight trials, four in which participants receive two cards and they select one, and the other four in which Billie receives two cards and he selects one. In all hands participants are

asked to judge the feelings of the agent in relation to the chosen card before and after seeing it.

The questions are now different. The initial question represents a judgment on the agent's feelings about a potential win or loss, and the final question focuses on the direction in which participants change the evaluations of the feelings of the agent once they discovered the value of the not selected card.

In four hands participants are asked to judge their feelings after winning, when they could have lost; and a judgment about their feelings after losing, when they could have won. In the other four hands participants are asked to report Billie's emotions after winning when he could have lost; and after losing when he could have won. The idea was that children's judgments of regret and elation both for self and others, would have appeared simultaneously, thus reflecting a conceptual view of these emotions based on a counterfactual prediction based on Wimmer *et al.* (1991), who claim that the simultaneous emergence of false belief comprehension in self and others reflects children's conceptual understanding of mental states. They also included two phases of pretest. The first assessed whether children would have judged the psychological expectations as an enhancer of the feelings of happiness and sadness, in two fictive scenarios, one in which Billie receives a gift, which is better than expected; the other in which Billie gets hurt a finger and so he feels worse than expected.

The second phase of pretest evaluated participants ability in playing cards. In four of the eight hands participants selected one of two upturned cards and they compared it with Billie's cards. They won and lost at least two times out of four.

In the other four hands Billie received cards and he selected one to be compared with experimenter's card.

After revealing the selected card, there were three questions. The initial one: "How do you feel / how does Billie feel after turning the card?". The counterfactual question after shooting the not selected card: "Who would win the sticker if you / Billie chose this card and not the one you / Billie selected? Billie, you or nobody?".

The counterfactual question is not about the feelings of the agent (as in studies 1 and 3). The final question is asked after covering the unselected card: "Do you remember you said that you were (Billie was) *happy/sad* after shooting the card? Now you (Billie) saw the unselected card. How do you (Billie) feel about your (his) choice? Do you (Billie) feel *happier/sadder* than before, the *same* as before, or less *happy/sad* than before?"

According to these results, the recognition of the two counterfactual emotions is not possible before 5-6 years of age. Data also show a simultaneous emergence of the ability to attribute counterfactual emotions to self and others.

According to the authors, the simultaneous emergence of the capacity to make judgments of regret and elation for self and others depends on young children's gaining insight, over time, about the value and significance of bringing knowledge about the possible world to bear on assessments of an agent's feelings about the real world.

In order to attribute regret to themselves and to others children need two components. One is the ability to reason and to represent the feelings of an agent

with respect to unrealized possibilities. Another is the influence of thinking about these possible states of affairs when judging the current ones.

1.7 Thinking about the emotional responses of another agent

Guttentag and Ferrell (2004) designed three experiments in order to test the understanding of regret and relief in children. Participants are asked to make decisions with respect to the emotional responses of other agents. The focus of the study is therefore on children's attribution of counterfactual emotions to others rather than to themselves. The authors used in this study a measure similar to the *Counterfactual Inference Test* (Hooker, Roese and Park, 2000). Participants are presented a few stories describing the experience of two characters who get outcomes as a result of decisions made. The stories always contain an element that differentiates the two characters, which is relevant for judging regret and relief. The task of the participants was to judge whether the characters in the story would have felt in the same way with respect to the results obtained, or if one or the other would have felt better or worse.

Unlike Amsel *et al.* (2003) who measured if the intensity of an emotional response varies when a participant finds out what might have happened if he had made a different choice, Guttentag and Ferrell (2004) simply measured if children are able to judge a protagonist in a different way than another character. Previous research suggests that for children, such comparisons are easy to make and tasks relating to such judgments are useful as sensitive measures of child emotion understanding.

1.8 The mutability of an event and the experience of regret

The experiment one of Guttentag and Ferrell (2004) examines the understanding of one or more aspects of the way in which the situational factors have an influence on the emotional responses based on counterfactual reasoning. Previous research suggests that when we compare two situations in which what might happen is better than what has occurred, adults experience regret more frequently and with more intensity when the event occurred is actually cognitively highly mutable.

One factor influencing the mutability of an event is the typical action that produces negative results: atypical action is more mutable than a typical course of action. A negative result will produce a more intense emotion of regret if we opt for an atypical course of action than for a typical course of action.

The experiment consists of four stories about two characters who take a decision with respect to two possible courses of action. The general characteristics of the situation, the results and possible alternative were the same for both characters: the only difference concerned the nature of their decisions. In one case, the course of action chosen by both characters was described as typical for an agent and atypical for another. In the other two stories the difference between the two characters was that one chooses to implement a certain behavior while the other chooses to not act at all. The participants were 18 five-year-old, 25 seven years old, 54 aged 9 and 83 adults. In line with Amsel *et al.* (2003), 5-year-old children fail to consider alternatives when making a decision.

In summary, two of the four stories described a typical course of action for one of the protagonists and an atypical course of action for the other two stories. A third pair of stories exposed the protagonist's action to an intentional act while in the last two stories the protagonist was not acting at all. Three categories of explanation were used in order to justify why the protagonists felt worse in some situations. The first was focused on the choice or on the alternative outcomes. The second one was focused on the story or something reported about the protagonist and the third was not to give any explanation. Other three categories were provided to explain why the characters felt the same way: 1) the results were the same for both characters; 2) choices or decisions of both characters; 3) no reasons why.

They also examined the way in which the mutability (typical/atypical action and acts of commission/omission) has no effect on emotional responses and negative outcomes. The decision making patterns of children aged 7 don't coincide with those of adults. Starting at 7 years old children are sensitive to the nature of the situational factors that influence the mutability of events. Children at 5 years old feel the same regardless of the situational factors. At this age it is not clear how a counterfactuals can influence the emotional responses.

1.9 The importance of alternative courses of action

In the same study, Guttentag and Ferrell (2004) focused on "what could have happened". The alternative courses of action were not the same for the two protagonists of the stories: for one of them was better, for the other was not different from the actual course of action. The structure of the story was organized

in order to maximize the salience of critical elements relevant to the experience of regret. A series of questions to verify the understanding of the story and the recall of critical details were added.

There were 18 participants aged 5 and 18 adults. The results showed that adults judged the feelings of the protagonist as more negative, while children reported that is the character who isn't the protagonist of the choice to feel worse. Adults judged the protagonist of the choice as the character who felt worse because the other decision would lead to better outcomes, while children thought that the non-target character was the one who felt worse because things would have gone wrong anyway, regardless of the choices made. Authors suggest that children seem to base their judgments on the quality of the outcomes only.

1.10 The experience of relief

In their third study, Guttentag and Ferrell (2004) inserted a neutral response and a positive instead of a negative one. While the emotion of regret is felt when the obtained outcome is more negative than a possible alternative, the emotion of relief is the result of a positive or a neutral outcome when the alternative is worse.

The procedure is similar to the experiment one: participants (17 aged seven and 18 adults) are told two stories in which two characters get more neutral results avoiding negative. In the first story the protagonist avoids a negative result through a typical action, while another character avoids a negative result through an atypical action. In the second story the protagonist avoids a negative result doing an action, and the other through a "non-action".

What emerges is that negative results stimulate more counterfactual thinking than neutral or positive results.

1.11 Possible explanations for the discrepancy in the emergence of regret and relief

Weisberg and Beck (2011) used an experimental procedure similar to the one of Amsel *et al.* (2000). A previous study (Weisberg and Beck 2010) had showed that regret emerges at five years old while relief at seven, suggesting three hypotheses about the causes of this gap: 1) the development of relief would take place later; 2) the evidence regarding the emergence of relief are more difficult to test; 3) the evidence for regret are the result of false positives.

Authors claimed that in order to experience a counterfactual emotion it is necessary to keep in mind two alternatives: the reality and the counterfactual world, and also to understand that they are both possible. Regret and relief are, among this type of emotions, both the result of a comparison between reality and something better, in the case of regret, or something worse, in the case of relief.

So, the focus of their study is to identify the reasons for the lag between regret and relief, which the authors summed up in three causes: a) actual delay for relief; b) methodological limitations of the studies; c) children's evidence for regret as false positives.

They claimed that the notion of negativity bias suggests that the relevance, power and predominance of negative events more easily trigger a reaction and perhaps counterfactual thinking. And this supports the idea of the first cause,

among the three mentioned, as the more probable reason for the lag between regret and relief.

They recruited 55 participants aged 4-5, 52 of 5-6 years old and 55 aged 6-7. Everyone perform a pretest in which the understanding of the 5-point rating scale, with 6 rounds of training measuring the happiness of the protagonist. Participants were shown two face down cards and they had to choose between the two. They could win or lose a number of tokens according to their choice. The following question is related to their feelings about the choice of the card. So the not chosen card was turned over and questions about their feelings were asked again. They changed the evaluation scale used before (see *fig.*1.6), introducing three arrows underneath (see *fig*.1.7).

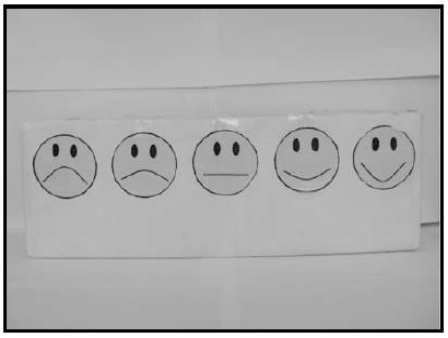

fig. 1.6 from Weisberg and Beck (2010)

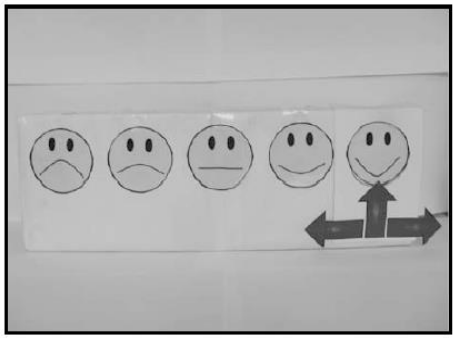

fig. 1.7 from Weisberg and Beck (2011)

Children were asked to rate their emotions (first evaluation) and then to rate their emotions again (second evaluation), using the arrows in order to point left or right if they want to rate "even sadder" or "even happier" or "the same" of the smileys. They also introduced regret and relief trials always with initial win, in which children won something but the alternative was better (regret) or worse (relief) and regret and relief trials with an initial loss, but with a best alternative

(regret) or a worst (relief). Children were also provided with feedbacks based on the correct or incorrect responses in the training procedure.

Only in regret trial with an initial win children aged 4-5 were able to feel regret. They also obtained for relief trial with an initial loss the experience of relief at 5-6 years old.

In order to manipulate the responsibility for the outcome, Weisberg and Beck (2011) designed a second experiment in which children were presented with three conditions. They used a between subject design. The first condition, named "choice", represents a replication of the experiment one, in which children chose one of two cards to turn over. The second condition is named "no choice-experimenter". The experimenter rolls one dice in order to determine the participant's card. In the third condition, named "no choice-child", the participant rolls a dice which determines his/her card.

101 participants aged 5-6, 94 children of 6-7 years old and 102 aged 7-8 were involved in this experiment. Once having completed the experiment one, they were assigned to one of the three conditions. After the card was turned over, children were presented with the original question: "How do you feel about the card you got?" And the participants chose the point on the scale that best matched their feelings. Then the other card was revealed and they were presented with the question and the scale again.

Results show that children are more likely to experience positive or negative counterfactual emotions if they are more responsible. In this second experiment both regret and relief are emotions that children are able to experience starting at 5-6 years old.

1.12 The addition of a baseline

O'Connor *et al.* (2012) introduced two methodological changes to Weisberg and Beck (2010) experiment. They introduced a baseline in order to measure the understanding of regret avoiding a first and a second evaluation after the choice and they used the three arrows employed by Weisberg and Beck (2011) experiment.

In a first experiment they involved 20 children aged 4-5, 16 aged 6-7 and 24 aged 8-9. As in Weisberg and Beck (2010) experiment, participants selected one of two boxes to win a prize. They also introduced a baseline, consisting in a trial in which children had to evaluate their emotions after their choice comparing it with a same outcome as counterfactual prize. They found evidence for regret in the age group of 6-7 years old and 8-9. Both these age groups were also able to explain their change in feelings because of the greater desirability of the counterfactual outcome. They obtained an increase of the reported counterfactual children for trials in which participants received the baseline first.

In a second experiment they still used the baseline, because of the results of the experiment one and they introduced three arrows as Weisberg and Beck (2011) did, in order to ask children to evaluate their emotions as even sadder, even happier of the same. All children received the baseline trial first. There were 18 children aged 4-5, 29 aged 6-7 years old and 31 aged 8-9. Results of experiment 2 confirmed those of experiment 1. Children were able to feel regret starting at 6 years old.

1.13 The role of executive functions

Burns *et al.* (2012) argue that the late emergence of regret in children compared to counterfactual thinking is due to the fact that they are asked to keep in mind at the same time two representations of reality (actual and counterfactual). In order to test this hypothesis they designed two tasks for regret and four tests for all components of the executive functions.

In their study they investigated the relationship between the emergence of counterfactual emotions in early childhood and the development of executive functions[2]. Authors believe that the differences in the development of executive functions predict the emergence of the experience of regret in young children. They adopted two methods in order to study the development of regret. The first, from Guttentag and Ferrell (2004), assessed the ability, in children, of attributing the experience of regret to others. The second approach aims to examine when children are able to feel regret in response to events that affect themselves (employing the same methodology as in the experiment of Weisberg and Beck, 2010).

This was the first study investigating the correlation between executive control and counterfactual emotions. The hypothesis is to test if individual differences in executive functions, particularly working memory and cognitive flexibility, are predictors or not of the experience of regret in children.

Counterfactual reasoning requires a cognitive flexibility in order to shift the focus from counterfactual to reality. It was also noted that at the same age in

[2] The executive functions can be contained in three distinct but related components: 1) updating and monitoring; 2) inhibitory control; 3) ability of switching.

which children experience regret there is also an improvement in working memory and cognitive flexibility. Beck *et al.* (2009) found that correct answers to counterfactual questions were related to ability in inhibitory control: what children found difficult in reasoning about false antecedents was inhibiting the actual knowledge about the world.

In order to test the relation between regret and executive control, Burns *et al.* (2012) propose to investigate executive functions (working memory, inhibitory control and switching), the experience of regret through a shortened and adapted version of the experiment of Weisberg and Beck (2010), and a measurement of the attribution to others of the emotions of regret through a study similar to that of Guttentag and Ferrell (2004).

They tested 104 children from the age of four to seven. All participants perform two test sessions: one on executive functions and the other on regret and counterfactual reasoning. The first session consisted of four tasks in order to test the three components of executive functions: two tasks of *working memory*, one of *switching* and one of *inhibitory control*. The tasks were performed in the same order for each participant.

The second session includes four types of tasks: 1) Boxes game, used by Amsel *et al.* (2000) and extended by Weisberg and Beck (2010); 2) Stories task, adapted from Guttentag and Ferrell (2004); 3) Marble game. test on counterfactual reasoning adapted from Beck *et al.* (2006).

Their results indicate that *switching* and not the task of *working memory* or *inhibition* is a strong predictor of regret.

They claimed that the experience of regret may require a certain amount of working memory, despite individual differences in working memory of their sample are not predictive of the experience of regret. But they also claimed that the role of working memory in relation to counterfactual thinking could have been overestimated by previous researches. Furthermore, this study indicates that cognitive processes, in particular the control of attention and behavior, are inherently involved in complex emotional experiences.

1.14. Evidences for false positives in previous studies?

Rafetsder and Perner (2012) designed four experiments in order to control, according to them, for all the alternative interpretations about the age at which children experience the emotion of regret. They described the participation of 16 children aged 3-4 and 21 children from the age of 5 to 6 in their first experiment. Children chose between two boxes and they were told that they could keep the contents. In the *dependent condition* participants were asked to report their feelings before seeing and after seeing the content of the not chosen box. In the *independent condition* children had to rate their feelings only after opening the not selected box. There were two sessions with the presentation of dependent or independent condition in a counterbalanced order. They used two identical boxes, with a barrier in the middle for each one. One side of the box contained always one candy and the other side always five candies. Children were said to choose between the two boxes and after their choice they were always presented with the side of the box with less candies. So experimenter opened the side containing one candy instead of five, independently from child's choice. After their choice they

were said “Oh, there is one candy. It’s yours now”. Then they were asked the *baseline question*: “How happy are you with your one candy? Can you show me on our scale?’’. So, they were said: ‘‘Now I am going to show you what is in the other box. Oh, look! There are five candies in it’’. In the *dependent condition* they were asked: ‘‘Now that you know that you could have got five candies, how happy are you with your one candy? Can you show me on our scale?’’. In the *independent condition*, after the opening of the chosen box, children were said: “Oh, there is one candy. It’s yours now. Now I am going to show you what is in the other box. Oh, look! There are five candies in it’’. So they were asked: “How happy are you with your one candy? Can you show me on our scale?”.

They introduced a new emotional evaluation scale, made of 8-point smiley faces from very happy to very sad. In this experiment children were not influenced by the knowledge of the alternative outcome in either of the two conditions. They finally found evidences for regret at the age of 9.

1.15. Overall conclusions and introduction to experimental research

As we have seen, the established literature on the development of regret and relief has produced contrasting results and lots of open questions. I think this is due both to methodological problems and to different ideas of what can be defined “counterfactual”. There is also another point that I’ll mention at the end, in the general conclusions.

In my research I tried first to replicate Weisberg and Beck’s paradigm (2010) (see Study I), which was according to me the best available paradigm on the development of counterfactual emotions. Children were provided with two

boxes in a game in which they could win or lose stickers. Their paradigm provided also children with an emotional evaluation on a five point Likert Scale made of smileys, so including the neutral smiley, as Amsel *et al.* (2003) did before. They measure both negative and positive counterfactual emotions, defining the positive counterfactual emotion as *relief* instead of *elation* as Amsel *et al.* (2003) did.

My experiments introduced methodological changes. All developmental studies employed a first and a second emotional evaluation. I propose a final emotional evaluation only, with both the chosen and the unchosen outcome available and in front of participants all the time, also when children are asked to report their emotions. As a consequence, children are provided with a choice without *ambiguity*: they can see the content of the boxes all the time. The boxes are transparent instead of the closed boxes used in previous studies. So participants are presented with their content immediately and for all the duration of each trial, instead of seeing the chosen and the unchosen content after the choice only. I also defined two conditions, one called *partial* (when the game is played with only one of the two boxes) and one called *complete* (when the game is played with both boxes). According to these definition, the partial condition may elicit *disappointment* and *elation* while the complete condition may elicit *regret* and *relief*, as in Camille *et al.* (2004) and Coricelli *et al.* (2005).

Children are at last involved in trials where they can opt for a *safe choice* (choosing the box which give the opportunity to win something for sure) or for a *risky choice* (choosing the box that gives the opportunity to win a high amount of tokens or nothing).

My experimental work is described in five chapters. The first experimental chapter (Chapter 2) reports Weisberg and Beck (2010) replication's results. The second one (Chapter 3) explores the possibility for a lag between regret and relief or for a simultaneous emergence of the two counterfactual emotions. Chapter 4 aims to study the difference in the experience of counterfactual emotions between being completely responsible for a choice (agency condition) and not being responsible at all (no agency condition). I examined the relationship between attributing counterfactual emotions to self or to others in Chapter 5 and in Chapter 6 I examined the difference in counterfactual emotions between playing the game alone (Regret or Relief conditions) or playing against another child (Envy or Gloating conditions).

CHAPTER 2

STUDY I

The experiment in this chapter is part of the paper named:

Guerini, R., Coricelli, G. (*in preparation*). *Regret and Relief in 3- to 10-year-old Children: The Ontogenesis of Counterfactual Emotions and the «Agency Effect»*.

2. STUDY I: REPLICATION OF WEISBERG AND BECK'S EXPERIMENT

Introduction

Counterfactual emotions are higher order emotions and they are closely linked to counterfactual thinking. Every day we experience counterfactual thinking in many of its forms: for example, if we lose a train, if we are late for an appointment or when we simply do what we after realize to be «a wrong choice». What is common to all these situations is the negative emotion that goes with it, or positive in the case in which, however, things are going well and then we save ourselves from a negative result.

Counterfactual thinking underlies all these cases, as it is to think of imaginary alternatives. Specifically, if we experience regret, we compare the reality with the best alternative to it (*upwards counterfactual thinking*), whereas if alternatives to actually turn out to be worse, we may experience relief (*downwards counterfactual thinking*) (Kasimatis & Wells, 1995; Markman, Gavanski, Sherman & McMullen, 1993).

Much was investigated in recent years about counterfactual emotions in adults. But it was not the same for children. Few studies were run, which showed contrasting results and have used different methods of investigation. The first was Amsel and Smalley (2000) study. They tested 3- to 5-year-old children and a group of adults in four studies. One of them has provided two protagonists (dolls) opening two boxes in order to win something. Each doll opened one of the boxes, saw the content and participants had to rate how she felt on a 4-point scale.

Afterwards they opened the unchosen box and after having seen the content they rated how the protagonist felt again.

Their study tested also counterfactual thinking and they found that starting from 3 years old children were able to think counterfactually, but they were unable until the age of 5 to change the ratings in the final question after seeing the content of the unchosen box.

In another study participants had to choose one of two face-down cards trying to beat the experimenter. Children were asked to rate their feelings about the selected and the unselected card for each trial of the game. The 3- to 5-year olds' ratings of the chosen card did not change after seeing the unselected card. Amsel and Smalley's results showed that children aged 3- to 5 were not able to experience regret or relief or to report that a protagonist is feeling regret or relief.

Guttentag and Ferrell (2004) used stories to investigate children's report of counterfactual emotions. In three experiments they investigated in 5-, 7-, 9- year-old children and adults their abilities to infer that a protagonist could experience regret and relief in performing atypical and typical actions. Their results were that children didn't experience regret until the age of 7 and they didn't find any evidence of relief.

Weisberg and Beck (2010) investigated the development of regret and relief in 5- to 8- year old children using a similar methodology as Amsel and Smalley (2000). They found that children are not able to experience regret until the age of 5 and relief until 7 and to attribute these emotions to others until 7.

They concluded that both the lag between regret and relief and the dissociation between experience and understanding the two counterfactual emotions need to be

more investigated in order to understand at what age children are able to think counterfactually as adults.

Ferrell *et al.* (2009) investigated the role of salience in counterfactual alternatives in order to understand regret and relief. Their hypothesis was that it's more simple to reason counterfactually after a negative outcome instead of a positive outcome, and then that if children were provided with a prompt they could reason counterfactually and experience counterfactual emotions before the age of 7. They created "low salience" and "high salience" stories in which there were two protagonists obtaining the same outcome after the same decisions, but one of them could have obtained another outcome taking another decision and it would not have been the same for the other protagonist. They didn't observe any evidence of regret before the age of 7.

In our first experiment we aimed to replicate Weisberg and Beck's (2010) results, using their same method.

Experiment I

Method

Participants

We tested 60 children (31 girls, 29 boys) aged 3 to 8. Children were divided in three groups of age: 3-4 (M= 3 years, 5 months; DS= .51); 5-6 (M= 5 years, 6 months; DS= .53) and 7-8 (M= 7 years, 2 months; DS= .49).

Materials

We used a 5-point scale for rating emotions from "very sad" to "very happy" and two boxes placed on a table (see *fig.* 2.1), 25 cm from each participant. Data were collected in a quiet room. Children were tested individually.

Figure 2.1. Boxes and emotional scale

Procedure

Participants were explained the emotional evaluation scale and they were asked to rate the very sad face, the sad, that neither sad nor happy, the happy, the very happy face in a random order for each child. Several attempts were granted until it was clear that the child was able to understand the scale. Children who have presented difficulties in understanding the scale were excluded from the sample (2 children aged 3). They were presented the boxes and it was explained that they had to choose one of the two closed boxes arranged on the table, which contained different amount of stickers. The experimental session was preceded by familiarization trials in order to be sure that the child had understood the task.

After children's choice, the box was opened (see *fig.* 2.2) and they had to rate on the 5-point scale how they felt. The alternative box was opened (see *fig.* 2.3) and they had to do an emotional evaluation again. Four trials were run.

Experimenter underlined for each trial that a particular outcome was following the participant choice and that "the alternative choice could have been his outcome but he/she didn't choose that box".

Figure 2.2 Opening the chosen box

Figure 2.3. Opening the unchosen box

Results and discussion

To analyze the data, in line with the procedure used by Weisberg and Beck (2010), we subtracted the initial score (baseline), reported on the scale of emotional evaluation, from the final score, in order to have a score difference between -4 and +4. The scores below zero indicated that participants were less happy for the choice of the box after seeing the contents of the alternative box (the one not chosen). This indicated regret. Scores above zero indicated instead relief.

This was followed by a 3 (Age: 3-4, 5-6 and 7-8) x 2 (Task: Regret or Relief) analysis of variance (ANOVA). For post hoc analysis we used Tukey's test in order to measure the significant interaction between task and age. The results showed a main effect for the task ($F_{1, 57}$ = 387.27, p <.001, partial η^2 = .343), a main effect for age ($F_{2, 57}$ = 50.46, p <.001, partial η^2 = .639) and a significant interaction between the type of task and age ($F_{2, 57}$ = 179.95, p <.001, η^2 = .863). To analyze the significant interaction Tukey's post hoc test were performed.

The results showed significant differences between the means of affective scores of children aged 3-4 with the means of the group aged 5-6 and 7-8 for Regret condition. We did not find a significant difference between the 5-6 age group and 7-8 age group. For Relief condition, there were significant comparisons between means of children aged 3-4 compared with the group of 7-8 years old. There weren't significant differences between the means of children aged 3-4 and 5-6 years old (see *fig.* 2.4).

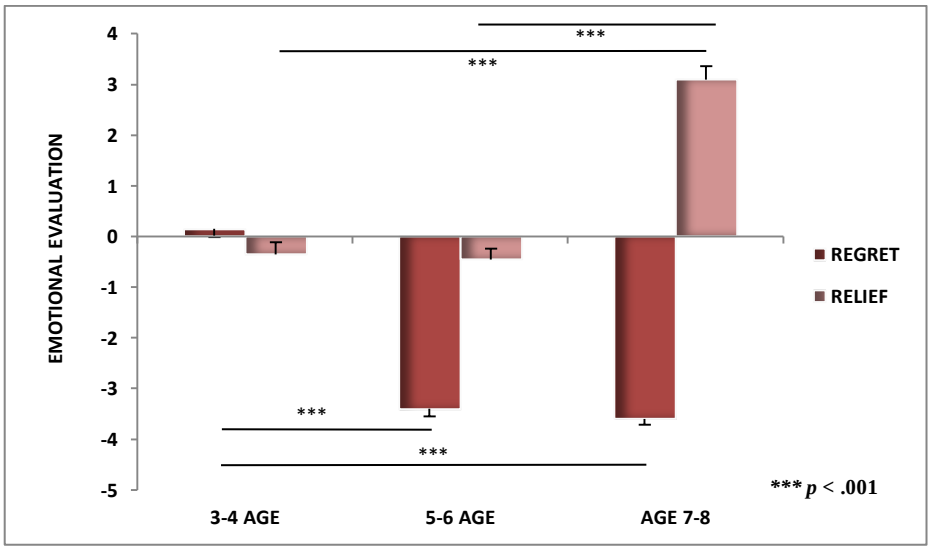

Figure 2.4. Means of children for each group

The obtained results confirm the possibility that regret may be an emotion experienced by children from the age of 5, in continuity to the results obtained by Weisberg and Beck (2010) and differently from the results obtained by Guttentag and Ferrell (2004) and Amsel and Smalley (2000; 2003). In the range of 3-4 years old children demonstrate to not understand this type of emotion: the responses between the first and the second evaluation do not differ or are discordant in the sense of having a positive connotation in both cases. A significant change is found

on the contrary for the age group 5-6, in which it is quite clear that the child is able to experience this emotion. A similar performance is found in the age group 7-8. Both the children aged 5-6 and those of 7-8 years present a performance significantly different from the group aged 3-4.

Results for Relief are also in line with those obtained by Weisberg and Beck (2010). We recorded the emotion of relief for the 7-8 year group only. The average score for relief of the group aged 7-8 were significantly different from the group aged 3-4 and 5-6. There were no significant differences between the means of the group aged 3-4 and 5-6. The study provides evidences for a lag between regret and relief, according Weisberg and Beck's (2010) results.

The lag between regret (at 5years old) and relief (at 7 years old) it is not clearly explained and would needs further investigation. We believe that it would be important to increase the salience for both the negative and for the positive outcomes, in order to investigate if children could understand regret before the age of 5, as Weisberg and Beck (2010) and Amsel and Smalley (2000), and relief before the age of 7 (Weisberg and Beck, 2010). We thus introduced the use of some avatars and children were asked to choose one of them to represent themselves in the game. They are important to underlie what happened after the choice of the child and what could have happened if child had chosen another box, as described in Experiment 2 and Experiment 3.

Another important point is the responsibility for the outcome. Less responsibility for the outcome has been shown to reduce feelings of regret (e.g. Burks, 1946; Byrne, 2002; Markman & Tetlock, 2000; Roese and Olson, 1995a; Zeelenberg, van Dijk & Manstead, 1998; Zeelenberg, van Dijk & Manstead,

2000). In another study results indicated that there was a strong positive correlation between regret and responsibility for the outcome (Zeelenberg *et al.* 1998).

We ran two experiments in order to investigate how a change in methodology can provide for different results from previous studies. Our study was approved by the ethic committee of the University of Trento. Parents of all participants gave their informed consent. Children were normally developing and of the same socioeconomic status.

CHAPTER 3

STUDY 2

The experiment in this chapter is part of the paper named:

Guerini, R., Coricelli, G. (*in preparation*). Regret and Relief in 3- to 10-year-old Children: The Ontogenesis of Counterfactual Emotions and the «Agency Effect».

3. Study II: Regret and Relief in 3- to 10-year-old Children

Experiment II

Introduction

In Experiment I we replicated Weisberg and Beck's results. We ran Experiment II with some methodological changes.

Previous studies investigating the development of regret and relief (Amsel *et al.* 2000, 2003; Beck *et al.* 2010) employed a first and a second emotional evaluation. In Amsel *et al.*'s first studies (2000) participants were involved in a game in which they had to rate the happiness of an agent and in their last experiments they played for themselves in a card game against the experimenter. Participants were asked to rate the happiness of the agents (or their happiness when played for themselves) on a 4-point scale with 4 smileys representing the following emotions: "not at all happy", "a little happy", "pretty happy" or "very happy". After the presentation of the scale, followed by the choice of the box and the revealing of the outcome, they were asked the first question: "How happy is (name of the doll) with the gift received?". So the alternative outcome was revealed and they were asked to report how happy is the doll again. Authors examined the differences in the answers to the initial question and the counterfactual question in order to test whether the participants gave different judgments before and after discovering the contents of the not chosen box.

In another experiment Amsel *et al.* (2003) introduced a new question. After revealing the selected card, questions became three. The initial one: "How do you feel / how does Billie feel after turning the card?". The counterfactual question after shooting the not selected card: "Who would win the sticker if you / Billie chose this card and not the one you / Billie selected? Billie, you or nobody?". And the final question, asked after covering the not selected card: "Do you remember you said that you was / Billie were / happy / sad after shooting the card? Now you/Billie saw the not selected card. How do you feel about your / his choice? Do you feel / Does Billie feel happier /sadder than before, less happy /sad or the same? According to their results, the recognition of the two counterfactual emotions is not possible before 5-6 years old. Data also show a simultaneous emergence of the ability to attribute counterfactual emotions to self and others.

Also Weisberg and Beck (2010) investigated regret and relief with a first and a second emotional evaluation in a task in which children had to choice between two boxes. Children were asked to rate their emotions (first evaluation) after the opening of the chosen box and to rate their emotions again (second evaluation) after the opening of the unchosen box.

Authors subtracted the initial score (baseline) from the final score, in order to have a score difference between -4 and +4. The scores below zero indicated that participants were less happy for the choice of the box after seeing the contents of the alternative box (the one not chosen). This indicated regret. Scores above zero indicated instead relief. They reported that regret emerges at five years old while relief at seven.

Weisberg and Beck (2011) employed the two emotional evaluations again but also three arrows pointing up, left or right in order to rate for the second emotional evaluation scores like “even sadder” (pointing left), “even happier” (pointing right), “the same” (pointing up). Children were also provided with feedbacks based on the correct or incorrect responses in the training procedure. In this second experiment both regret and relief are emotions that children are able to experience starting at 5-6 years old.

O’Connor *et al.* (2012) introduced two methodological changes to Weisberg and Beck’s (2010) experiment. They introduced a baseline in order to measure the understanding of regret avoiding a first and a second evaluation after the choice and they used the three arrows employed by Weisberg and Beck’s (2011) experiment. The baseline aimed to rate their emotions after the choice comparing it with a same outcome as a counterfactual prize. They found evidence for regret in the age group of 6-7 years old and 8-9. Both these age groups were also able to explain their change in feelings because of the greater desirability of the counterfactual outcome. They obtained an increase of the reported counterfactual children for trials in which participants received the baseline first.

In a second experiment they still used the baseline, because of the results of the experiment one and they introduced three arrows as Weisberg and Beck (2011) did, in order to ask children to evaluate their emotions as even sadder, even happier of the same. All children received the baseline trial first. Children were able to feel regret starting at 6 years old.

In Rafetsder and Perner’s (2012) experiments participants were presented with a 8-point smiley faces from very happy to very sad. They were shown two

boxes in order to choose one. They tested children's ratings both presenting the question twice (before and after seeing the alternative outcome) and presenting the question only one time, after showing the unchosen outcome. Their results are that children experience regret starting at 9.

In my experiment children are provided with a choice without *ambiguity*: they can see the content of the boxes all the time. The boxes are transparent instead of the closed boxes used in previous studies. So participants are presented with their content immediately and for all the duration of each trial, instead of seeing the chosen and the unchosen content after the choice only. I propose a final emotional evaluation only, with both the chosen and the unchosen outcome simultaneously shown. I also defined two conditions, one defined as *partial* (and it is determined when we provide the outcome of the chosen box only) and one defined as *complete* (when we provide the outcome of both the chosen and the unchosen box). According to these definition, the partial condition may elicit *disappointment* and *elation* while the complete condition may elicit *regret* and *relief*, as in Camille *et al.* (2004) and Coricelli *et al.* (2005).

Children can opt for a *safe choice* (choosing the box which give the opportunity to win something for sure) or for a *risky choice* (choosing the box which gives the opportunity to win a high amount of tokens or nothing).

Method

Participants

We tested 209 participants aged 3 to 10 (116 boys, 93 girls) (mean age = 7 years, 6 months; range from 3 years, 0 months to 10 years, 11 months).

Children were divided in four age groups: 3-5 year-old (*n* = 76, 38 male and 38 female; *M* = 5 years, 2 months; range = 3 years, 0 month to 5 years, 10 months); 6-7 year-old (*n* = 90, 44 male and 46 female; *M* = 6 years, 6 months; range = 6 years, 0 months to 7 years, 11 months); 8-9 year-old (*n* = 94, 46 male and 48 female; *M* = 8 years, 6 months; range = 8 years, 0 months to 9 years, 11 months); 10 year-old (*n* = 56, 28 male and 28 female; *M* = 10 years, 4 months, range = 10 years, 0 months to 10 years, 11 months).

Each child was tested in a quiet room in the kindergarten or in the school for a session of twenty minutes. From the initial sample of 213 children three children aged 4 were excluded because they failed the emotional evaluation training and one child aged 3 was excluded because he failed the training session.

Materials

Training Phase. All participants were involved in an emotional evaluation training before the task in order to test their comprehension of the five point Likert scale used in the study. Each participant was asked to point the very sad face, the very happy face, the sad face, the happy face and the neutral face (not happy or sad) in a random order. Children who were not able to point one of the five faces or who was wrong after three times and the experimenter explanation were excluded from the sample.

The emotional evaluation training was followed by an explanation of the task and a training session. Who failed the training session was excluded from the sample.

Procedure

Children were presented two transparent boxes, each divided into two parts, tokens and smileys (see *fig.* 3.1). They were explained they could win tokens to change for stickers at the end of the game. They were presented the PC and eight avatars. Each child was asked to choose an avatar to represent himself in the game and a rival avatar (see *fig.* 3.2 e *fig.* 3.3).

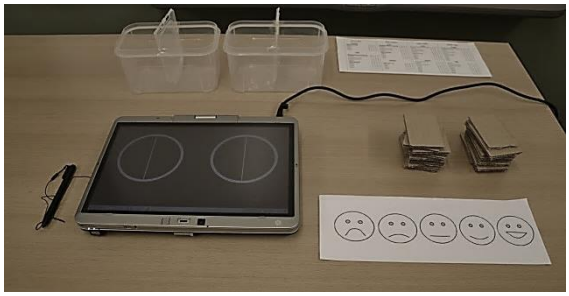

Fig. 3.1 Boxes, PC, smileys and tokens

Fig. 3.2 Avatars

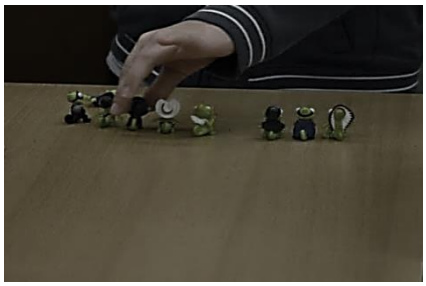

Fig. 3.3 Choice of the avatars

Test Phase

The experimenter put in the boxes each token one by one. Child was said to choose one of the boxes and to put his/her avatar in front of the chosen box (not in the left or in the right part but in the middle). The child was provided with two

types of choices: the «safe choice» (e.g. containing three tokens in the left side of the box and five tokens in the right side) and the «risky choice» (containing many tokens to win or zero, e.g. containing eight tokens in the right side of the box and zero tokens in the left).

The PC was placed in front of the two boxes. It was a PC laptop with the possibility to turn the screen and fold it up to make it stick to the keyboard. So children were presented with a surface that had not even the appearance of a PC. It represented two wheels in order to place the left wheel in front of the left box and the right wheel in front of the right box. After the child's choice a square appeared around the left or the right wheel according to the choice made, a spinning arrow started spinning for few seconds, and then stop pointing to the right or the left side of the box. Thus indicating if the child won the right or the left side of the chosen box (see *fig.* 3.4 and *fig.* 3.5).

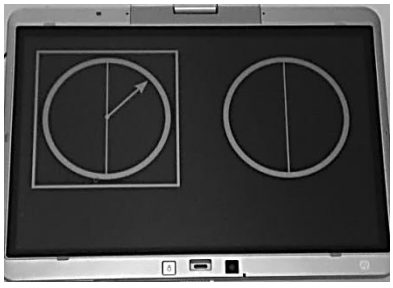

Fig. 3.4 left wheel pointing right

Fig. 3.5 left wheel pointing left

In the complete feedback condition, we provided the outcome of the chosen and unchosen boxes. Indeed, two spinning arrows appeared inside each wheel (chosen surrounded by a square, and the unchosen), they were spinning for few seconds, then they stop simultaneously, indicating the obtained outcome of

the chosen box and the outcome that they could have obtained if the child had chosen the other box (see *fig.* 3.6 and *fig.* 3.7).

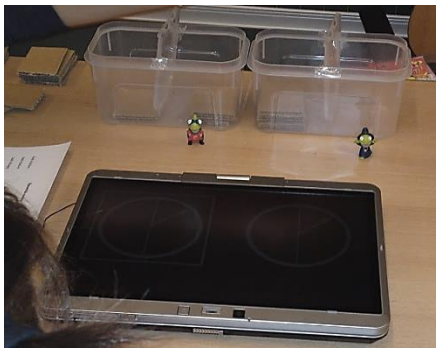

Fig. 3.6 arrows pointing to the outcomes of the chosen box and the unchosen one (child's choice: left box)

Fig. 3.7 arrows pointing to the outcomes of the chosen box and the unchosen one (child's choice: right box)

According to the condition (partial or complete) the child avatar and the rival avatar were placed in front of the boxes. In disappointment and elation trials (partial condition) the child avatar was moved from the middle of the box (where the child placed it after the choice) (see *fig.* 3.8) to the left or the right part of the box (according to the outcome of the arrow) and the rival avatar in the opposite side of the same box (see *fig.* 3.9).

Fig. 3.8 Child avatar, boxes, PC

Fig. 3.9 Child avatar and rival avatar in front of the chosen box, indicating the obtained and the unobtained outcome

In regret and relief trials (complete condition) the child avatar was moved from the middle of the box (where the child placed it after the choice) (see *fig*. 3.10) to the left or the right part of the box (according to the outcome of the arrow) and the rival avatar in front of the side of the unchosen box, according to the side pointed by the arrow of the other wheel (see *fig*. 3.11).

Fig. 3.10 Child avatar and rival avatar in front of the boxes

Fig. 3.11 Chosen avatar on the left side of the left box and rival avatar on the right side of the right box

Four trials were run both for the partial condition (two trials for disappointment and two trials for elation) and for the complete condition (two trials for regret and two trials for relief). Each condition was preceded by a familiarization trial.

Participants were asked to rate for each trial how they felt on the 5-point scale (see *fig*. 3.12). The experimenter underlined for each trial that a particular outcome was following the participant choice and that «the alternative choice could have been his/her outcome but he/she didn't choose that box».

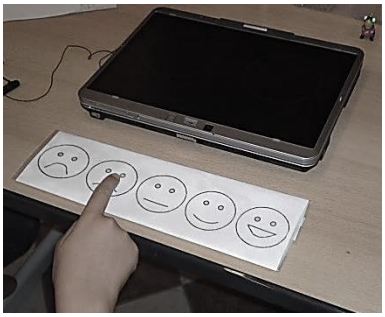

Fig. 3.12 Emotional evaluation

Each condition was presented to participants in counterbalanced order: "disappointment/elation condition" followed by "regret/relief condition" for half participant and "regret/relief condition" followed by "disappointment/elation condition" for the other half.

Results and discussion

Participants received a score ranging from -2 to +2 depending on their emotional rating. The answer named "very sad" was coded as "-2", the answer named "sad" as "-1", the "not happy or sad" as "0", the "happy" answer as "1" and the "very happy" as "2".

In our experimental setting, we considered the effect of the counterfactual outcome (i.e., the unobtained outcome in the partial feedback and the outcome of the unchosen option in the complete feedback) on the evaluation of the obtained outcome, as the difference between elation and disappointment and relief and regret, in the partial and complete condition respectively. Additionally, we considered a more restrictive definition of regret effect, defined as the differential

evaluation (i.e. amplification effect) between upward counterfactual in the partial (disappointment) vs. complete condition (regret).

We ran a 4 (*Age group*: 3-5; 6-7; 8-9; 10) x 4 (*Task*: Disappointment; Elation; Regret; Relief) analysis of variance (ANOVA). We obtained a main effect of *Task*, $F_{(3,\ 204)} = 106.93$ $p < .001$, partial $\eta^2 = .343$ and a significant interaction between *Task* and *Age group*, $F_{(9,\ 204)} = 14.12$ $p < .001$, partial $\eta^2 = .172$. Mean emotional evaluation for the different emotions are shown in *fig.* 3.13.

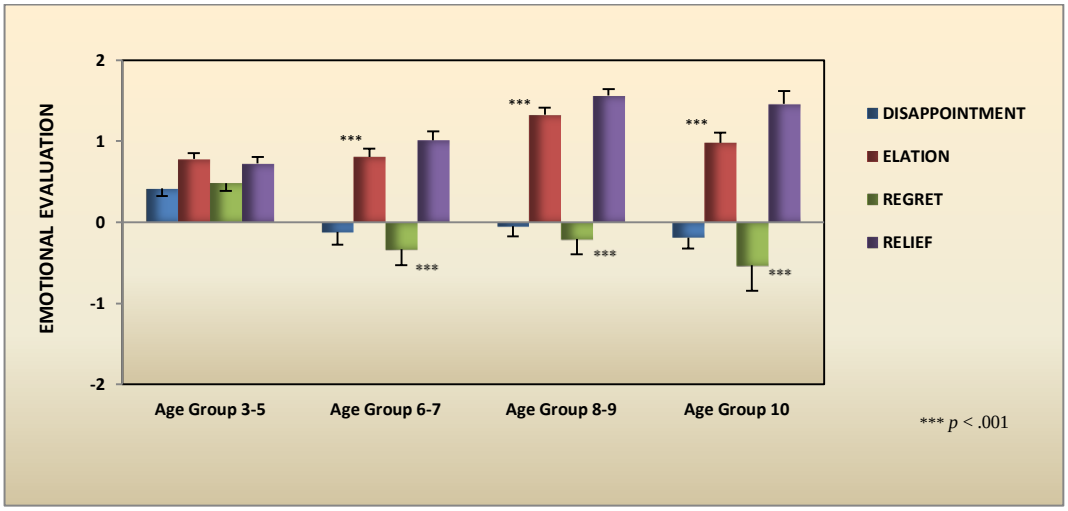

Fig. 3.13 Mean scores of each age group

For disappointment and elation trials (*partial feedback*) post hoc Tukey's HSD tests showed a significant difference between disappointment and elation for the age group of 6-7 year-old ($p < .001$), for the age group of 8-9 year-old ($p < .001$) and for the age group of 10 year-old ($p < .001$). No significant differences were found for the age group of 3-5 year-old (see *fig.* 3.14).

For regret and relief trials (*complete feedback*) post hoc Tukey's HSD tests showed a significant difference between regret and relief trials for the age group

of 6-7 year-old ($p < .001$), for the age group of 8-9 year-old ($p < .001$) and for the age group of 10 year-old ($p < .001$). No significant differences were found for the age group of 3-5 year-old (see *fig.* 3.15).

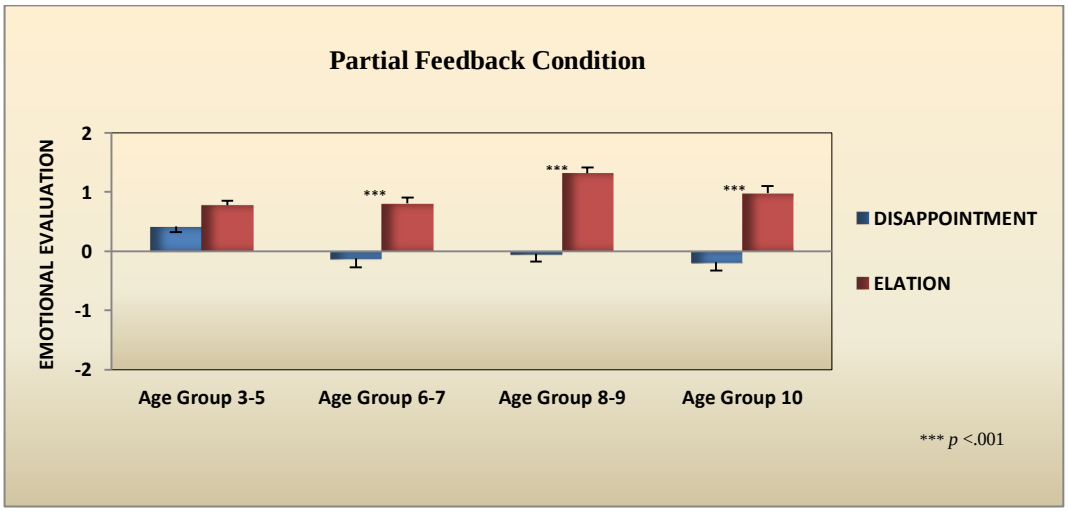

Fig. 3.14 Mean scores for age groups in the partial feedback condition

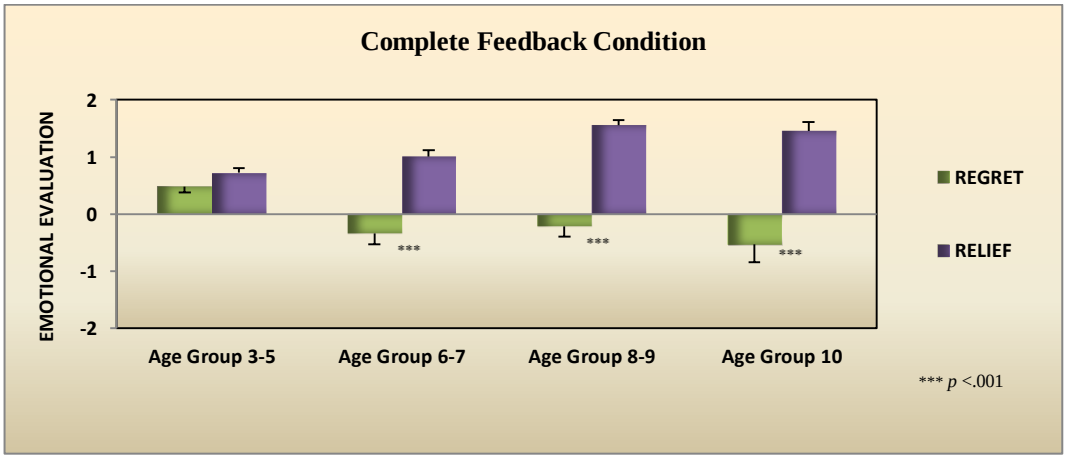

Fig. 3.15 Mean scores for age groups in the complete feedback condition

No significant differences were found for disappointment or for elation scores between age groups. There was a significant difference for regret scores for the age group of 6-7 compared with the age group of 3-5 ($p < .001$), for the age group of 8-9 compared with the age group of 3-5 ($p < .001$) and for the age group

of 10 compared with the age group of 3-5 (p <.001). For relief scores there was a significant difference between the age group of 8-9 compared with the age group of 6-7 (p <.001).

In the range of 3-5 years old children demonstrate to not understand disappointment and regret. They do understand the game but they are not able to compare what happened with what would have happened, both when they are responsible for the outcome and when they are not. This evidence is also supported by children verbal's reports.

In order to compare differences for each single age instead of groups, we ran a second Analysis of Variance comparing all ages. We performed a 8 (*Age*) x 4 (*Task*) Analysis of Variance (ANOVA). We obtained a main effect of *Task*, $F_{(3, 200)} = 99.23$ $p < .001$, partial $\eta^2 = .331$ and an interaction between *Task* and *Age*, $F_{(21, 200)} = 7.10$ $p < .001$, partial $\eta^2 = .199$. Means are shown in *fig.* 3.16.

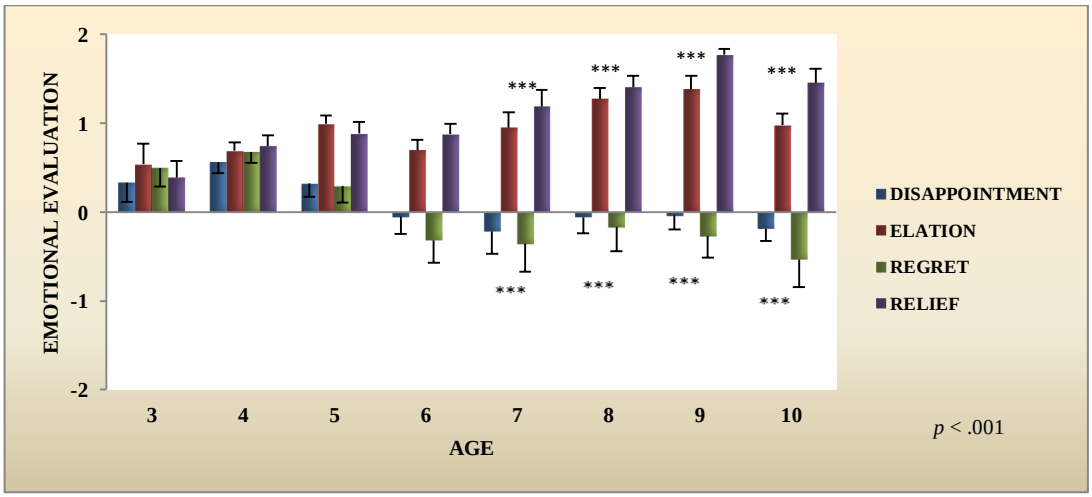

Fig. 3.16 Mean Scores for each age

For disappointment and elation trials (*partial feedback*) post hoc Tukey's HSD tests showed a significant difference between disappointment and elation starting from the age of 7 year-old (see *fig.* 3.17). For regret and relief trials (*complete feedback*) post hoc Tukey's HSD tests showed a significant difference between regret and relief starting from the age of 7 year-old (see *fig.* 3.18).

Starting from 6 year-old children reported the evaluation of disappointment with a score below zero, but this difference compared with elation it's not significant. At the same age they started to report regret below the score of zero and the difference with relief is significant at 10% level (p = .06).

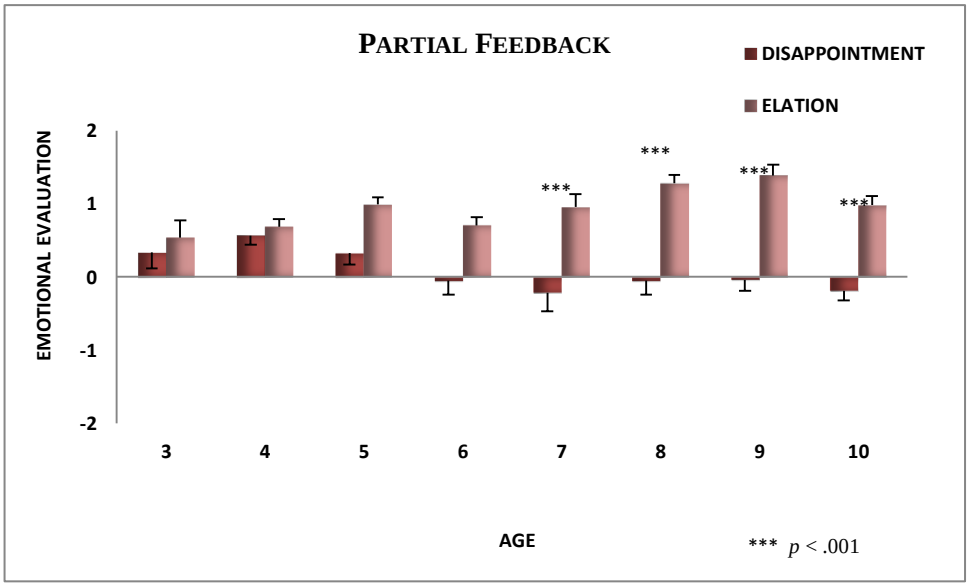

Fig. 3.17 Mean scores for each age in partial feedback trials

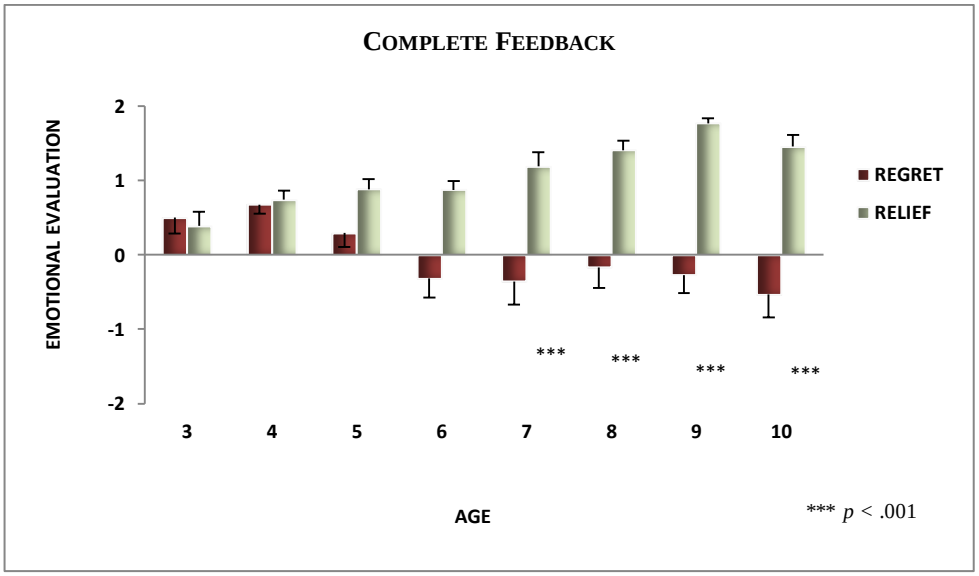

Fig. 3.18 Mean scores for each age in complete feedback trials

We also wanted to test whether scores for each age deviated from zero using one-sample t tests. A significant positive result provided evidences for relief and a significant negative result provided evidences for regret.

The first evidence for relief was at 6, $t_{(25)} = 7.49$, $p < .001$. At the same age we found the first evidence for elation, $t_{(25)} = 7.64$, $p < .001$. The first evidence for regret was at 9, $t_{(25)} = -2.88$, $p < .001$. At the same age we found the first evidence for disappointment, $t_{(25)} = -2.74$, $p < .01$.

No significant differences were found between disappointment and regret before the age of 9, $t_{(25)} = -2.88$, $p < .001$. We found a significant difference between elation and relief started from the age of 6, $t_{(25)} = 7.49$, $p < .001$.

Both regret and relief are reported by children starting from the age of 6. If we examine the effect of the counterfactual outcome on the evaluation of the obtained outcome as the difference between elation and disappointment and relief

and regret, we could conclude that regret and relief are both emotions experienced starting at 7. If we consider a more restrictive definition, defined as the differential evaluation between upward counterfactual in the partial (disappointment) vs. complete condition (regret), we have to conclude with the idea of a lag between the two emotions, with relief experienced before regret. Indeed we found a significant difference between regret and disappointment starting at 9, so we have to conclude for a first evidence of regret in children at the age of 9, as in Rafetseder & Perner (2012) experiment.

Considering a more restrictive definition also for relief, defined as the differential evaluation between downward counterfactual in the partial (elation) vs. complete condition (relief) we found significant differences between the two conditions starting at 6.

In our study children scored lower in reporting negative counterfactual emotions than the positive ones. This may be due to the more important role that negative counterfactual emotions play in adaptive behavior. For the emotion of regret implies an assumption of responsibility for one's own actions and the consequent necessity to learn from the past and behave in a different way in the future. All this implies more commitment, as well as more sophisticated cognitive abilities than those involved in being relieved for one's own actions.

In order to investigate the role of the responsibility for the outcome with a manipulation of participants' sense and judgment of agency, we ran study 3.

CHAPTER 4

STUDY 3

The experiment in this chapter is part of the paper named:

Guerini, R., Coricelli, G. (*in preparation*). Regret and Relief in 3- to 10-year-old Children: The Ontogenesis of Counterfactual Emotions and the «Agency Effect».

4. STUDY III: THE ROLE OF SENSE OF AGENCY ON COUNTERFACTUAL EMOTIONS

Experiment III

Introduction

In our everyday experience of our voluntary actions we have a certain phenomenal experience of mineness of these actions. E.g., when reaching for a cup, I know this to be my action. This experience, however, involves at least two fundamentally different aspects of minimal action-related self-awareness, which - in this case - coincide and are phenomenally indistinguishable: the sense of agency (SoA), i.e. the realization that I am the initiator of my reaching for a cup (rather than somebody or something else); a sense of body ownership (SoO), i.e. the registration that my arm which is reaching for a cup belongs to me (rather than belonging to somebody or something else).

SoO and SoA are analog in their formal representational structure in that each of them can be framed in a comprehensive multi-level framework outlined by Synofzik *et al.* (2008). This framework gradually increases in representational and functional complexity and proceeds from basic non-conceptual sensorimotor representations to full-blown conceptual representations of agency and ownership, respectively. Each level of the SoA and the SoO, respectively, can be individuated by means of the following individuation criteria:

(i) its form of representation;

(ii) the cognitive capacity it makes use of;

(iii) the underlying neurocognitive process;

(iv) its differential break-down in certain neurological or psychopathological circumstances.

By means of these criteria one can identify at least four systematic levels of the SoA and the SoO, respectively:

Levels of the sense of agency and the sense of ownership

	Sense of agency	Sense of ownership
Non-conceptual and momentary representation	Sensory registration of action–effect-couplings	
Non-conceptual and stable representation	Feeling of agency	Feeling of ownership
Conceptual representation	Judgment of agency	Judgment of ownership
Meta-representation	Ascription of moral responsibility	Meta-representation of ownership

Source: Synofzik *et al.* (2008).

Sense of Agency

Sensory registration of action-effect-couplings. In order to experience oneself as the initiator of one's own actions, it is a very basic prerequisite that a system learns to systematically register a certain sensory event as the typical effect of its own actions.

Feeling of agency. If the action-effect-registration is systematically used by the cognitive system to establish a stable representation of an action as self-produced, then the non-conceptual feeling of being the agent is produced. What is learned on this level is to establish a stable perception-based representation of the effect of one's own action as the effect of one's own action.

The feeling of agency is produced by a gradual and highly plastic subpersonal weighting process of different action-related perceptual and motor cues, which are partly afferent (visual feedback, proprioception) and partly efferent (action prediction, body schema). One of the most important sensorimotor

cues for the feeling of agency is provided by the so-called "comparator system". According to a well-established model of normal action control, when the brain executes a motor plan, an "efference copy" of each set of motor instructions is transformed via one or more body emulator systems and used to construct a "forward model" of the expected sensory consequences of the action. This can then be compared both with the motor intention itself and with the incoming perceptual data, allowing for swift correction of the action as it unfolds (e.g. Wolpert & Ghahramani, 2000; Wolpert & Kawato, 1998). The idea is then that a congruency between predicted and actual state may be used by the cognitive system to register a sensory event as caused by oneself, while an incongruence may lead to the registration of a sensory event as externally caused.

Judgment of agency. if the non-conceptual feeling of agency is further processed by the cognitive system by additionally involving conceptual capacities and belief stances, then a conceptual, interpretative judgment of being the agent is produced. What is learned on this level is to conceptually represent the effect of one's own action as the effect of one's own action. The judgment of agency is formed by a rationalization process that normally has a feeling of agency as input. Thus, the judgment of agency normally starts with the output of the weighting of sensorimotor authorship indicators (e.g. the comparator output) and then proceeds with ad hoc theorizing and belief formation about oneself, which is produced by a weighting of cognitive authorship indicators (e.g. contextual cues, belief states, etc.). But the judgment of agency does not necessarily presuppose a feeling of agency. The rationalization process has multiple inputs such that it works even if the feeling of agency input signal is missing.

Ascription of moral responsibility. If a cognitive system cannot only form agency beliefs and judgments, i.e. attribute a certain action to a certain author (in the sense of being the cause), but also reliably register the mental state preceding the action – viz. the intentional action planning –, it is capable of ascribing moral responsibility.

To our knowledge, the only study manipulating the responsibility for the outcome in relation to counterfactual emotions was Weisberg and Beck (2011) study. The responsibility for the outcome has much in common according to us with a sense of *feeling* to be the author of one's actions and also to *judge* the outcome of one's action rating own consequent feelings.

Weisberg and Beck (2011) designed an experiment in which children were presented with three conditions. The experiment was a between subject design. The first condition, named "choice", represents a replication of the experiment one, in which children chose one of two cards to turn over. The second condition is named "no choice-experimenter". The experimenter rolls one dice in order to determine the participant's card. In the third condition, named "no choice-child", the participant rolls a dice which determines his/her card. Their results report that in *no choice* conditions participants are less likely to experience regret and relief.

In order to test whether our methodology provide for different results and to investigate the role of something that is not an animate agent as in Weisberg and Beck's (2011) experiment, we ran experiment III. We used a PC in the role of an inanimate agent providing a choice and a subsequent outcome for our participants.

Method

Participants

We tested 225 participants aged 3 to 10 (109 boys, 116 girls). Children were divided in four age groups: 3-5 year-old (n = 89, 44 male and 45 female; M = 4 years, 2 months, range = 3 years, 0 months to 5 years, 10 months); 6-7 year-old (n = 50, 22 male and 28 female; M = 6 years, 8 months; range = 6 years, 0 months to 7 years, 11 months); 8-9 year-old (n = 56, 28 male and 28 female; M = 8 years, 10 months; range = 8 years, 0 months to 9 years, 11 months); 10 year-old (n = 30, 15 male and 15 female; M = 10 years, 2 months; range = 10 years, 0 months to 10 years, 11 months).

Each child was tested in a quiet room in the kindergarten or in the school for a session of twenty minutes. No child failed the emotional evaluation training or the training session.

Procedure

Training Phase. As in experiment II, all participants were involved in an emotional evaluation training before the task in order to test their comprehension of the five point Likert scale used in the study. Each participant was asked to point the very sad face, the very happy face, the sad face, the happy face and the neutral face (not happy or sad) in a random order. Children who were not able to point one of the five faces or who was wrong after three times and the experimenter explanation were excluded from the sample.

The emotional evaluation training was followed by an explanation of the task and a training session. Who failed the training session was excluded from the sample.

Materials

Children were presented with the same boxes as in the experiment two. They were explained they could win tokens to change for stickers at the end of the game. They were presented the PC and eight avatars. Each child was explained, as in the previous study, to choose an avatar to represent himself/herself in the game and a rival avatar. All children were tested both in the *agency* condition and in the *no agency* condition, presented to participant in a counterbalanced order.

Agency Condition

For the *Agency Condition* the test phase was the same as in experiment II, with the experimenter putting in the boxes each token one by one. So the child chose one of the boxes and put his avatar in front of it (not in the left or in the right part but in the middle). Then the wheel of the PC, pointing left or right, decided among the chosen box the outcome and for regret and relief condition both the outcome inside the chosen box and the outcome child didn't get because he didn't choose that box.

Participants were asked to rate for each trial how the feel on the 5-point scale. The experimenter underlined for each trial that a particular outcome was following the participant choice and that «the alternative choice could have been his/her outcome <u>but</u> he/she didn't choose that box».

No agency condition

In the *no agency* condition each child was presented with the same materials but the PC was provided with a little wheel placed below the two wheels (see *fig.* 4.1) in front of the boxes.

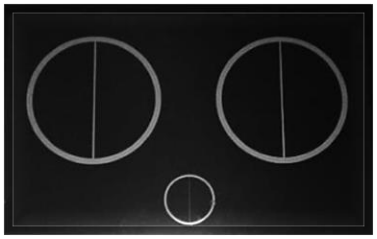

Fig. 4.1 PC for the *no agency* condition

It was explained to the children that the choice was made by the PC. The choice of the computer was indicated by the direction of an arrow in a small wheel placed on the bottom of the screen. The arrow inside the little wheel spins for few seconds, and then it stops, indicating the selected (big) wheel, thus the selected chosen box. A square appears around the wheel (see *fig.* 4.2).

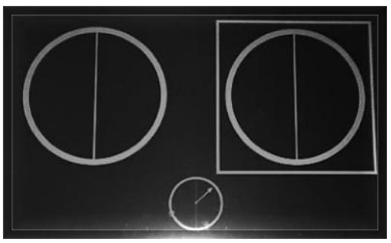

Fig. 4.2 choice made by the PC

A few seconds later the wheel chosen by the PC starts spinning, and then it stops pointing left or right portion of the chosen box, thus the obtained outcome (see *fig.* 4.3).

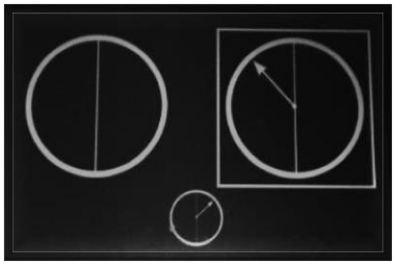

Fig. 4.3 No-agency partial feedback condition. The arrow indicates that the obtained outcome is the outcome on the left of the box selected by the computer.

The same procedure was followed in a no-agency complete condition. The experimenter underlined for each trial that a particular outcome was following the computer's choice and that «the alternative choice could have been his/her outcome but the computer didn't choose that box».

Participants were asked to rate for each trial how they felt according to the computer's choice and their following outcome. The two different conditions, *Agency* and *No Agency*, were run in a counterbalanced order.

Results and discussion

As in Experiment 2, participants received a score ranging from -2 to +2 depending on their emotional rating. The answer named "very sad" was coded as "-2", the answer named "sad" as "-1", the "not happy or sad" as "0", the "happy" answer as "1" and the "very happy" as "2".

We performed a 4 (*Age*: 3-5; 6-7; 8-9; 10) x 4 (*Trial Type*: Disappointment, Elation, Regret, Relief) x 2 (*Condition*: Agency; No agency) Analysis of Variance (ANOVA). The Analysis of Variance (ANOVA) showed a main effect for *Trial Type*, $F_{(3, 221)} = 379.52$, $p < .001$, partial $\eta^2 = .631$. There was

a significant interaction between *Trial Type* and *Age Group*, $F_{(9, 221)} = 22.41$, $p < .001$, partial $\eta^2 = .233$; a significant interaction between *Trial Type* and *Condition*, $F_{(3, 221)} = 60.15$, $p < .001$, partial $\eta^2 = .214$; and a significant three-way interaction between *Trial Type*, *Condition* and *Age Group*, $F_{(9, 221)} = 7.59$, $p < .001$, partial $\eta^2 = .093$. We conducted Tukey's HSD post hoc tests in order to test the significant interactions. Means are shown in *fig.* 4.4 and *fig.* 4.5.

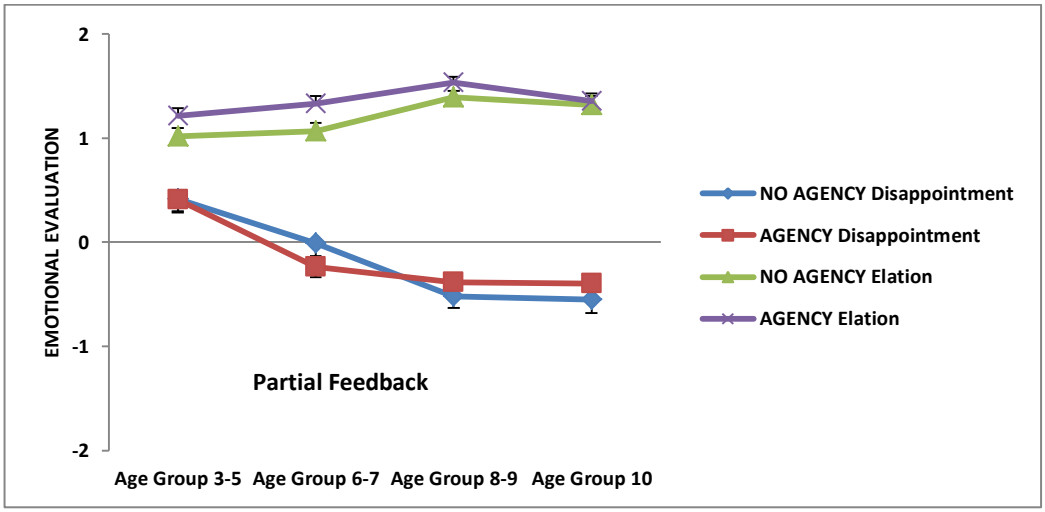

Fig. 4.4 Comparison of *Agency* and *No Agency* conditions for partial feedback trials

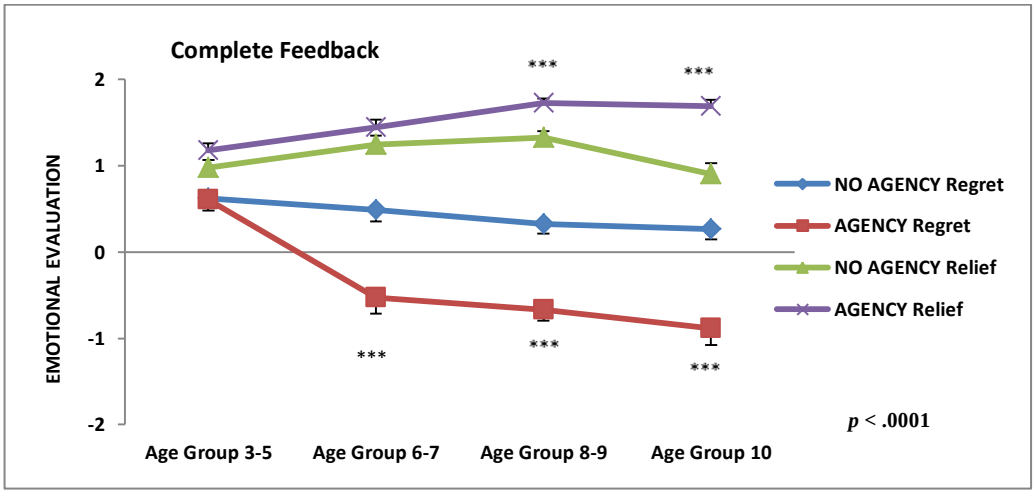

Fig. 4.5 Comparison of *Agency* and *No Agency* conditions for complete feedback trials

The comparison between *Agency Regret* and *No Agency Regret* provides us with significant differences for the age group of 6-7 (p <.001), for the age group of 8-9 (p <.001) and for the age group of 10 (p <.001) (see *fig.* 4.5 and *fig.* 4.6).

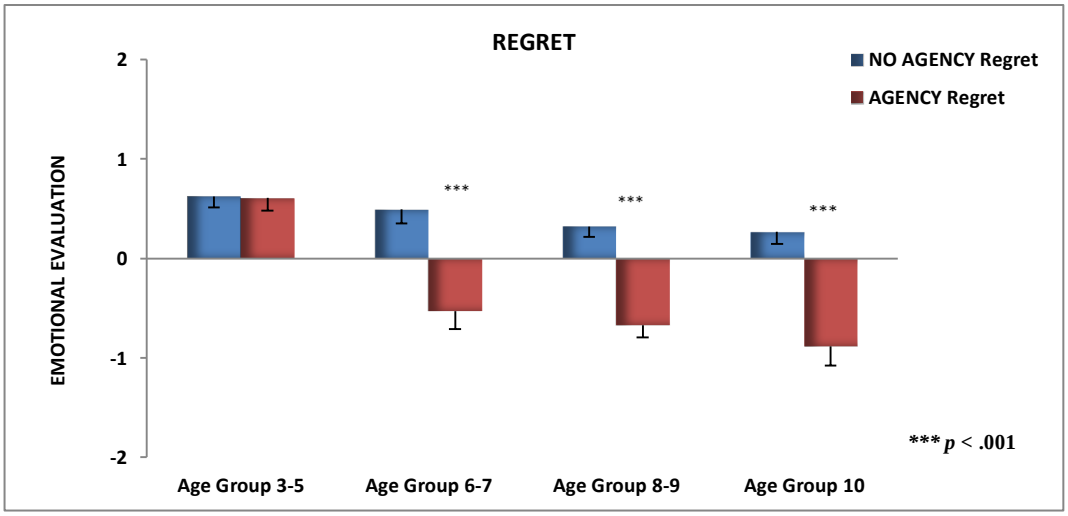

Fig. 4.6 Comparison of *Agency* and *No Agency* conditions for Regret trials

No significant differences were found for the age group of 3-5, supporting the idea that this negative counterfactual emotions is experienced and reported only starting from the age of 6-7. We didn't find any significant differences for any of the Age Groups comparing the conditions of *Agency Disappointment* and *No Agency Disappointment* (see *fig.* 4.4), supporting the idea of a difference between the emotions of Disappointment and Regret.

No significant differences between groups were found for Elation trials comparing the *Agency* with the *No Agency* conditions (see *fig.* 4.4). A significant difference was found only for the age group of 10 (p <.001) comparing the *Agency* and the *No Agency* conditions for Relief trials (*fig*. 4.5 and *fig.*4.7).

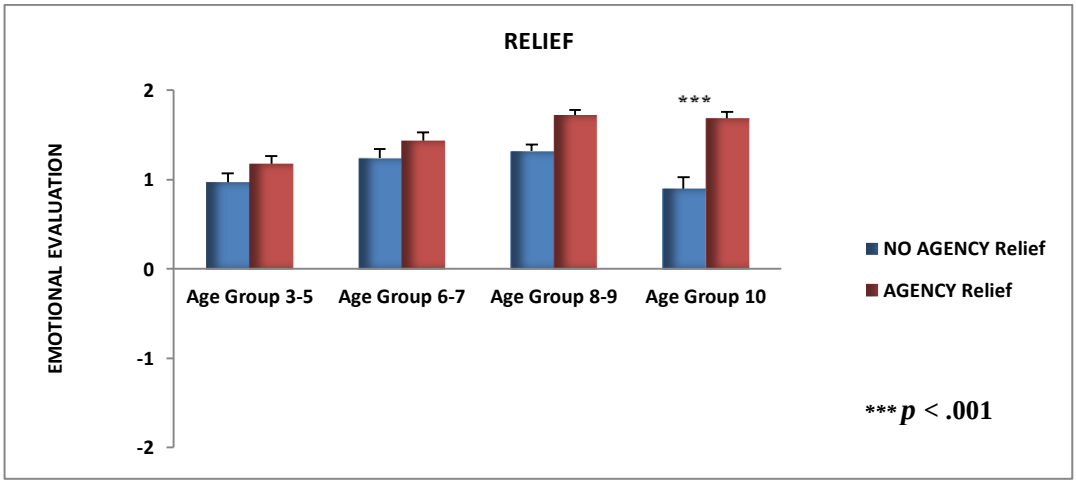

Fig. 4.7 Comparison of *Agency* and *No Agency* conditions for Relief trials

In *Agency Condition* we replicated results of experiment 2, finding significant differences between disappointment and elation trials and regret and relief trials for the age group of 6-7 year-old ($p < .001$), 8-9 year-old ($p < .001$), 10 ($p < .001$) and no significant differences for the age group of 3-5 year-old (see *fig.* 4.8).

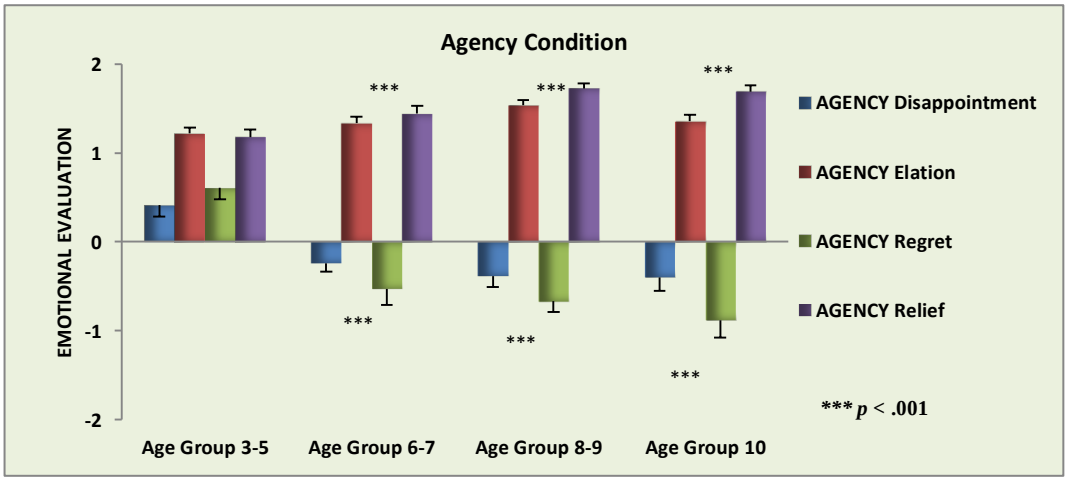

Fig. 4.8 Emotional evaluation for all the age groups in *Agency Condition*

Consistently with experiment 2, we also found a significant difference between elation and relief started at 6, ($t_{(30)} = 16.37$, $p < .001$) and a significant difference between disappointment and regret starting at 9 ($t_{(28)} = -4.81$, $p < .001$).

Also in this experiment in the range of 3-5 years old children demonstrate to not understand disappointment and regret. They do understand the game but they are not able to compare what happened with what would have happened, both when they are responsible for the outcome and when they are not. This evidence is also supported by the non- significant differences between no agency and agency conditions and by children verbal's reports.

CHAPTER 5

STUDY 4

The experiment in this chapter is part of the paper named:

Guerini, R. e Coricelli, G. (*in preparation*). Social comparison and self/other attribution of counterfactual emotions.

5. STUDY IV: SELF AND OTHER-ATTRIBUTION OF COUNTERFACTUAL EMOTIONS IN A SAMPLE OF 3- TO 10 YEAR-OLD CHILDREN

Introduction

Previous studies investigating self- and other- attribution of counterfactual emotions reported contrasting results.

In Amsel *et al.* (2003) study in *Self* conditions the experimenter introduced two dolls representing two agents of the same sex of the participants. Close to the dolls were placed two boxes. Participants were said to be gift boxes. They contained a plastic figurine for children and $ 5 for adults. The evaluation of the agent's happiness in relation to the choice consisted of a 4-point scale represented by 4 smileys: not at all happy, a little happy, pretty happy or very happy. After the presentation of the scale they were asked the first question: "How happy is (name of the doll) with the gift received?". So the alternative outcome was revealed and they were asked to report how happy is the doll again. The participants were randomly assigned to two conditions. One was the condition with the alternative outcome as a better gift than received and the other one was the condition with a worse alternative outcome compared with the gift received. The evaluation of the feelings of the agent was asked after revealing the content of the not chosen box and the counterfactual question was asked: "How much would have been happy (name of) if he/she had chosen the other box?". This was followed by a final question: "How happy is now (name of) with the gift received?". It would be a repetition of the initial question, but after knowing the alternatives.

The authors examined the answers' differences between the initial question and the counterfactual question in order to examine whether the participants gave different judgments before and after discovering the contents of the not chosen box. Their results revealed a significant effect of the alternative outcome: if positive, the main character was judged happier than the protagonist getting a negative alternative result, all in relation to the given answers in response to the counterfactual question compared to the original question. This effect was seen in all the age groups.

The qualitative analysis suggested to authors that pre-school children as well as adults judge the feelings of the protagonist on possible states of things. A second analysis assesses the differences in the initial and final answer to the question, and so the judgments about the feelings of the protagonists in relation to the fact that it was revealed the contents of the not selected box. Through the results of this study they assumed that young children represent themselves and think like adults with regard to the feelings of the protagonists in relation to states of things that could have happened. Counterfactual thinking, therefore, is thought to be possessed even by very young children.

Other researchers have also become interested in the emergence of counterfactual thinking in preschool children, claiming that the visible change at 4/5 years regarding the counterfactual reasoning is due to several factors: an increase in the mental capacity of children to represent explicitly and reason about real alternatives, the acquisition of the ability to imagine alternatives to reality than those involving only negative outcomes, the acquisition of the ability to think about alternative states of things.

The idea to test is the possibility that children think about an alternative world but not in connection with the real one and that they actually give a judgment on the amount of gift received instead of reporting a counterfactual emotion. In order to test this hypothesis, Amsel *et al.* (2003) ran another experiment, with the presence of details about the agent.

Guttentag and Ferrell (2004) designed three experiments in order to test the understanding of regret and relief in children. Participants were asked to make decisions with respect to the emotional responses of some agents. The focus of the study was therefore on understanding children's emotional responses of others rather than to focus on their own emotions. As a dependent variable a measure similar to the *Counterfactual Inference Test* (Hooker, Roese and Park, 2000) was used. Participants were presented a few stories describing the experience of two characters who get some results after the decisions made. The stories always contained an element that differentiated the two characters, which was relevant for judging regret and relief. The task of the participants was to judge whether the characters in the story would have felt in the same way with respect to the results obtained, or if one or the other would feel better or worse.

While Amsel *et al.* (2003) measured if the intensity of an emotional response varies when a participant finds out what might have happened if he had made a different choice, in this study Guttentag and Ferrell (2004) simply measured if children were able to judge a protagonist in a different way than another.

Previous researches have suggested that for children such comparisons are easy to make, and tasks relating to such judgments are useful as sensitive measures of children's emotions understanding.

Finally, in the study of Weisberg and Beck (2010) they introduced a pinguin playing the game.

Participants were explicitly presented with the following description before opening the alternative box: «Arnold does not win what is inside this (the alternative) box». They found that children were able to attribute counterfactual emotions to themselves before attributing to others. In their experiment children were able to attribute counterfactual emotions to self and to others starting at 7.

In order to test the self- and hetero- attribution of counterfactual emotions employing our new methodology and the relationship between counterfactual emotions and social comparison, we ran an experiment with children aged 3 to 10 and a second experiment with children aged 3 to 11.

Our study was approved by the ethic committee of the University of Trento. Parents of all participants gave their informed consent. Children were normally developing and of the same socioeconomic status.

Experiment I

Method

Participants

We tested 211 participants aged 3 to 10 (105 boys, 106 girls). Children were divided in four age groups: 3-5 year-old (n = 67, 35 male and 32 female; M = 4 years, 4 months; range = 3 years, 0 months to 5 years, 11 months); 6-7 year-old (n

= 56, 26 male and 30 female; *M* = 6 years, 7 months; range = 6 years, 0 months to 7 years, 11 months); 8-9 year-old (*n* = 60, 30 male and 30 female; *M* = 8 years, 5 months; range = 8 years, 0 months to 9 years, 11 months); 10 year-old (*n* = 28, 14 male and 14 female; *M* = 10 years, 3 months; range = 10 years, 0 months to 10 years, 11 months).

Each child was tested in a quiet room in the kindergarten or in the school for a session of twenty minutes. From the initial sample of 215 children four children aged 3 were excluded because he failed the training session.

Procedure

Training Phase. All participants were involved in an emotional evaluation training before the task in order to test their comprehension of the five point Likert scale used in the study. Each participant was asked to point the very sad face, the very happy face, the sad face, the happy face and the neutral face (not happy or sad) in a random order. Children who were not able to point one of the five faces or who was wrong after three times and the experimenter explanation were excluded from the sample.

The emotional evaluation training was followed by an explanation of the task and a training session. Who failed the training session was excluded from the sample.

Materials

Children were presented two transparent boxes, each divided into two parts, tokens and stickers (see *fig.* 5.1). They were explained they could win tokens to change for stickers at the end of the game. They were presented the PC and eight avatars. Each child was explained to choose an avatar to represent

himself in the game and a rival avatar. The two different conditions, *Self* and *Other*, were run in a counterbalanced order.

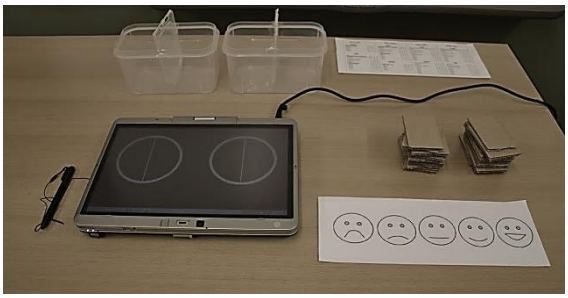

Fig. 5.1 Boxes, PC, smileys and tokens

«Self» Condition

The experimenter put in the boxes each token one by one. Child was said to choose one of the boxes and to put his avatar in front of the chosen box (not in the left or in the right part but in the middle). The child was provided with two types of choices: the «safe choice» (one box containing something to win for sure even if not much, e.g. containing three tokens in the left side of the box and five tokens in the right side) and the «risky choice» (containing many tokens to win or zero, e.g. containing eight tokens in the right side of the box and zero tokens in the left).

Immediately facing the two boxes was placed the PC. It was a PC laptop with the possibility to turn the screen and fold it up to make it stick to the keyboard. So children were presented with a surface that had not even the appearance of a PC. It represented two wheels in order to place the left wheel in front of the left box and the right wheel in front of the right box. After the child's choice a square appeared around the left or the right wheel according to the choice

made and a spinning of the wheel's arrow decided if the child won the right or the left side of the box chosen (see *fig.* 5.2).

Fig. 5.2 the laptop with the two wheels

Fig. 5.3 the chosen avatar and the rival avatar placed in front of the chosen box (partial condition)

According to the condition (partial or complete) the child avatar and the rival avatar were placed in front of the boxes. In disappointment and elation trials (partial condition) the child avatar was moved from the middle of the box (where the child placed it after the choice) to the left or the right part of the box (according to the outcome of the arrow) and the rival avatar in the opposite side of the same box (see *fig.* 5.3). In regret and relief trials (complete condition) the

child avatar was moved from the middle of the box (where the child placed it after the choice) to the left or the right part of the box (according to the outcome of the arrow) and the rival avatar in front of the side of the unchosen box, according to the side pointed by the arrow of the other wheel (see *fig.* 5.4). Four trials were run both for the partial condition (two trials for disappointment and two trials for elation) both for the complete condition (two trials for regret and two trials for relief). Each condition was preceded by a familiarization trial.

Fig. 5.4 complete condition

Participants were asked to rate for each trial how they feel on the 5-point scale. The experimenter underlined for each trial that a particular outcome was following the participant choice and that «the alternative choice could have been his/her outcome <u>but</u> he/she didn't choose that box».

Each condition was presented to participants in counterbalanced order: "disappointment/elation condition" followed by "regret/relief condition" for half participant and "regret/relief condition" followed by "disappointment/elation condition" for the other half.

«Other» Condition

In the *other* condition materials and procedure were the same, but in this condition the child had only the role of observer (see *fig.* 5.5) of the game and he/she was asked to rate how the experimenter felt about the outcome of his/her choice (see *fig.* 5.6).

Fig. 5.5 The child in the role of the observer

Figure 5.6 The experimenter playing the game and the child as the observer

The experimenter underlined for each trial that a particular outcome was following the experimenter's choice and that «the alternative choice could have been his/her outcome but he/she didn't choose that box».

The child was asking to rate for each trial how the experimenter felt according the choice and the outcome. Each condition was presented to participants in counterbalanced order: "disappointment/elation condition" followed by "regret/relief condition" for half participant and "regret/relief condition" followed by "disappointment/elation condition" for the other half.

Results and discussion

Participants received a score ranging from -2 to +2 depending on their emotional rating. The answer named "very sad" was coded as "-2", the answer named "sad" as "-1", the "not happy or sad" as "0", the "happy" answer as "1" and the "very happy" as "2".

We performed a 4 (*Age Group*: 3-5; 6-7; 8-9; 10) x 4 (*Trial Type*: Disappointment, Elation, Regret, Relief) x 2 (*Condition*: Self; Other) ANOVA. We obtained a main effect for *Condition*, $F_{(1, 207)} = 13.35$, $p < .001$, partial $\eta^2 = .060$, a main effect for *Trial Type*, $F_{(3, 207)} = 461.60$, $p < .001$, partial $\eta^2 = .690$, a significant interaction for *Trial Type* and *Condition*, $F_{(3, 207)} = 4.74$, $p < .001$, partial $\eta^2 = .022$ and a significant interaction for *Trial Type* and *Age Group*, $F_{(9, 207)} = 22.67$, $p < .001$, partial $\eta^2 = .247$. We conducted Tukey's HSD post hoc tests in order to test the significant interactions. Mean scores are reported in *fig.* 5.7 and *fig.* 5.8.

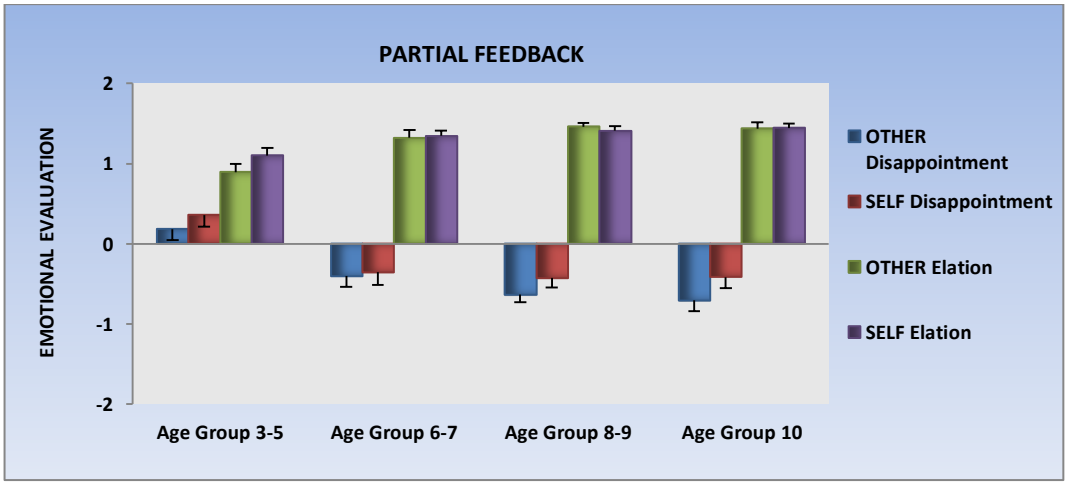

Fig. 5.7 Mean scores with age groups in partial feedback trials

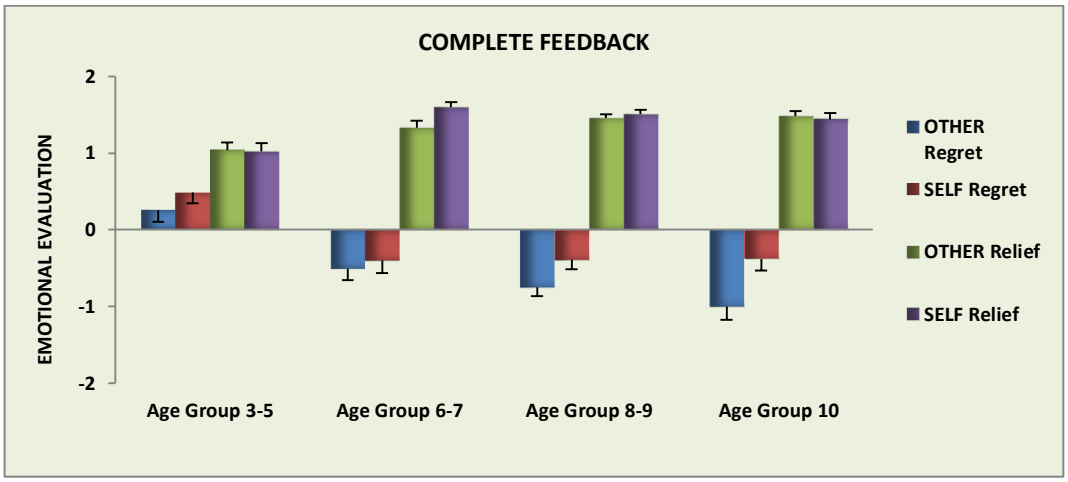

Fig. 5.8 Mean scores with age groups in complete feedback trials

For Regret trials in *Other* Condition we obtained significant different results between the age group of 3-5 and 6-7 ($p < .05$), between the age group of 3-5 and 8-9 ($p < .001$), between the age group of 3-5 and 10 ($p < .001$). No significant differences were found between the three groups (see *fig.* 5.9).

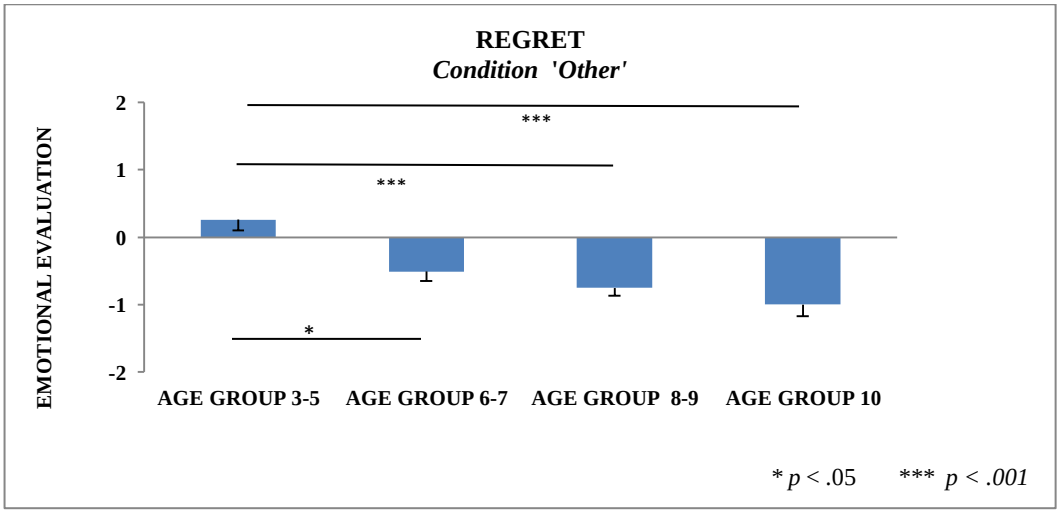

Fig. 5.9 Regret trials in *Other* Condition

For Regret trials in *Self* Condition we obtained a significant difference between the age group of 3-5 and 6-7 ($p < .05$), a significant difference between the age group of 3-5 and 8-9 ($p < .001$), and a significant difference between the age group of 3-5 and 10 ($p < .05$). No significant differences were found between the three groups.

The comparison between *Self Regret* and *Other Regret* provides us with significant differences for the age group of 6-7 ($p < .05$), for the age group of 8-9 ($p < .001$) and for the age group of 10 ($p < .001$) (see *fig.* 5.10). Children reported a more negative evaluation for Regret trials in *Other* Condition than in *Self Condition* but this difference is significant starting from the age group of 6-7. We didn't consider the difference between the two in the age range 3-5 because of children's positive emotional evaluation instead of negative.

We didn't find any significant differences for any of the Age Groups comparing the conditions of *Self Disappointment* and *Other Disappointment* (see *fig.* 5.7), No significant differences between groups were found for Elation trials comparing *Self* with *Other* conditions (see *fig.* 5.7). For Relief Trials in *Self* and *Other* conditions we found significant differences for the age group of 6-7 only ($p < .001$) (see *fig.* 5.8 and *fig.* 5.11).

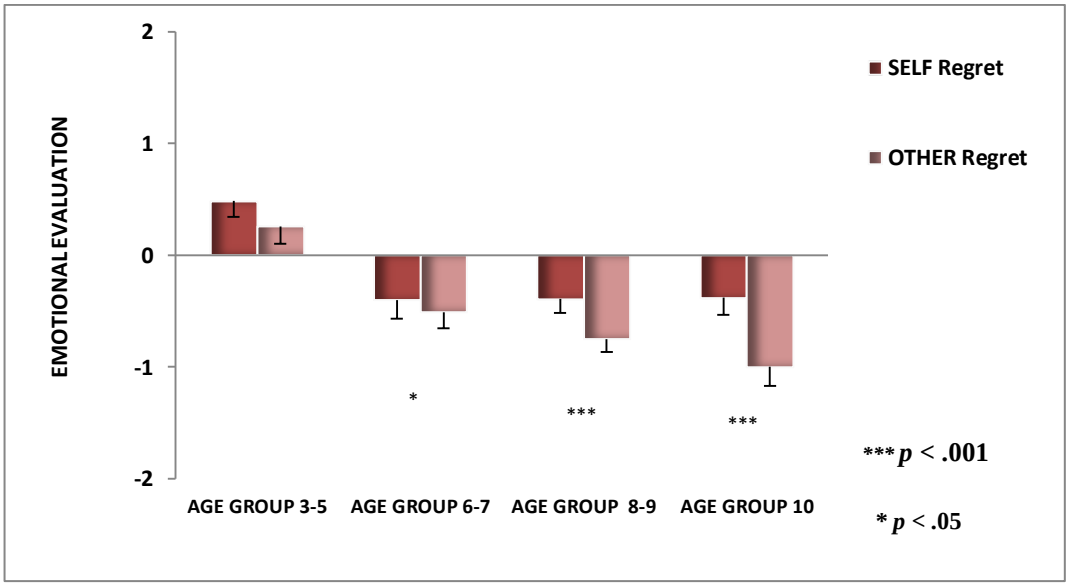

Fig. 5.10 Means for Regret trials in *Self* and *Other* conditions

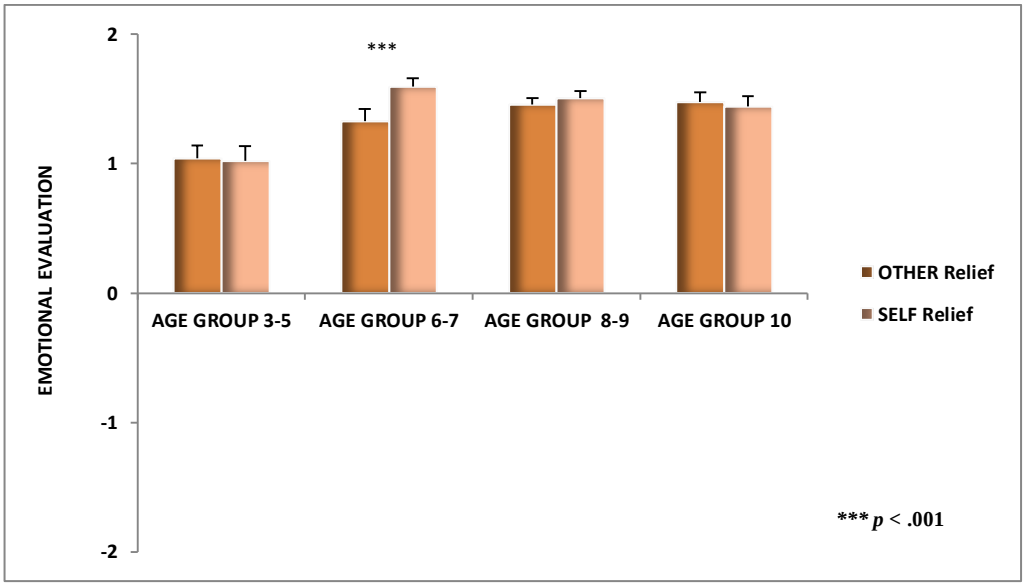

Fig. 5.11 Means for Relief Trials in *Self* and *Other* conditions

In disappointment and regret trials results show lower scores for *Other* condition than *Self* condition. In elation and relief trials they performed the same. We hypothesize that children found more simple to attribute negative counterfactual emotions to the experimenter rather than attributing to themselves.

We didn’t find this effect for positive counterfactual emotions: in these trials children performed the same in both conditions.

In order to test the effect of social comparison in reporting counterfactual emotions, we ran experiment 2.

CHAPTER 6

STUDY 5

The experiment in this chapter is part of the paper named:

Guerini, R. e Coricelli, G. (*in preparation*). Social comparison and self/other attribution of counterfactual emotions.

6. STUDY V : COUNTERFACTUAL EMOTIONS AND SOCIAL COMPARISON IN A SAMPLE OF 3-TO 11 YEAR- OLD CHILDREN

Experiment II

Introduction

In our previous experiment we investigated self- and hetero- attribution of counterfactual emotions to an animate agent rather than an inanimate agent as in previous studies (Amsel *et al.* 2000; Weisberg & Beck, 2010). Participants showed to be able to attribute to others counterfactual emotions as well as to themselves starting from 6 years old.

The aim of this experiment is to study counterfactual emotions in social comparisons' trials.

To our knowledge the only study investigating counterfactual emotions derived from social comparison in children was Steinbeis & Singer's (2013) study. They tested 182 participants aged from 7 to 13 in a monetary reward and punishment task. Children were rewarded or punished in an evaluation of their performance based on reaction times. Afterwards, in *social condition* trials, they were provided with feedbacks about competitor's performances and performances of theirs and they were asked to rate how they felt about the outcome. They obtained a decrease with age both of Envy and Schadenfreude.

In our sample children's age is from 3 year-old. This implicates we are not dealing with the emotion of envy until the age of 6-7, but with a social comparison between child's performance and outcome and schoolfellow's performance and outcome. Another important point is our way to name the

positive counterfactual emotion. We adopted the word *gloating*[3] instead of *Schadenfreude,* because we hypothesize that child is happy for own positive outcome compared with his/her schoolfellow's outcome, instead of being happy because of schoolfellow's negative outcome. This is supported by children's verbal reports.

Method

Participants

We tested 242 participants aged 3 to 11 (106 boys, 136 girls) (*M* = 7 years, 3 months; range = 3 years, 0 months to 11 years, 11 months).

Children were divided in four age groups: 3-5 year-old (*n* = 63, 23 male and 40 female; *M* = 4 years, 3 months; range = 3 years, 0 months to 5 years, 9 months); 6-7 year-old (*n* = 59, 29 male and 30 female; *M* = 6 years, 2 months; range = 6 years, 0 months to 7 years, 11 months); 8-9 year-old (*n* = 57, 27 male and 30 female; *M* = 8 years, 7 months; range = 8 years, 0 months to 9 years, 11 months); 10-11 year-old (*n* = 63, 27 male and 36 female; *M* = 10 years, 3 months; range = 10 years, 0 months to 11 years, 11 months). No child failed the emotional evaluation training or the training session.

In this experiment children entered the room in pairs. They were presented with materials (the same as the previous experiment) and they were asked to choice an avatar. Children were explained the game and they were tested in a quiet room in the kindergarten or in the school for a session of twenty minutes.

[3] Gloating is differentiated from Schadenfreude in that it does not necessarily require malice (one may gloat to a friend about having defeated him in a game without ill intent) and that it describes an action rather than a state of mind (one typically gloats to the subject of the misfortune or to a third party).

Procedure

Training Phase. All participants were involved in an emotional evaluation training before the task in order to test their comprehension of the five point Likert scale used in the study. Each participant was asked to point the very sad face, the very happy face, the sad face, the happy face and the neutral face (not happy or sad) in a random order. Children who were not able to point one of the five faces or who was wrong after three times and the experimenter explanation were excluded from the sample.

The emotional evaluation training was followed by an explanation of the task and a training session. Who failed the training session was excluded from the sample.

Materials

Children were presented two transparent boxes, each divided into two parts, tokens and stickers, as in the previous study. They were explained they could win tokens to change for stickers at the end of the game. They were presented the PC and eight avatars. Each child was explained to choose an avatar to represent himself in the game and a rival avatar. Different types of trials, *private* or *social*, were run in a counterbalanced order. For private trials a random order was established to decide who played the game alone first.

Testing Phase

Private Trials

In the *private trials* each child played the game alone (employing the chosen avatar and the rival avatar) while the other child was involved in other activities in order to distract him/her from the game played by his/her schoolfellow.

Each child was provided with a safe choice or a risky choice as in previous experiment and with the two boxes in order to choose and play the game. After each trial he/she had to rate how she/he felt on the emotional evaluation scale.

In this game only trials with complete feedback (only regret or relief trials) were run.

Social trials

In the *social trials* children played the game together. Each child had previously chosen his/her avatar and was explained that in that game the rival avatar was going to be represented by the schoolfellow's avatar.

Participants were presented the two boxes, the experimenter inserted tokens one by one into them and they were asked to think about their choice for a few seconds (see *fig.*6.1) and to say to the experimenter the word "Done!" when they had chosen the box.

Fig. 6.1 Social Trials

The experimenter asked them to point to the chosen box (see *fig.* 6.2 and *fig.* 6.3) after a countdown followed by the starting signal (they were also explained they can opt for the same box, as they prefer).

Fig. 6.2 Choice of different boxes in the social trials

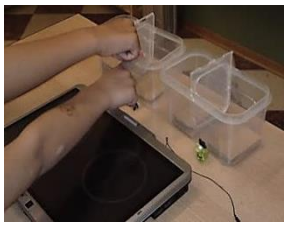

Fig. 6.3 Choice of the same box in the social trials

After the choice each avatar was placed in front of the chosen box and the game started. In this game only complete feedback trials (envy or gloating trials) were run.

Participants were asked to rate for each trial how they felt on the 5-point scale and they rated their emotions in turn. The child who was waiting to rate was engaged in looking to the other side of the room.

The experimenter underlined for each trial that a particular outcome was following the participant's choice and that «the alternative choice could have been

his/her outcome but he/she didn't choose that box, while his/her schoolfellow chose it».

Results and discussion

As in Experiment 1 participants received a score ranging from -2 to +2 depending on their emotional rating. The answer named "very sad" was coded as "-2", the answer named "sad" as "-1", the "not happy or sad" as "0", the "happy" answer as "1" and the "very happy" as "2".

We performed a 4 (*Age Group*: 3-5; 6-7; 8-9; 10) x 4 (*Trial Type*: Regret, Relief, Envy, Gloating) analysis of variance (ANOVA). The analysis of variance showed a main effect for *Trial Type*, $F_{(3, 227)} = 459.61$, $p < .001$, partial $\eta^2 = .669$ and a significant interaction for *Trial Type* and *Age Group*, $F_{(9, 227)} = 17.92$, $p < .001$, partial $\eta^2 = .191$. Mean scores are shown in *fig.* 6.4.

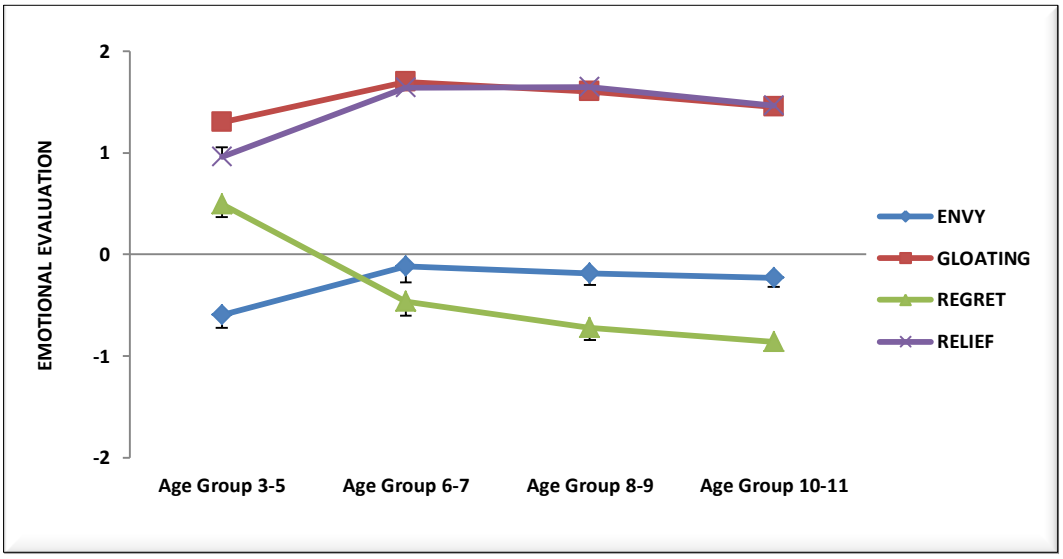

Fig. 6.4 Mean scores for age groups

Both for regret and relief trials (*private trials*) post hoc Tukey's HSD tests showed a significant difference between the age group of 3-5 with the age group of 6-7 year-old ($p < .001$), between the age group of 3-5 and the age group of 8-9 year-old ($p < .001$), between the age group of 3-5 and the age group of 10-11 (Regret, $p < .001$; Relief, $p < .05$). We didn't find any significant difference comparing the age group of 6-7 with the age group of 8-9 and 10-11, and the age group of 8-9 with the age group of 10-11. This is consistent with the idea that regret and relief are counterfactual emotions simultaneously experienced by children starting from the age of 6-7.

For Social Trials (*Envy* and *Gloating*) post hoc Tukey's HSD tests showed the following significant differences. For Envy trials we found a significant difference between the group of 3-5 and 6-7 year-old ($p < .01$). We didn't find other significant differences between the other age groups. For gloating trials we didn't find any significant difference comparing groups.

In order to compare differences for each single age instead of groups, we ran a second Analysis of Variance comparing all ages.

We performed a 9 (*Age*) x 4 (*Trial Type*) Analysis of Variance (ANOVA). We obtained a main effect of *Trial Type*, $F_{(3, 222)} = 395.21$, $p < .001$, partial $\eta^2 = .640$ and an interaction between *Trial Type* and *Age*, $F_{(24, 222)} = 8.41$, $p < .001$, partial $\eta^2 = .232$. Mean scores are shown in *fig.* 6.5.

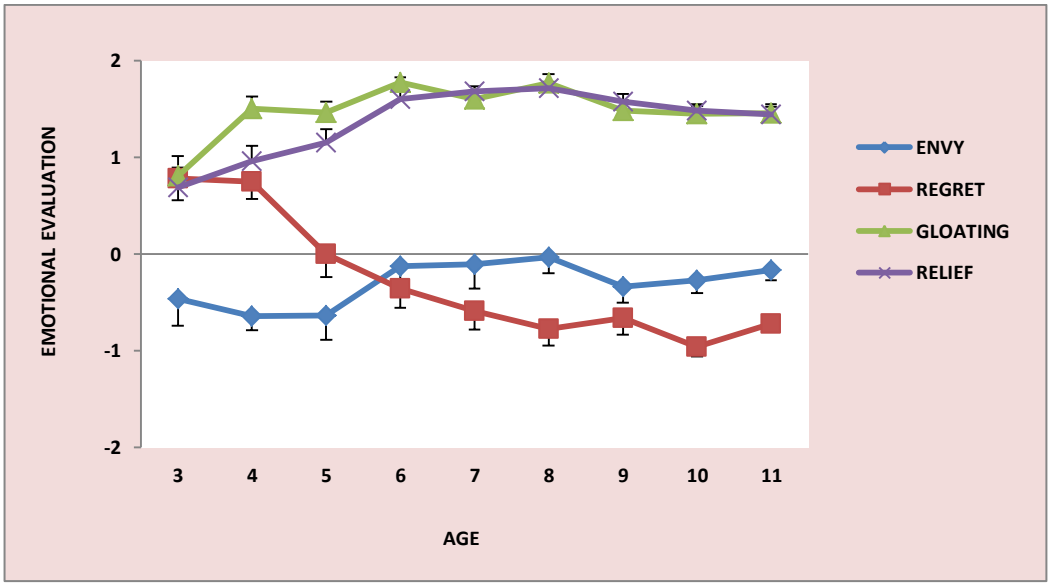

Fig. 6.5 Mean scores for all ages

For Private Trials (*Regret* and *Relief*), considering the effect of the counterfactual outcome on the evaluation of the obtained outcome as the difference between relief and regret, we didn't find any significant difference for Regret and Relief trials between children aged 3, and 4, but we found significant differences starting from the age of 5 ($p < .001$) (see *fig.* 6.6).

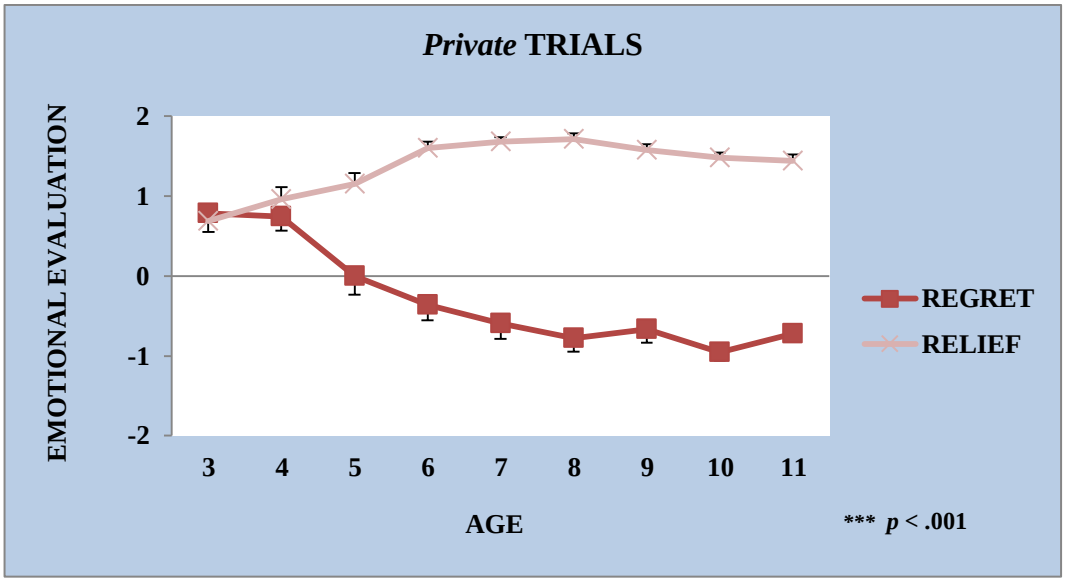

Fig. 6.6 Means of Regret and Relief. All differences are significant ($p < .001$) starting at 5

For Social Trials (*Envy* and *Gloating*), considering the effect of the counterfactual outcome on the evaluation of the obtained outcome as the difference between Envy and Gloating, we found significant differences starting from the age of 4 ($p < .001$) (see *fig.* 6.7).

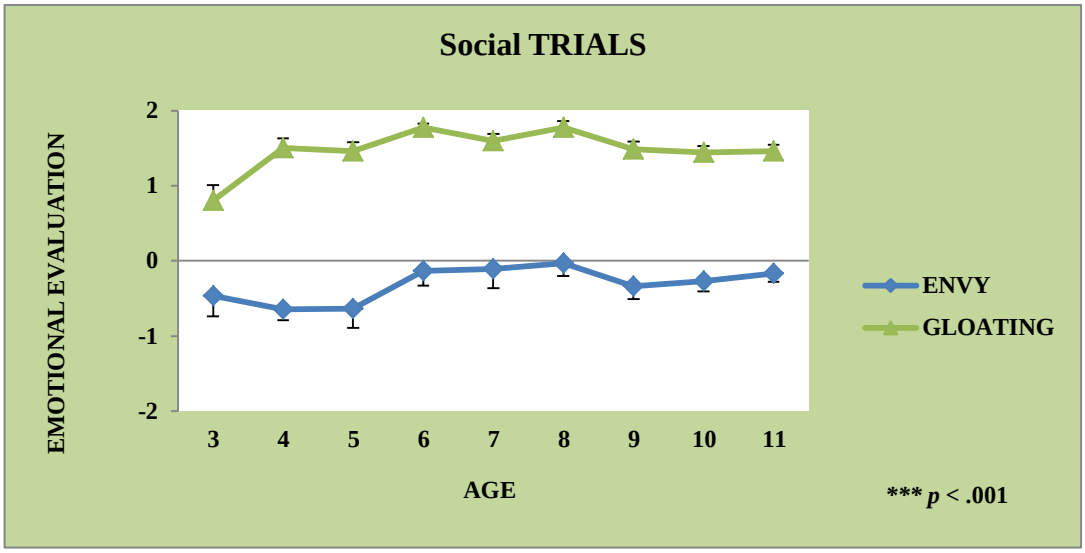

Fig. 6.7 Means of Envy and Gloating. All differences are significant ($p < .001$) starting at 4

We also wanted to test whether scores for each age deviated from zero using one-sample t tests. A significant positive result provided evidences for relief (*private* trials) and for gloating (*social trials*) and a significant negative result provided evidences for regret (*private trials*) and for envy (*social trials*).

The first evidence for envy was at 4, $t_{(24)} = -4.89$, $p < .001$. At the same age we found the first evidence for gloating, $t_{(23)} = -2.71$, $p < .001$. The first evidence for regret was at 7, $t_{(26)} = -3.08$, $p < .001$. The first evidence for relief was at 5, $t_{(21)} = 8.13$, $p < .001$.

We found the first significant difference between regret and envy at the age of 4, $t_{(24)}$= - 4.89, $p < .001$. At the same age we found the only significant difference between relief and gloating, $t_{(24)} = 10.14$, $p < .001$ (see *fig.* 6.9).

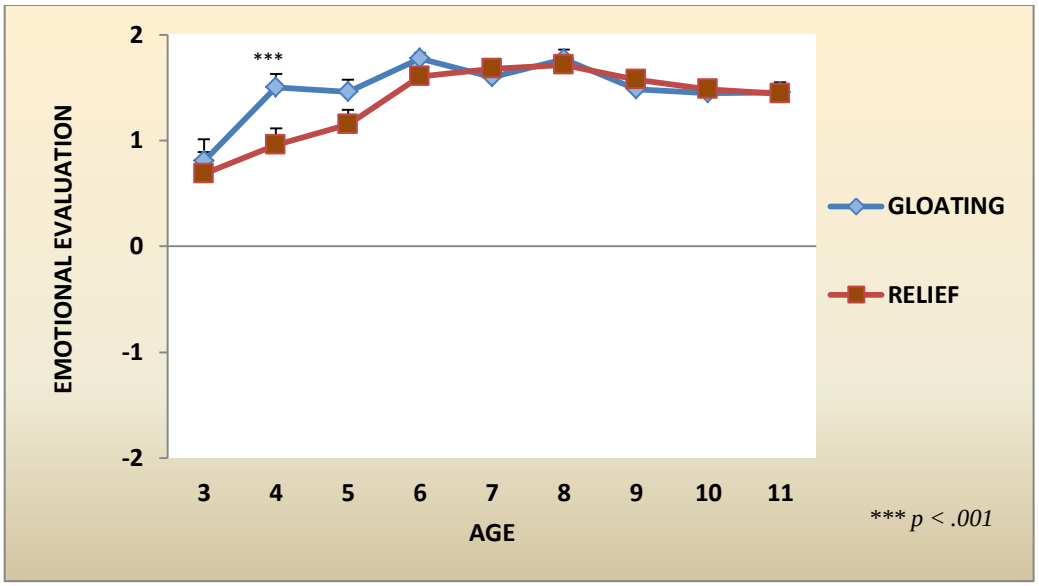

Fig. 6.8 Mean scores in Gloating and Relief trials for all ages

Results show the differences between *social* counterfactual emotions and *private* counterfactual emotions and also the differences between positive counterfactual emotions and negative counterfactual emotions in the two types of trials named *social* and *private*.

We found children's first report of the emotion of envy at the age of 3, when they still are not able to report the emotion of regret. Significant differences between the two were found starting from the age of 4. We also found children's first report of the emotion of gloating at the age of 3, when they also started to

report gloating. But the differences between the two positive counterfactual emotions were found for the age of 4 only. They evaluated the same starting from the age of 5, without a distinction between a *private* and a *social* condition. This didn't happen for negative counterfactual emotions, continuing to be differentiated during development.

Another evidence is children's reports of the emotion of envy when they still are not able to report regret. This may be due both to an early development of *social* counterfactual emotions before *private* counterfactual emotions and to the fact that in *social* counterfactual emotions they have not to imagine the alternative scenario. They have it in front of them and they register that another child makes the right choice and they don't.

Because of the presence of the alternative scenario in front of them also in our private trials, we do have to hypothesize that social components and social comparisons play a fundamental role.

CHAPTER 7

GENERAL DISCUSSION

7. GENERAL DISCUSSION

7.1 Summary

It has been my aim in this work to investigate children's early experience of counterfactual emotions. The thesis is divided into four parts, focusing on children's early experience of regret and relief (Experiment 1 and 2), the role of responsibility in children's reports of counterfactual emotions (Experiment 3), children's ability to attribute counterfactual emotions to others (Experiment 4), and the age in which children become able to report *social* counterfactual emotions, i.e. counterfactual emotions after social comparisons (Experiment 5).

My studies aimed to contribute to clarify some open questions found in the literature on counterfactual emotions, such as the absence of a distinction between the emotions of disappointment and regret, as well as between the emotions of elation and relief, the methodological differences between the previous studies, and finally the lack of studies on *social* counterfactual emotions.

7.2 Links to the previous literature

Counterfactual thinking is a necessary condition for the experience of counterfactual emotions, although it is not a sufficient condition. Now, research in developmental psychology provided evidence for children's ability in counterfactual thinking at the age of 3 (e.g. Harris *et al.* 1996; German & Nichols, 2003). But Beck *et al.* (2010) didn't replicate these results and claimed that previous studies reported false positives. In order to think counterfactually is indeed necessary the development of language skills and also a sufficiently developed inhibitory control system (Robinson & Beck, 2000).

Counterfactual reasoning implies to focus not exclusively on reality (e.g obtained outcome), but to consider both reality and its alternatives (e.g. outcome we could have obtained with a different choice). Beck *et al*. (2009) argue that until children are able to represent the imagine of "a double chance" according what happened and what would have happened, they cannot think counterfactually, and hence cannot feel regret. The researchers reported that it is only from the age of six that children become able to imagine counterfactual thinking as a "double chance". This is in agreement with Rafetseder *et al.* (2010), who maintained that children under five/six years of age do not think in a counterfactual mode but rather exploit other strategies such as conditional or logical reasoning.

In our Experiment 2 children reported regret after the age of 6. We agree with the claim that the experience of counterfactual emotions rests on inhibitory control and the ability to represent a double scenario. The necessity of more demanding cognitive abilities and a more advanced inhibitory control is also congruent with our hypothesis of a more mature form of the two counterfactual emotions emerging from the age of 9-10 -- as our data show on the base of a more restrictive definition of regret and relief.

Amsel and Smalley (2000) were the first authors who investigated regret in children. They involved participants in a game with boxes, testing counterfactual emotions and counterfactual thinking in 3- to 5-year-old children. They found an ability to think counterfactually at the age of 3 but evidence for regret not before the age of 5.

In a successive study Amsel and Smalley (2003) used a game involving cards instead of boxes to study both negative (termed 'regret') and positive (called 'elation') counterfactual emotions. Their focus was on the participants' judgements of the counterfactual-based emotion of regret in others and in themselves. Their results suggest that the recognition of the two counterfactual emotions is not possible before 5-6 years of age. In addition, their data show a simultaneous emergence of the ability to attribute counterfactual emotions to self and others. This simultaneous emergence of the two emotions starting from the age of 6-7 is also confirmed by our results in Experiment 4.

Guttentag and Ferrell (2004) ran experiments in which children were asked to make decisions with respect to the emotional responses of other agents, presenting stories where the characters achieve an outcome as a result of a decision made. It resulted that children didn't experience regret until the age of 7; and no evidence of relief was found.

Ferrell *et al.* (2009) investigated the role of salience in counterfactual alternatives in order to understand regret and relief. They made two hypotheses: that it is simpler to reason counterfactually after a negative outcome instead of a positive outcome; and that if children were provided with a prompt they could reason counterfactually and experience counterfactual emotions before the age of 7. They created "low salience" and "high salience" stories in which there were two protagonists who achieved the same outcome after making the same decisions, with only one of the two protagonists having had the opportunity to obtain a different outcome with an alternative decision. The researchers didn't observe any evidence of regret before the age of 7.

Weisberg and Beck (2010) investigated the development of regret and relief in 5- to 8- year old children using a similar methodology as Amsel and Smalley (2000). They found that children are not able to experience regret until the age of 5 and relief until 7 and to attribute these emotions to others until 7. In Experiment 1 we employed Weisberg and Beck's (2010) methodology replicating their results.

Weisberg and Beck (2011) used two boxes again and arrows. Children were also provided with feedbacks based on the correct or incorrect responses in the training procedure. In this second experiment both regret and relief are emotions that children are able to experience starting at 5-6 years of age.

Following Weisberg and Beck (2011), O'Connor *et al.* (2012) tested children with boxes and arrows but introducing a baseline. They found evidence for regret starting from the age of 6-7 years.

In Rafetsder and Perner's (2012) experiments, the participants were presented two boxes. The researchers tested children's ratings both presenting the question about the emotional evaluation twice (before and after seeing the alternative outcome) and asking the question only once, after showing the unchosen outcome. It resulted that children experience regret starting from the age of 9 years.

7.3 Methodological issues

Most of previous studies that investigate the development of regret and relief employed a first and a second emotional evaluation on a scale (Amsel *et al.* 2000, 2003; Beck *et al.* 2010). In Amsel *et al.*'s first studies (2000) the

participants were involved in a game in which they had to rate the happiness of an agent, and in their last experiments they played for themselves in a card game against the experimenter. The participants were asked to rate the happiness of the agents (or their happiness when played for themselves). Their scale was a 4-point scale with 4 smileys representing the following emotions: “not at all happy”, “a little happy”, “pretty happy” or “very happy”. After the presentation of the scale, followed by the choice of the box and the revealing of the outcome, they were asked the first question: “How happy is (name of the doll) with the gift received?”. So the alternative outcome was revealed and they were asked to report how happy is the doll again. Authors examined the differences in the answers to the initial question and the counterfactual question in order to test whether the participants gave different judgments before and after discovering the contents of the unchosen box.

In another experiment Amsel *et al.* (2003) introduced a new question. After revealing the selected card, questions became three. The initial one: “How do you feel / how does Billie feel after turning the card?”. The counterfactual question after shooting the non-selected card: “Who would win the sticker if you / Billie chose this card and not the one you / Billie selected? Billie, you or nobody?”. And the final question, asked after covering the non-selected card: “Do you remember you said that you was / Billie were / happy / sad after shooting the card? Now you/Billie saw the non-selected card. How do you feel about your / his choice? Do you feel / Does Billie feel happier /sadder than before, less happy /sad or the same? According to their results, the recognition of the two counterfactual

emotions is not possible before 5-6 years old. Data also show a simultaneous emergence of the ability to attribute counterfactual emotions to self and others.

Also Weisberg and Beck (2010) investigated regret and relief with a first and a second emotional evaluation in a task in which children had to choice between two boxes. Children were asked to rate their emotions (first evaluation) after the opening of the chosen box and to rate their emotions again (second evaluation) after the opening of the unchosen box. Authors subtracted the initial score (baseline) from the final score, in order to have a score difference between -4 and +4. The scores below zero indicated that participants were less happy for the choice of the box after seeing the contents of the alternative box (the one not chosen). This indicated regret. Scores above zero indicated instead relief. They reported that regret emerges at five years old while relief at seven.

Weisberg and Beck (2011) employed the two emotional evaluations again but also three arrows pointing up, left or right in order to rate for the second emotional evaluation scores like "even sadder" (pointing left), "even happier" (pointing right), "the same" (pointing up). Children were also provided with feedbacks based on the correct or incorrect responses in the training procedure. In this second experiment both regret and relief are emotions that children are able to experience starting at 5-6 years old.

O'Connor *et al.* (2012) introduced two methodological changes to Weisberg and Beck's (2010) experiment. They introduced a baseline in order to measure the understanding of regret avoiding a first and a second evaluation after the choice and they used the three arrows employed by Weisberg and Beck's (2011) experiment. The baseline aimed to rate their emotions after the choice

comparing it with a same outcome as a counterfactual prize. They found evidences for regret in the age group of 6-7 years old and 8-9. Both these age groups were also able to explain their change in feelings because of the greater desirability of the counterfactual outcome. They obtained an increase of the reported counterfactual children for trials in which participants received the baseline first.

In a second experiment they still used the baseline, because of the results of the experiment one and they introduced three arrows as Weisberg and Beck (2011) did, in order to ask children to evaluate their emotions as even sadder, even happier of the same. All children received the baseline trial first. Children were able to feel regret starting at 6 years old.

Finally, in Rafetsder and Perner's (2012) experiments participants were presented with a 8-point smiley faces from very happy to very sad. They were shown two boxes in order to choose one. They tested children's ratings both presenting the question twice (before and after seeing the alternative outcome) and presenting the question only one time, after showing the unchosen outcome. Their results are that children experience regret starting at 9.

In our experiments we decided to imply the same scale as in Weisberg and Beck's (2010) study and also to ask how participants feel instead of how much they are happy, as in Amsel and Smalley's (2000; 2003) study. But, as I described, we introduced only a final emotion evaluation in games in which children are provided with choices in which they can see the content of two transparent boxes (and consequently the obtained and unobtained outcome) all the time.

7.4 Conclusions

I have proposed a new methodology in order to test the development of regret and relief, also with a distinction between the emotions of disappointment and elation (partial feedback condition) and the emotions of regret and relief (complete feedback condition). After a replication of Weisberg's and Beck's (2010) results (Experiment 1), employing their same methodology, with a lag between regret (5 years old) and relief (7 years old), I ran Experiment 2 with the new methodology.

Results show that in the range of 3-5 years old children demonstrate to not understand disappointment and regret. They do understand the game and the scale, as we tested with training trials and the emotional evaluation training, but they are not able to compare what happened with what would have happened, both when they are responsible for the outcome (regret) and when they are not (disappointment). Children aged 3 to 5 always scored positive emotions both in elation and relief trials and in disappointment and regret trials, probably because they enjoyed the game, as they themselves referred when asked about their positive evaluation even if they didn't obtain anything (or they obtained 3 or 1) but they would have obtained, for example, 8.

First evidences for disappointment and regret reports were not until the age of 6. But the difference between the two emotions is not significant.

If we examine the effect of the counterfactual outcome on the evaluation of the obtained outcome as the difference between elation and disappointment and relief and regret, we could conclude that regret and relief are both experienced

starting at 7. This is first time that the difference between the counterfactual emotions of regret and relief is significant. But this doesn't consider a distinction between our partial condition (elation and disappointment) and complete condition (regret and relief).

Considering a more restrictive definition, defined as the differential evaluation between upward (downward) counterfactual in the partial vs. complete condition -- and hence disappointment (elation) vs. regret (relief) --, we found a lag between the two emotions, with relief experienced first time at 6 and regret experienced first time at 9, as in Rafetseder & Perner (2012).

The idea of a lag, with the emergence of regret after relief is also supported by lower scores in reporting regret than relief. The emotion of regret implies an assumption of responsibility for one's own actions and the consequent necessity to learn from the past and behave in a different way in the future. All this implies more commitment, as well as more sophisticated cognitive abilities than those involved in being relieved for the positive results of one's own actions in response to a potential loss.

So, in order to investigate the role of the responsibility for the outcome, with a manipulation of participants' sense and judgment of agency, we ran Experiment 3. In this experiment children rated the counterfactual emotion of regret starting from the age of 6. And no significant differences were found for the age group of 3-5. We didn't find any significant differences for any of the Age Groups comparing the conditions of *Agency Disappointment* and *No Agency Disappointment*, supporting the idea of a difference between the emotions of Disappointment and Regret. No significant differences between groups were

found also for Elation trials comparing the *Agency* with the *No Agency* conditions. A significant difference was found only for the age group of 10 comparing the *Agency* and the *No Agency* conditions for Relief trials. This support the idea that positive counterfactual emotions are something children experience starting at 6-7 but that the role of responsibility and -- maybe other cognitive factors -- contribute to an amplification of them not before the age of 10.

Differences between *Agency Regret* and *No Agency Regret* were found starting from the age group of 6-7, supporting the idea of an ability to understand and report regret at this age. In *Agency Condition* we replicated results of Experiment 2, finding significant differences between disappointment and elation trials and regret and relief trials for the age group of 6-7 year-old, a significant difference between elation and relief started at 6 and a significant difference between disappointment and regret starting at 9.

Experiment 4 aimed to test differences between self- and other- attributing of counterfactual emotions. We found significant results in Regret trials between *Self* and *Other* conditions starting from the age group of 6-7. Children were more able to report negative counterfactual emotions for others then for themselves.

We didn't find any significant differences for any of the Age Groups comparing the conditions of *Self Disappointment* and *Other Disappointment, Self* and *Other Elation* and also *Self Relief* and *Other Relief*.

In the disappointment and regret trials results showed lower scores for *Other* condition than *Self* condition. In the elation and relief trials they performed the same. We hypothesize that children found more simple to attribute negative counterfactual emotions to the experimenter rather than attributing to themselves,

because of the difficulty in the introspection of these complex emotions. We didn't find this effect for positive counterfactual emotions: children performed the same in both conditions, supporting again the idea of a difference between the two emotions with a more complexity for regret.

Finally, Experiment 5 tested the effect of social comparison in reporting counterfactual emotions. We found children's first report of the emotion of envy at the age of 3, when they still are not able to report the emotion of regret. But significant differences between the two were found starting from the age of 4. We also found children's first report of the emotion of gloating at the age of 3, when they also started to report relief. But the differences between the two positive counterfactual emotions were found for the age of 4 only. They evaluated the same starting from the age of 5, without a distinction between a *private* and a *social* condition. This didn't happen for negative counterfactual emotions, continuing to be differentiated during development.

The evidence for envy before regret may be due both to an early development of *social* counterfactual emotions before *private* counterfactual emotions and to the fact that for *social* counterfactual emotions children don't need to imagine the alternative scenario. They have the result of the choice made by another child in front of them, and they have only to register that the latter made the right choice and they didn't.

But because of the presence of the alternative scenario in front of them also in our private trials, we do have to hypothesize that social components and social comparisons play a fundamental role.

In conclusion, we showed for the first time evidences for envy and gloating at the age of 4, and for regret and relief at the age of 6-7. Our findings support the idea of a development of a late and more mature ability for those two counterfactual emotions after the age of 9-10.

There are many limits for our studies and maybe one of them, as well as in previous studies, could be the lack of testing with implicit measures together with the emotional evaluation scale.

REFERENCES

Amsel, E. & Smalley, D. (2000). Beyond really and truly: Children's counterfactual thinking about pretend and possible worlds. *Children's Reasoning and the Mind*, 99-134.

Amsel, E., Robbins, M., Tumarkin, T., Janit, A., Foulkes, S., & Smalley, J. D. (2003). The card not chosen: The development of judgment of regret in self and others. *Unpublished manuscript*.

Arkes, H. R., Kung, Y. H., & Hutzel, L. (2002). Regret, valuation, and action inertia. *Organizational Behavior and Human Decision Processes, 87*, 371-385.

Bechara, A., Damasio, A.R., Damasio, H. & Anderson, S.W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition*, 50, 7-15.

Bechara, A., Damasio, H., Tranel, D., & Damasio, A.R. (1997). Deciding Advantageously Before Knowing the Advantageous Strategy. *Science*, 275, 1293-1294.

Bechara, A., Damasio, H., & Damasio, A.R. (2000). Emotion, decision making and the orbitofrontal cortex. *Cerebral cortex*, 10, 295-307.

Bechara, A., Damasio, H., Tranel, D., & Damasio, A.R. (2005). The Iowa Gambling Task and the somatic marker hypothesis: some questions and answers. *Trends in cognitive sciences*, 9, 159-162.

Beck. S.R., Robinson, E.J., Carroll, D.J, & Apperly, I.A. (2006). Children's thinking about counterfactuals and future hypotheticals as possibilities. *Child Development, 77,* 413-426.

Beck, S.R. & Crilly, M. (2009). Is understanding regret dependent on developments in counterfactual thinking?. *British Journal of Developmental Psychology*, 27, 505-510.

Beck, S.R., Riggs, K.J., & Gorniak, S.L. (2009). Relating developments in children's counterfactual thinking and executive functions. *Thinking and Reasoning*, 15, 337–354.

Beck, S.R., Riggs, K.J., & Gorniak, S.L. (2010). The effect of causal chain length on counterfactual conditional reasoning. *British Journal of Developmental Psychology, 28,* 505-521.

Beck, S.R., McColgan, K.L.T., Robinson, E.J., & Rowley, M.G. (2011). Imagining what might be: why children under-estimate uncertainty. *Journal of Experimental Child Psychology, 110,* 603-610.

Beck, S.R. & Guthrie, C. (2011). Almost thinking counterfactually: children's understanding of close counterfactuals. *Child Development, 82,* 1189-1198.

Beck, S.R., Robinson, A., Ahmed, S., & Abid, R. (2011). Children's understanding that ambiguous figures have multiple interpretations. *European Journal of Developmental Psychology, 8,* 403-422.

Beck, S.R., Riggs, K.J., & Burns, P. (2011). Multiple developments in counterfactual thinking. Chapter in C. Hoerl, T. McCormack, & S.R. Beck, (Eds.), *Understanding counterfactuals, understanding causation*.

Bell, D. (1982). Regret in decision making under uncertainty. *Operations Research*, 20, 961–81.

Bell, M.A., & Fox, N.A. (1992). The relations between frontal brain electrical activity and cognitive development during infancy. *Child Development*, 63, 1142–1163.

Blair, R.J. & Cipolotti, L. (2000). Impaired social response reversal. A case of 'acquired sociopathy'. *Brain*, 123, 1122–1141.

Blair, R.J.R., Colledge, E., & Mitchell, D.G.V. (2001). Somatic markers and response reversal: Is there orbitofrontal cortex dysfunction in boys with psychopathic tendencies. *Journal of Abnormal Child Psychology*, 29, 499–511.

Bokura, H., Yamaguchi, S., & Kobayashi, S. (2001). Electrophysiological correlates for response inhibition in a Go/No-Go task. *Clinical Neurophysiology*, 112, 2224–2232.

Burks, A. W. (1946). Laws of nature and reasonableness of regret. *Mind: A Quarterly Review of Psychology and Philosophy, 55,* 170-172.

Burns, P., Riggs, K.J. & Beck, S.R. (2012). Executive control and the experience of regret. *Journal of Experimental Child Psychology*, 111, pp. 501-515.

Byrne, R.M.J. (2002). Mental models and counterfactual thoughts about what might have been. *Trends in Cognitive Sciences,* 6(10), 426-431.

Byrne, R. M. J., & McEleney, A. (2000). Counterfactual thinking about actions and failures to act. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 26,* 1318-1331.

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*, 1167–1170.

Carter, C.S., MacDonald III, A.M., Botvinick, M.M., Ross, L.L., Stenger, V.A., Noll, D., & Cohen, J.D. (2000). Parsing executive processes: Strategic vs. evaluative functions of the anterior cingulate cortex. *Proceedings of the National Academy of Sciences*, 97, 1944–1948.

Connolly, T., Ordonez, L. D., and Coughlan, R. (1997). Regret and responsibility in the evaluation of decision outcomes. *Organizational Behavior and Human Decision Processes*, 70, 73–85.

Coricelli, G., Critchley, H.D., Joffily, M., O'Doherty, J.P., Sirigu, A., & Dolan, R.J. (2005). Regret and its avoidance: a neuroimaging study of choice behavior. *Nature Neuroscience*, *8*, 1255–1262.

Coricelli, G., & Schwarzbach, J. (2008). Cervello e decisioni. In Bonini N., Del Missier, F., & Rumiati R. (Eds.). *Psicologia del giudizio e della decisione*, Bologna: Il Mulino, 151-170.

Derryberry, D., & Reed, M. A. (1996). Regulatory processes and the development of cognitive representations. *Development and Psychopathology*, 8, 215–234.

Diamond, A. & Goldman-Rakic, P. S. (1989). Comparison of human infants and rhesus monkeys on Piaget's A-not-B task: Evidence for dependence on dorsolateral prefrontal cortex. *Experimental Brain Research, 74*, 24-40.

Edwards, W., Kiss, I., Majone, G. & Toda, M. (1984). What constitutes "a good decision"? *Acta Psychologica*, 56, 5–27.

Epstude, K., & Roese, N. J. (2008). The functional theory of counterfactual thinking. *Personality and Social Psychology Review*, 12, 168-192.

Feeney, A., & Handley, S. (2006). Comparisons, mental models, and the action effect in judgements of regret. *Memory & Cognition, 34*, 1422–1430.

Ferrell, J. & Guttentag, R.E & Gredlein, J.M. (2009). Children's understanding of counterfactual-thinking-based emotions: The effects of counterfactual-information salience. *British Journal of Developmental Psychology*, 27, 569-585.

Frijda, N.H., Kuipers, P., & ter Schure, E. (1989). Relations among emotion, appraisal and emotional action readiness. *Journal of Personality and Social Psychology*, 57, 212–228.

Garon, N., & Moore, C. (2004). Complex decision-making in early childhood. *Brain and Cognition* (Special Issue on Development of Orbitofrontal Function), 55, 158–170.

Gergely,G. *et al*. (2002) Rational imitation in preverbal infants. *Nature* 415, 755.

German, T.P. & Nichols, S. (2003). Children's counterfactual inferences about long and short causal chains. *Developmental Science*, 6, pp. 514-523.

Girotto, V., Legrenzi, P., & Rizzo, A. (1991). Event controllability and counterfactual thinking. *Acta Psychologica*, 78, 111–133.

Girotto, V., Ferrante, D., Pighin, S., & Gonzalez, M. (2007). Post-decisional counterfactuals by actors and readers. *Psychological Science*, 18, 510–515.

Gleicher, F., Kost, K. A., Baker, S. M., Strathman, A. J., Richman, S. A., & Sherman, S. J. (1990). The role of counterfactual thinking in judgments of affect. *Personality and Social Psychology Bulletin, 16*, 284–295.

Gogtay, N., Giedd, J.N., *et al.* (2004). Dynamic mapping of human cortical development during childhood through early adulthood. *Proceedings of the National Academy of Sciences*, 101(21), 8174 –8179.

Golden, C.J. (1981). The Luria-Nebraska children_s battery: Theory and formulation. In G.W. Hynd & J.E. Obrzut (Eds.), *Neuropsychological assessment and the school-aged child* (pp. 277–302). New York: Grune & Stratton.

Guajardo, N.R., Parker, J., & Turley-Ames, K. (2009). Association among false belief understanding, counterfactual reasoning, and executive function. *British Journal of Developmental Psychology*, 27, pp. 681-702.

Guttentag, R.E. & Ferrell, J. (2004).Reality compared with its alternatives: Age differences in judgments of regret and relief. *Developmental Psychology*, 40 (5), pp.765-775.

Habib, M., Cassotti, M., Borst, G., Simon, G., Pineau, A., Houdé, O. & Moutier, S. (2012). Counterfactually mediated emotions: A developmental study of regret and relief in a probabilistic gambling task. *Journal of Experimental Child Psychology*, 112, pp. 265-274.

Happaney, K.R., Zelazo, P.D., & Stuss, D. T. (2004). Orbitofrontal function: A developmental perspective. *Brain and Cognition, 55*, 1-10.

Harris, P.L., Johnson, C.N., Hutton, D., Andrews G., & Cooke, T. (1989). Young children's theory of mind and emotion. *Cognition and Emotion*, 3, 379-400.

Harris, P.L., German, T. & Mills, P. (1996). Children's use of counterfactual thinking causal reasoning. *Cognition, 61*, 233-259.

Harris, P.L., German, T. & Mills, P. (1996). Children's use of counterfactual thinking causal reasoning. *Cognition*, 61, 233-259.

Harris, P.L. (1997). On realizing what might have happened instead. *Polish Quarterly of Developmental Psychology, 3,* 161-176.

Harris, A., Rowley, M.G., Beck, S.R., Robinson, E.J., & McColgan, K.L.T. (2011) Agency affects adults', but not children's, guessing preferences in a novel game of chance. *Quarterly Journal of Experimental Psychology, 64,* 1772-1787.

Hoerl, C., McCormack T. & Beck S.R. (2011). *Understanding Counterfactuals, Understanding Causation. Issues in Philosophy and Psychology*. Oxford University Press.

Hooker C, Roese NJ, Park S. (2000). Impoverished counterfactual thinking is associated with schizophrenia. *Psychiatry*, 63, 326–335.

Hornak, J., Rolls, E.T. & Wade, D. (1996). Face and voice expression identification in patients with emotional and behavioural changes following ventral frontal lobe damage. *Neuropsychologia* 34, 247–261.

Hornak, J. *et al.* (2003). Changes in emotion after circumscribed surgical lesions of the orbitofrontal and cingulate cortices. *Brain*, 126, 1671–1712 (2003).

Johnson, M.K., & Sherman, S.J. (1990). Constructing and reconstructing the past and the future in the present. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (Volume 2, pp. 482-526). New York: Guilford Press.

Kahneman, D. & Tversky, A. (1982). The simulation heuristic. Judgement under uncertainty: Heuristics and biases, pp.201-208.

Kahneman, D. (1995). Varieties of counterfactual thinking. In Roese, N. J., & Olson, J. M. (Eds.). *What might have been: The social psychology of counterfactual thinking*, Mahwah, NJ: Erlbaum, 375–396.

Kahneman, D., & Miller, D. (1986). Norm theory: Comparing reality to its alternative. *Psychological Review*, 93, 136–153.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47, 263–291.

Kahneman, D., & Tversky, A. (1982). The simulation heuristic. In Kahneman, D., Slovic, P., & Tversky, A. (Eds.). *Judgment under uncertainty: Heuristics and biases*, New York: Cambridge University Press, 201-208.

Kasimatis, M., & Wells, G. L. (1995). Individual differences in counterfactual thinking. In N. J. Roese & J. M. Olson (Eds.). *What might have been: The social psychology of counterfactual thinking*, pp. 81–101. Mahwah, NJ: Erlbaum.

Kerr, A., & Zelazo, P.D. (2004). Development of ''hot'' executive function: The children's gambling task. *Brain and Cognition* (Special Issue: Development of Orbitofrontal Function), 55, 148–157.

Landman, J. (1987). Regret and elation following action and inaction: Affective reactions to positive versus negative outcomes. *Personality and Social Psychology Bulletin*, 13, 524–536.

Landman, J. (1993). *Regret: The persistence of the possible*. Oxford, UK: Oxford University Press.

Loomes, G. & Sugden, R. (1982). Regret theory: An alternative theory of rational choice under uncertainty, *Economic Journal*, 92, 805–24.

Luria, A. R. (1973). *The working brain: An introduction to neuropsychology* (B. Haigh, Trans.). New York: Basic Books.

Marchetti, A. & Castelli, I. (2007). Teoria della Mente e Neuroeconomia: la comprensione degli stati mentali nei processi di decision making. In Pravettoni, G., Vago, G. (a cura di), *La scelta imperfetta. Caratteristiche e limiti della decisione umana.* McGraw-Hill, Milano, pp. 53-74.

Marchetti, A., Castelli, I., Harlé, K.M., Sanfey, A.G. (2011). Expectations and outcome: The role of proposer features in the Ultimatum Game. *Journal of Economic Psychology*, 32, pp. 446-449.

Marchetti, A. & Castelli, I. (2012). *Come decidono I bambini. Psicoeconomia evolutiva*. Milano, Raffaello Cortina.

Markman, K.D., Gavanski, I., Sherman, S.J., & McMullen, M.N. (1993). The mental simulation of better and worse possible worlds. *Journal of Experimental Social Psychology*, 29, 87-109.

Markman, K.D., & Tetlock, P.E. (2000). Accountability and close-call counterfactuals: The loser who nearly won and the winner who nearly lost. *Personality and Social Psychology Bulletin*, 26, 1213-1224.

Moore, C., Barresi, J., & Thompson, C. (1998). The cognitive basis of future oriented prosocial behavior. *Social Development*, 7, 198–218.

Myers-Levy, J. & Maheswaran, D. (1992). When timing matters: The influence of temporal distance on consumers' affective and persuasive responses. *Journal of Consumer Research,* 19, pp. 424-433.

N'gbala, A., & Branscombe, N. R. (1997). When does action elicit more regret than inaction and is counterfactual thinking the mediator of this effect? *Journal of Experimental Social Psychology, 33,* 324–343.

O'Connor, E., McComarmack, T. & Feeney, A. (2012). The Development of regret. *Journal of Experimental Child Psychology*, 111, pp. 12-127.

Overman, W.H., Bachevalier, J., Schuhmann, E., & Ryan, P. (1996). Cognitive gender differences in very young children parallel biologically based cognitive gender differences in monkeys. *Behavioral Neuroscience,* 110, 673–684.

Orzhekhovskaya, N.S. (1981). Fronto-striatal relationships in primate ontogeny. *Neuroscience and Behavioral Physiology*, 11, 379-385.

Perner, J., Sprung, M., & Steinkogler, B. (2004). Counterfactual conditionals and false belief: A developmental dissociation. *Cognitive Development*, 19, 179–201.

Piaget, J. (1954). *The construction of reality in the child*. New York: Basic Books.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind?. *Behavioral and Brain Sciences*, 1, 515–526.

Rafetseder, E., Cristi-Vargas, R. & Perner, J. (2010). Counterfactual reasoning: Developing a sense of "nearest possible world.". *Child Development*, 81(1), pp. 376-389.

Rafetseder, E. & Perner, J. (2010). Is reasoning from counterfactual antecedents evidence for counterfactual reasoning?. *Thinking and Reasoning*, 16(2), pp. 131-155.

Rafetseder, E. & Perner, J. (2012). When the alternative would have been better: Counterfactual reasoning and the emergence of regret. *Cognition and Emotion*, 26 (5), 800-819.

Riggs, K.J., Peterson, D.M., Robinson, E.J., & Mitchell, P. (1998). Are errors in false belief tasks symptomatic of a broader difficulty with counterfactuality? *Cognitive Development*, 13, 73–91.

Riggs, K.J., & Peterson, D.M. (2000). Counterfactual thinking in pre-school children: mental state and causal inferences. In P. Mitchell & K. Riggs

(Eds.), *Children's reasoning and the mind* (pp. 87–99). Hove, UK: Psychology Press.

Robinson, E. J., & Beck, S. R. (2000). What is difficult about counterfactual reasoning? In P. Mitchell & K.J. Riggs (Eds.), *Children's reasoning and the mind* (pp. 101–119). Hove, UK: Psychology Press.

Roese, N. J. (1994). The functional basis of counterfactual thinking. *Journal of Personality and Social Psychology*, 66, 805-818.

Roese, N.J. & Olson, J.M. (1995). Outcome controllability and counterfactual thinking. *Personality and Social Psychology Bulletin*, 21, 620–628.

Roese, N.J. (1997). Counterfactual thinking. *Psychological Bulletin*, 121, 133-148.

Roese, N. & Olson, J.M. (1997). Counterfactual thinking The intersection of affect and function. *Advances in Experimental Social Psychology*, 29, 1-59.

Roese, N. J. (1999). Counterfactual thinking and decision making. *Psychonomic Bulletin and Review*, 6, 570-578.

Roese, N. J., & Summerville, A. (2005). What we regret most … and why. *Personality and Social Psychology Bulletin, 31*, 1273–1285.

Roseman, I.J., Wiest, C., & Swartz, T.S. (1994). Phenomenology, behaviors, and goals differentiate discrete emotions. *Journal of Personality and Social Psychology*, 67, 206–211.

Roseman, I.J., Antoniou, A.A., & Jose, P.E. (1996). Appraisal determinant s of emotions: Constructing a more accurate and comprehensiv e theory. *Cognition and Emotion*, 10, 241–277.

Saffrey, C., Summerville, A., & Roese, N. J. (2008). Praise for regret: People value regret above other negative emotions. *Motivation and Emotion, 32*, 46-54.

Schoenbaum, G., & Setlow, B. (2001). Integrating orbitofrontal cortex into prefrontal theory: Common processing themes across species and subdivisions. *Learning and Memory*, 8, 134–147.

Sherman, S. J., & McConnell, A. R. (1995). Dysfunctional implications of counterfactual thinking: When alternatives to reality fail us. In N. J. Roese & J. M. Olson (Eds.), *What might have been: The social psychology of counterfactual thinking* (pp. 199-231). Mahwah, NJ: Erlbaum.

Synofzik, M., Vosgerau, G. & Newen, A. (2008). Beyond the Comparator Model: A Multifactorial Two-Step Account of Agency. *Consciousness and Cognition*, 17, 219-239.

Steinbeis, N., & Singer, T. (2013). The effects of social comparison on social emotions and -behaviour during childhood: The ontogeny of envy and Schadenfreude predicts developmental changes in equity-related decisions. *Journal of Experimental Child Psychology*, 115(1), 198-209

Stuss, D.T., Gallup, G.G., & Alexander, M.P. (2001). The frontal lobes are necessary for ‘‘theory of mind’’. *Brain*, 124,279–286.

Thompson, C., Barresi, J., & Moore, C. (1997). The development of future-oriented prudence and altruism in preschoolers. *Cognitive Development*, 12, 199–212.

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

Weisberg, D.P., & Beck, S.R. (2011). The development of children’s regret and relief. *Cognition and Emotion*, pp. 1-16.

Wimmer, H., Landerl, K., Linortner, R. & Hummer, P. (1991). The relationship of phonemic awareness to reading acquisition: more consequence than precondition, but still important. *Cognition*, 40, 219-249.

Wolpert D.M., Miall R.C. & Kawato M. (1998). Internal models in the cerebellum. *Trends in Cognitive Sciences*, 2, 338-347.

Wolpert D.M. & Ghahramani Z. (2000). Computational principles of movement neuroscience, *Nature Neuroscience*, 3, 1212-1217.

Zeelenberg, M., van Dijk, W.W., & Manstead, A.S.R. (1998). Reconsidering the relation between regret and responsibility. *Organizational Behavior and Human Decision Processes*, 74, 254-272.

Zeelenberg, M. (1999a). The use of crying over spilled milk: A note on the rationality and functionality of regret. *Philosophical Psychology*, 13, 326-340

Zeelenberg, M. (1999b). Anticipated regret, expected feedback and behavioral decision-making. *Journal of Behavioral Decision Making*, 12, 93–106.

Zeelenberg, M., & Beattie, J. (1997). Consequences of regret aversion 2: Additional evidence for effects of feedback on decision making. *Organizational and Human Decision Processes*, 72, 63-78.

Zeelenberg, M., Beattie, J., Van der Pligt, J., & De Vries, N. K. (1996). Consequences of regret aversion: Effects of expected feedback on risky decision-making. *Organizational Behavior and Human Decision Processes*, 65, 148–158.

Zeelenberg, M., van Dijk, W.W., Manstead, A.S.R., & van der Pligt, J. (1998b). The experience of regret and disappointment. *Cognition and Emotion*, 12, 221± 230.

Zeelenberg, M., van Dijk, W.W., van der Pligt, J., Manstead, A.S.R., van Empelen, P., & Reinderman, D. (1998d). Emotional reactions to outcomes of decisions: The role of counterfactual thought in the experience of regret and disappointment. *Organizational Behavior and Human Decision Processes*, 75, 117± 141.

Zeelenberg, M., & Pieters, R. (1999). Comparing service delivery to what might have been: Behavioral responses to regret and disappointment. *Journal of Service Research*, 2, 86–97.

Zeelenberg, M., Wilco W. van Dijk, A.S.R., Manstead & van de Pligt, J. (2000). On bad decisions and disconfirmed expectancies: The psychology of Regret and Disappointment, *Cognition and Emotion*, 14 (4), 521± 541.

Zeelenberg, M., van den Bos, K., van Dijk, E., & Pieters, R. (2002). The inaction effect in the psychology of regret. *Journal of Personality and Social Psychology, 82*, 314–327.

Zeelenberg, M., & Pieters, R. (2007). A theory of regret regulation 1.0. *Journal of Consumer Psychology*, 17, 3-18.