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The effects of social comparison on social emotions and behavior during childhood: The ontogeny of envy and Schadenfreude predicts developmental changes in equity-related decisions

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ABSTRACT

Social comparison can elicit emotions such as envy, which can affect social interactions. The emergence and development of such social emotions through ontogeny, and their influence on social interaction, are unknown. We tested 182 children from 7 to 13 years of age with a novel monetary reward-and-punishment task measuring envy and Schadenfreude (i.e., gloating or taking delight in someone else's misfortune). Children were either rewarded or punished in a trial-by-trial evaluation of their performance on a speeded reaction time task. In a social condition, feedback of their own and a competitor's performance was given for each trial. Afterward, children rated how they felt about the outcome. The ratings suggest that when children won, they felt better if the competitor lost instead of winning (i.e., Schadenfreude). Conversely, when children lost, they felt worse if the competitor won instead of losing (i.e., envy). Crucially, levels of envy and Schadenfreude decreased with age. We also studied how these emotions relate to social decisions made separately during three resource allocation paradigms. In each, children chose between two options that differed in the distribution of valuable tokens between themselves and an anonymous other. The combination of choices allowed the measurement of inequity aversion (i.e., equality for all) and spite (i.e., self-profit to maximal disadvantage of the other). We found an age-related increase in inequity aversion and

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decrease in spite. Crucially, age-related changes in both envy and Schadenfreude predicted the developmental change in equity-related decisions. These findings shed light on the development of social emotions and demonstrate their importance in the development of prosocial behavior in children.

Introduction

Comparing oneself with others happens universally across human cultures (Gibbons & Buunk, 1999; White & Lehman, 2005). From personal attributes such as beauty and intelligence to possessions such as cars and homes, social comparison processes can significantly influence how good one feels about oneself (Festinger, 1954). Think about how men compare the size of their vehicles; to improve their sense of self-worth, they compare themselves with those with smaller or cheaper cars or perhaps perform actions that sabotage those with larger or more expensive ones (see Taylor & Lobel, 1989, and Zizzo, 2003, for similar behavior in other domains). Particularly in competitive environments, it has been shown that social comparison leads to envy as well as Schadenfreude (i.e., gloating or taking delight in someone else's misfortune) (Smith & Kim, 2007). It has been argued that envy and Schadenfreude are strongly linked emotional states (Smith & Kim, 2007; Smith et al., 1996), as indicated by an alleviation of envy when misfortune befalls the envied other, resulting in Schadenfreude (Smith et al., 1996; Takahashi et al., 2009). Furthermore, both envy and Schadenfreude have been linked to grossly antisocial behavior (Hein, Silani, Preuschoff, Batson, & Singer, 2010; Zizzo, 2003). Given these potentially detrimental effects of emotions resulting from social comparison, understanding their emergence and development during childhood is of particular interest. However, to date, little is known about the ontogeny of envy and Schadenfreude and how they relate to the development of prosocial behavior.

The literature on the development of social comparisons has focused predominantly on the age at which children begin to compare themselves with their peers and how these comparisons affect subsequent self-appraisal, motivation, and performance judgments during competitive tasks (Butler, 1989; Pomerantz, Ruble, Frey, & Greulich, 1995; Rhodes & Brickman, 2008; Ruble, Eisenberg, & Higgins, 1994). Between 5 and 10 years of age, relative failures typically lead to negative self-appraisals and decreased motivation (Boggiano & Ruble, 1979; Butler, 1989; Pomerantz et al., 1995; Ruble, Boggiano, Feldman, & Loebl, 1980; Ruble et al., 1994; Ruble, Feldman, & Boggiano, 1976; Ruble, Parsons, & Ross, 1976). Given that the effect of social comparison on emotional states in adults is considerable (Smith & Kim, 2007), it is all the more surprising that only a few studies have investigated a direct link between social comparison and affective states in children (Carlson & Masters, 1986; Masters, Carlson, & Rahe, 1985). Importantly, to our knowledge, only one study has addressed the direct effects of both upward and downward social comparison (i.e., comparison with someone currently better and worse off, respectively) on affective states in children (LoBue, Nishida, Chiong, DeLoache, & Haidt, 2011), and none has studied how these effects change with age.

Previous research has reported an increase in the extent to which social comparison occurs during middle childhood (Butler, 1989; Pomerantz et al., 1995; Ruble et al., 1994). Therefore, one hypothesis is that these increases should be accompanied by a rise in the associated emotions such as envy and Schadenfreude. At the same time, however, it has been shown that with age, children become increasingly aware of the negative aspects of social comparison (Pomerantz et al., 1995). Thus, an alternative hypothesis is that increases in social comparison lead to greater regulation of negative emotions, resulting in less envy and Schadenfreude during childhood. To directly address these hypotheses, we devised a novel experimental paradigm and studied whether and how emotions that arise out of social comparison change through development in children from 7 to 13 years of age. Even though previous studies have focused predominantly on younger ages, we were interested in further developmental changes right throughout middle and late childhood. In addition, piloting suggested that the paradigm was easily followed by 7-year-olds but less so by younger children. Pragmatically, this represented the lower bound of our age range. Because our focus was on the development of social

emotions during childhood, the onset of adolescence, typically estimated to occur between 12 and 14 years of age, represented the upper bound. Using such an age range permits us to chart the development of emotions arising out of social comparison and whether an age-related increase in social comparison occurs with a concomitant increase or decrease in associated emotions.

Effects of envy are also interesting in terms of their putative influence on human social decisions. This is, for example, evidenced by the commonly displayed preference for dividing a resource into equal parts, also known as *inequity aversion* (Fehr & Schmidt, 1999). Numerous studies on the development of this preference provide evidence for age-related changes in behavior reflecting inequity aversion (Almas, Cappelen, Sorensen, & Tungodden, 2010; Blake & McAuliffe, 2011; Fehr, Bernhard, & Rockenbach, 2008; Harbaugh, Liday, & Krause, 2003; Moore, 2009; Shaw & Olson, 2012; Steinbeis, Bernhardt, & Singer, 2012; Thompson, Barresi, & Moore, 1997). It has been shown that with age, children increasingly reject unfair offers in the Ultimatum Game (Harbaugh et al., 2003; Steinbeis et al., 2012), which can be interpreted as resulting from increasing inequity aversion. Blake and McAuliffe (2011) further reported that whereas 4- to 7-year-olds reject offers that put themselves at a disadvantage, children of approximately 8 years of age also reject offers that put another at a disadvantage, a finding that was recently replicated (Shaw & Olson, 2012). In addition, inequity aversion develops through adolescence, as indicated by developmental changes in the explicit justification of inequality (Almas et al., 2010).

Using a set of three economic games, Fehr et al. (2008) showed that between 3 and 8 years of age, children increasingly choose sharing options that ensure equal pay-offs for all parties involved. In each game, a child needed to decide how a number of sweets were to be divided between himself/herself and an anonymous other and was faced with two options. One option divided the sweets equally, and an alternative option favored one of the two players. For the child making the decision, the alternative options could be either advantageous (i.e., one sweet for the child and none for the other) or disadvantageous (i.e., one sweet for the child and two for the other). These games provide a systematic test for how strongly children of a certain age prefer equality depending on the costs incurred to create it. The study found an age-related increase in strong inequity aversion, as indicated by a greater willingness to incur costs to one's own pay-off to obtain equality. Similarly, there was an age-related decrease in spiteful decisions, namely those that always left the other disadvantaged, even when this did not incur any additional benefits to the child making the choice. In the current study, we employed the same measures to test for inequity aversion and spite. Given our tested age range, we modified the incentive structure and used age-appropriate toys instead of sweets as rewards. It has been shown that the type and value of the experimentally implemented currency can have a considerable impact on equity-related decisions in children (Blake & Rand, 2010). Therefore, we expected to replicate the pattern of an age-related increase in inequity aversion and decrease in spite, as reported by Fehr et al. (2008), given the use of salient and age-appropriate attractive rewards.

Importantly, we sought to test whether emotions associated with social comparison play a role in bringing about equity-related decisions. In spite of the evident wealth of studies on the development of inequity aversion, the mechanisms underlying age-related changes in this preference remain elusive and emotional development may constitute a plausible candidate. Whereas it has been shown that changes in explicit norm-related reasoning may play a role (Blake & McAuliffe, 2011), nothing is known of the possible involvement and development of emotional processes. So far, only few studies have addressed the role of emotions in social decision making (Gummerum, Hanoch, Keller, Parsons, & Hummel, 2010; Kogut, 2012; LoBue et al., 2011) without providing a direct link between the emotions and decisions. Therefore, we were interested in whether age-related differences in social emotions (i.e., emotions that occur exclusively in real or imagined social situations), such as envy and Schadenfreude, could predict developmental changes in inequity aversion as measured by equity-related decisions. To address this, we linked our measures of envy and Schadenfreude with those of equity-related decisions derived from children's choices in the economic games.

It has been shown that the emotional consequences of decisions can be anticipated, which in turn influences the decisions themselves (Coricelli et al., 2005; Loewenstein, Weber, Hsee, & Welch, 2001). Thus, it is likely that anticipated emotions affect decisions regarding the distribution of resources. For instance, individual differences in the experience of an emotion, such as regret, predict the extent to which that same emotion is anticipated to occur as a result of a decision (Coricelli et al., 2005). Therefore, we hypothesized that our measures of envy and Schadenfreude should constitute predictors of

equity-related decisions. Specifically, we hypothesized that anticipating feelings of envy (i.e., feeling worse when the other has more than oneself compared with when both have equally little) should lead to decisions that aim to increase the other's disadvantage (i.e., spiteful decisions). It has been argued that Schadenfreude and envy are tightly coupled emotional states (Smith & Kim, 2007; Smith et al., 1996). This appears to be due to the fact that the experienced envy is alleviated when seeing misfortune befall the envied other, something to result in Schadenfreude (Smith et al., 1996; Takahashi et al., 2009). Therefore, we predicted that anticipating feelings of Schadenfreude (i.e., feeling better when one has more than the other compared with when both have equally as much) should also lead to decisions that maximize the disadvantage of the other (i.e., spiteful decisions). Thus, we hypothesized that individual differences in our measures of envy and Schadenfreude would be predictive of spiteful decisions, as measured by the choices made in the context of economic games. Furthermore, we hypothesized that age-related changes in feelings of envy and Schadenfreude would mediate the observed age-related changes in equity-related decisions.

Methods

Participants

Participants were 182 children (105 boys and 77 girls, mean age = 10.07 years, range = 7.01–13.96). Of these children, 177 were Swiss, 2 were German, 1 was Thai, 1 was Swedish, and 1 was English. Parents of all participants gave their informed consent, and the study was approved by the ethics committees of the University of Zurich and the Canton of Zurich (E68/2008). Children were recruited from primary schools in the town of Rapperswil in the canton St. Gallen, Switzerland. All children were normal developing, and socioeconomic status was mixed.

Procedure

Testing took approximately 2 h and was carried out at the school in rooms specifically reserved for that purpose during school time. Children were tested in groups that never exceeded four. At the beginning of testing, children were shown a table filled with presents of varying sizes and values. Presents were displayed such that there was an increase in value from left to right. Children were told that they were going to be playing some games in which they could win poker chips (henceforth *tokens*) that they could exchange for one of the gifts at the end of the games. It was emphasized that the more tokens they had earned, the wider the selection of presents they could choose from would be. This was iterated by means of a sign attached to the table displaying a rough quantity of tokens required to obtain a present from each particular section. This method has a clear advantage over the vast majority of previous studies on the development of equity-related decisions in that incentives for earnings were kept constant across all ages. Children were randomly assigned to one of two experimenters. Testing occurred at two adjacent tables, each equipped with two laptops and with walls erected out of cartons so that none of the players could see each other. There were two separate parts to testing: one consisting of a competitive game designed to measure social emotions and another designed to test for equity-related decisions. Both experimental parts were counterbalanced across participants. Each is described in turn below.

Envy and Schadenfreude task

To assess social emotions such as envy and Schadenfreude in children, we developed a paradigm based on a competitive game in which children were always paired anonymously with another child of the same group playing the same game. Tokens could be won or lost as a function of their speeded response on a go/no-go task (see Fig. 1A). The magnitude of wins and losses was identical. Children were informed that they could win an additional number of tokens if overall they were faster than the competitor. More specifically, children knew they were playing against one of the other children but did not which one. It was made clear that responses needed to be made as quickly as possible to a change in a feature of a large blue circle presented on the computer screen for 1500 to 4500 ms. The

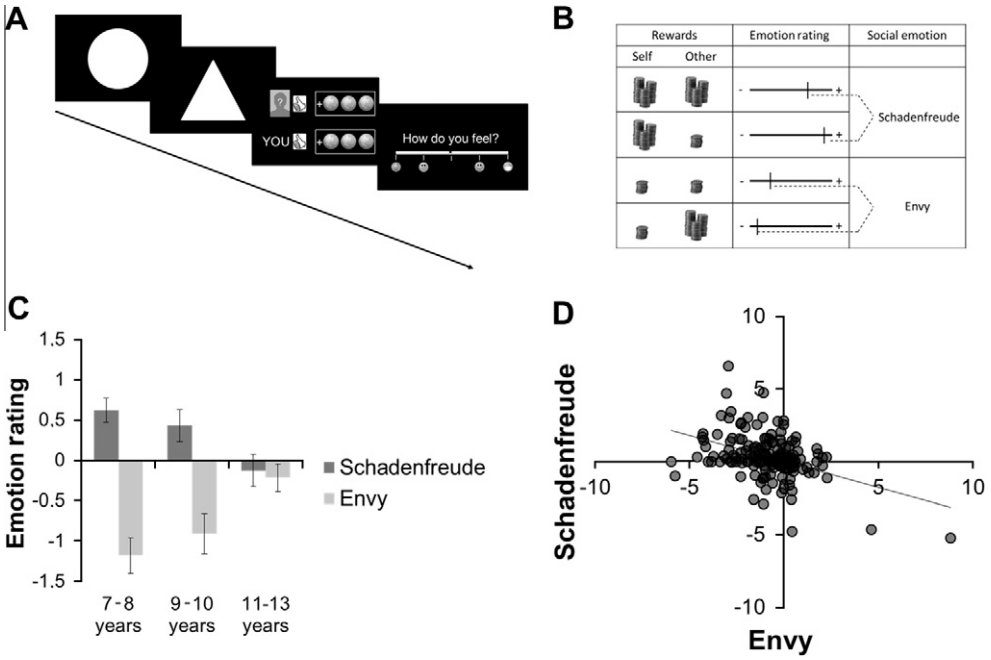

Fig. 1. Paradigm, operationalization, and effects of envy and Schadenfreude. (A) Speeded reaction time used to induce emotions. (B) Operationalization of each social emotion as a function of the wins and losses incurred by self and other. (C) There was an age-related decrease in both envy and Schadenfreude in the sample of tested children. Error bars show standard errors of means. (D) There was a strong correlation between experienced envy and Schadenfreude.

circle either changed shape (triangle, square), changed size (large, small), or changed color (green, red), and children needed to press the space bar as soon as the change was detected, for which they had 1 s to do so. To avoid children pressing the space bar before the change, they were told to respond only to changes in shape or size and to inhibit a response for changes in color. False alarms incurred punishment by means of point deduction. Response speed was rewarded by gaining 4 tokens and punished by losing 4 tokens. This was provided as feedback on the screen for 5000 ms and accompanied briefly by the sound of a bell in the case of winning and the sound of a buzz in the case of losing, both of which were presented via a set of headphones (Sennheiser HD202).

Children first played a block of rounds in which only their own wins and losses were displayed on the screen (single condition) and then another block of rounds in which both their own and the competitor's wins and losses were displayed (double condition). In the double condition, children saw their own pay-off surrounded by a blue frame and the competitor's pay-offs surrounded by a green frame. No feedback was given on the response times.

Children played 14 rounds in the single condition and 30 rounds in the double condition. Wins and losses were predetermined within the experimental randomization such that there were always 6 of each trial type, with the additional trials consisting of no-go trials. After each trial, children had 5000 ms to indicate by means of an analogue scale how happy or sad they felt about the specific outcome of a given round. This was done by using the left and right arrow keys to move a little star along a horizontal bar toward either a happy face or a sad face on each side and with a neutral point in the middle. (In some trials, children were also asked to rate how they thought the other player felt when winning and losing. These data will be reported elsewhere.) Prior to each block, children played several practice trials to get used to the task and the rating. Control questions ensured that all children had fully understood the nature of the task (see Appendix).

Schadenfreude was estimated by measuring how participants' affective ratings when winning were influenced by seeing the other player either win or lose. It was operationalized as participants feeling

Table 1
Choice options (A and B) for each of the three games used to measure equity-related decisions as well as the decision-making profiles resulting from the combination of choices (A and B) in the three games.

Game	Choice options				Decision-making profiles				
	Choice A		Choice B		Strongly inequity averse	Weakly inequity averse	Strongly generous	Weakly generous	Spiteful
	Self	Other	Self	Other					
Prosocial	1	1	1	0	A	A	A	A	B
Sharing	1	1	2	0	A	B	A	B	B
Disadvantageous inequality	1	1	1	2	A	A	B	B	A

better on trials when winning and seeing the other player lose compared with trials when winning and seeing the other player also win. To compute this, ratings given in the self win/other win condition were subtracted from ratings given in the self win/other loss condition. Envy, in turn, was estimated by measuring how participants' affective ratings when losing were influenced by seeing the other player win or lose. It was operationalized as participants feeling *worse* on trials when losing and seeing the other player win compared with trials when losing and seeing the other player also lose. To compute this, ratings given in the self loss/other loss condition were subtracted from ratings given in the self loss/other win condition (see Fig. 1B).

Equity games

The procedure for this part was closely matched to that described previously (Fehr et al., 2008). Children played three games, and in each one they could choose between an equal or unequal division of tokens between themselves and an unknown child (see Table 1). The unknown child was introduced as belonging to another school and that, like the participants, he or she would be able to choose from the gifts laid out on the table. In the first game (prosocial game), children could choose between an equal allocation for themselves and the other child (1,1) and an allocation biased to themselves (1,0). This game measures basic prosociality because benefits can be delivered at no personal cost. In the second game (disadvantageous inequality game), children could choose between the allocation of (1,1) and that of (1,2). Again, in this game, it is possible to deliver a benefit at no cost. Together with the first game, it allows for teasing apart if someone is interested in creating equality by choosing the (1,1) option in both cases or merely wants to have more than the other, thereby choosing (1,0) in the first game and (1,1) in the second game. In the third game (sharing game), children could choose between the allocation (1,1) and that of (2,0). This game measures a strong form of inequity aversion because providing the other with a benefit incurs costs.

Individual decision-making profiles were derived based on the combination of choices made on each game (see Table 1 for an overview). Participants could be classified as strongly inequity averse [choosing (1,1) on all options], weakly inequity averse [choosing (1,1) on all but the sharing game, where equality is costly], strongly generous (maximizing the other's outcome in every game), weakly generous (maximizing the other's outcome in the prosocial and disadvantageous inequality games but not in the sharing game), and spiteful (minimizing the other's outcome in every game). It is important to understand that it is the combination of choices on all three games, and not choices on one single game, that gives rise to these profiles. Thus, for instance, statements made with regard to spite refer to the decision-making profile reflecting such a preference as opposed to a particular emotion while making the decision. The order of games was counterbalanced across participants. Careful explanation and control questions ensured that all children had fully understood the nature of the task (see Appendix).

Results

For the sake of comparability with previous studies using some of the same paradigms, we analyzed the data by age groupings used previously (Fehr et al., 2008).

Envy and Schadenfreude task

Single condition

Emotion ratings in the envy and Schadenfreude task were subjected to a repeated-measures mixed analysis of variance (ANOVA). Effects of gains and losses in the absence of the other's pay-off were looked at first (single condition) with the factors *gain* (gain/loss) and *age* (7–8 years/9–10 years/11–13 years). There was a main effect of gain, $F(1,171) = 675.886$, $p < .01$, $\eta_p^2 = .798$, indicating significantly different ratings for gains ($M = 7.29$, $SD = 0.19$) than for losses ($M = -3.71$, $SD = 0.33$). There was also a significant interaction between the factors gain and age, $F(2,171) = 8.111$, $p < .01$, $\eta_p^2 = .087$, indicating that the strength of ratings in the single condition decreased with age. Separate analyses of ratings for gains and losses revealed that the age decrease in ratings was found only for gains, $F(2,173) = 15.216$, $p < .01$, $\eta_p^2 = .15$, and not for losses ($p > .10$). These data show that the current paradigm was successful in inducing separable effects of positive and negative emotions in response to winning or losing in a competitive speeded reaction time task.

Double condition

To test for an effect of the other's pay-off on ratings of wins and losses (double condition), a repeated-measures mixed ANOVA with the factors *self* (self win/self loss), *other* (other win/other loss), and *age* was conducted. There was a significant effect of the factor self, $F(1,171) = 891.239$, $p < .01$, $\eta_p^2 = .84$, as well as an interaction between the factors self and age, $F(1,171) = 9.095$, $p < .01$, $\eta_p^2 = .097$, suggesting that ratings for one's own wins and losses also decreased with age in the double condition. In addition, there was a significant effect of the factor other, $F(1,171) = 32.193$, $p < .01$, $\eta_p^2 = .159$, indicating that the competitor's wins and losses affected one's own emotion ratings, which also decreased with age, as indicated by a significant interaction between the factors other and age, $F(1,171) = 7.215$, $p < .01$, $\eta_p^2 = .078$. Furthermore, there was a significant interaction between the factors self and other, $F(1,171) = 12.700$, $p < .01$, $\eta_p^2 = .07$, indicating that effects of the other's wins and losses were stronger on participants' ratings when the children themselves had lost compared with when they had won. This implies that the effects of envy were stronger than the effects of Schadenfreude, a factor that did not interact further with the factor age. Given this interaction, we carried out separate analyses for the two social emotions.

Effects of envy and Schadenfreude

For gains, analyses were conducted using the factor *Schadenfreude* (self win/other win or self win/other loss) and *age*. For losses, analyses were conducted using the factor *envy* (self loss/other loss or self loss/other win) and *age*. There was a significant effect of Schadenfreude, $F(1,171) = 9.166$, $p < .01$, $\eta_p^2 = .051$, as well as envy, $F(1,171) = 38.872$, $p < .01$, $\eta_p^2 = .186$. Importantly, there was an interaction with the factor age for both Schadenfreude, $F(2,171) = 4.240$, $p < .05$, $\eta_p^2 = .047$, and envy, $F(2,171) = 5.640$, $p < .01$, $\eta_p^2 = .062$, revealing a decrease in both with age (see Fig. 1C). When controlling for individual differences in emotional response to winning and losing in the single condition, effects of envy remained significant (main effect of envy: $F(1,166) = 24.795$, $p < .01$, $\eta_p^2 = .13$; interaction between envy and age: $F(2,166) = 7.060$, $p < .01$, $\eta_p^2 = .078$), whereas those of Schadenfreude did not or only marginally did so (main effect of Schadenfreude: $p > .10$; interaction between Schadenfreude and age: $F(2,166) = 2.846$, $p < .10$, $\eta_p^2 = .033$). In addition, we found a significant correlation between envy and Schadenfreude scores ($r = -.424$, $p < .01$), suggesting that the same children who had a tendency to feel strong feelings of envy were also those who experienced more Schadenfreude (see Fig. 1D, upper left quadrant, for effects of envy and Schadenfreude). This correlation was equally strong for all age groups, as indicated by a nonsignificant interaction with the strength of the correlation between envy and Schadenfreude and age, $F(3,172) = 2.744$, $p < .10$.

Equity games

To look at age-related changes in the context of the three games testing for equity-related decision making, choices made in each game were subjected to logit regressions. There was a significant increase in inequity-averse choices in both the prosocial game ($\beta = -0.916$, $SE = 0.238$, $Wald = 14.841$,

$p < .01$) and the sharing game ($\beta = -0.687$, $SE = 0.275$, $Wald = 6.245$, $p < .05$), but not in the disadvantageous inequality game (see Fig. 2A). Using the previously established decision-making profiles, we could show that there was an increase in strong inequity aversion with age ($\beta = -1.283$, $SE = 0.503$, $Wald = 6.508$, $p < .05$) as well as a decrease in spite with age ($\beta = 0.880$, $SE = 0.244$, $Wald = 12.971$, $p < .01$) (see Fig. 2B).

Envy and Schadenfreude and equity games

To investigate the predictive relationship between social emotions as measured by the envy and Schadenfreude task in classifying subjects into their decision-making profile, we performed regression analyses. Given that we predicted a specific link between envy and Schadenfreude and spite, we tested the hypotheses of whether greater Schadenfreude and envy are linked to a greater likelihood to behave spitefully. A logit regression revealed that individual differences in envy could successfully predict individual differences in spiteful choices, whereby more envious individuals in the envy and Schadenfreude task were more likely to also behave spitefully in the resource allocation paradigms ($\beta = 0.445$, $SE = 0.147$, $Wald = 9.131$, $p < .01$) (see Fig. 3A), which persisted when controlling for age ($\beta = 0.389$, $SE = 0.153$, $Wald = 6.49$, $p < .05$). We could also show that individual differences in Schadenfreude were predictive of individual differences in spiteful choices, whereby individuals with greater

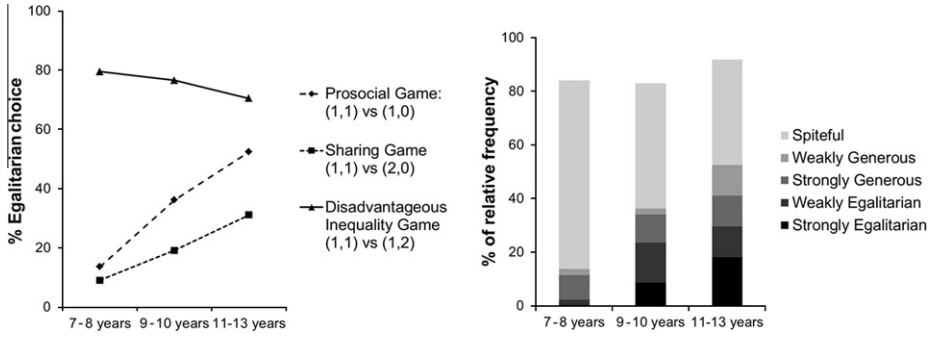

Fig. 2. Behavior in the decision-making task. (A) Percentage of children who made inequity-averse choices for each age group and for each of the three games. There was an increase in inequity-averse choices in both the prosocial and sharing games. (B) Decision-making profiles constructed on the combination of choices made in the three games for each of the three age groups. There was an increase in inequity-averse decisions with age as well as a decrease in spiteful decisions with age.

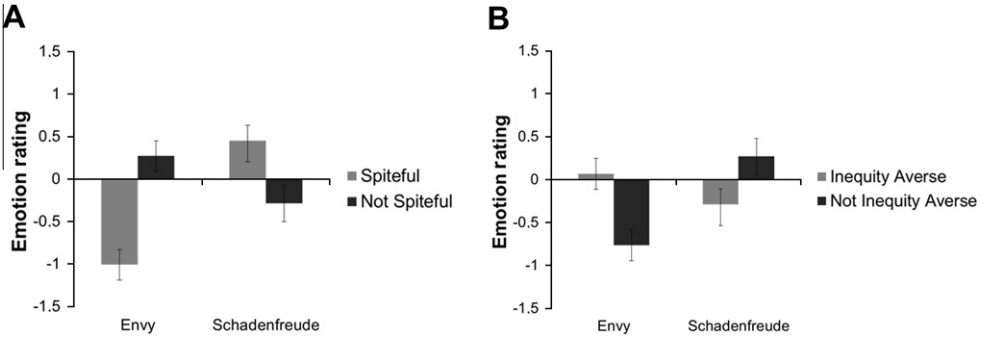

Fig. 3. Envy and Schadenfreude scores for children classified as either spiteful or inequity averse. (A) Those classified as spiteful were significantly more envious and showed more Schadenfreude than those classified as not spiteful. (B) Those classified as inequity averse were significantly less envious than those classified as not inequity averse.

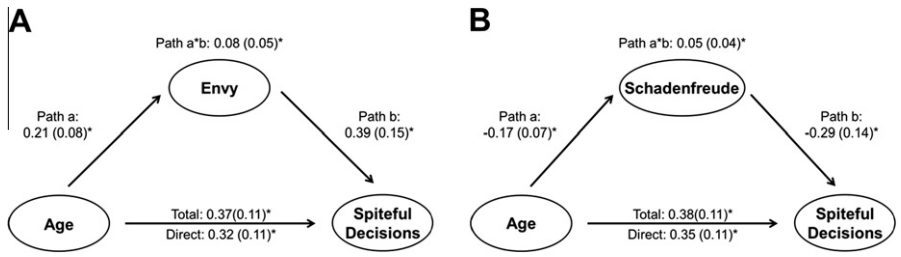

Fig. 4. Mediation models for the effects of age on spiteful decisions via social emotions. Values are standardized regression coefficients, and asterisks indicate significant coefficients (*$p < .05$). (A) Feelings of envy significantly mediated age effects on spite. (B) Feelings of Schadenfreude significantly mediated age effects on spite.

Schadenfreude were more likely to also behave spitefully in the resource allocation paradigms ($\beta = -0.356$, $SE = 0.141$, $Wald = 6.352$, $p < .05$) (see Fig. 3A), which also persisted when controlling for age ($\beta = -0.288$, $SE = 0.144$, $Wald = 4.003$, $p < .05$). We also tested for explanatory power of individual differences in envy and Schadenfreude for the other decision-making profiles (strong and weak inequity aversion, strong and weak generosity). None of these relationships was significant. However, given the low incidence of inequity aversion in the current population, we pooled strong and weak inequity-averse participants to test for an association between our measures of social emotions and inequity aversion per se. A logit regression revealed that individual differences in envy could successfully predict individual differences in inequity-averse choices, implying that less envious individuals were also more likely to opt for inequity-averse choices ($\beta = -0.276$, $SE = 0.137$, $Wald = 4.046$, $p < .05$) (see Fig. 3B), which remained marginally significant when controlling for age ($\beta = -0.229$, $SE = 0.137$, $Wald = 2.79$, $p < .10$). This link was not found for Schadenfreude and inequity aversion.

We had also hypothesized a possible relationship between age-related changes in social emotions and equity-related decisions, so that we tested for whether the observed age effects on envy and Schadenfreude might explain the age-related changes observed in spiteful and inequity-averse decisions. A significant mediation would imply that the observed age-related decrease in envy and Schadenfreude could account for the age-related decrease in spiteful decisions and possibly also the increase in inequity aversion. To do so, we conducted mediation analyses where age was the predictor, envy and Schadenfreude were the mediators, and spiteful or inequity-averse choices were the outcome variables. Analyses were conducted using bootstrapping procedures recommended for smaller samples and dichotomous outcome variables (Preacher & Hayes, 2004) and operationalized in an SPSS Macro (Preacher & Hayes, 2008). We used 10,000 bootstrap resamples of the data with replacement. Statistical significance with alpha at .05 is indicated by the 95% confidence intervals not crossing zero. As in previous analyses, we treated envy and Schadenfreude separately, assuming that convergent results would be found. We found a significant mediation effect of envy with respect to the relationship between age and spiteful choices (indirect effect = .18, $SE = .11$, 95% confidence intervals = .037, .47) (see Fig. 4A) and found no such effect for inequity-averse choices. We also found a significant mediation effect of Schadenfreude with respect to the relationship between age and spiteful choices (indirect effect = .13, $SE = .08$, 95% confidence intervals = .015, .37) (see Fig. 4B) and again found no such effect for inequity-averse choices. In each case, mediation was partial, meaning that the direct effect of age alone could still predict significant portions of the variance observed in spiteful decisions. This suggests that age-related differences in social emotions may be one important underlying mechanism but not the only one driving observed age-related decreases in spite.

Discussion

Using a novel experimental task, we demonstrated a marked decrease with age in both envy and Schadenfreude. Our findings show that these two social emotions are highly correlated in our sample of children, suggesting that Schadenfreude and envy are already closely linked emotions early in development. Crucially, individual differences in envy and Schadenfreude predicted whether

participants behaved spitefully or inequity averse in their distribution of economic goods. Furthermore, we found that the age-related decreases in spiteful decisions were mediated by age-related decreases in envy and Schadenfreude. Our findings demonstrate that individual differences in the experience of social emotions can predict individual differences in choice profiles in social decision making and can explain age-related changes in prosocial behavior.

The observed age-related decrease in envy remained significant even after controlling for emotional ratings made in response to losses in the single nonsocial conditions, suggesting that emotional engagement per se in the task cannot explain the current effects of envy. In contrast, Schadenfreude appears to necessitate a certain degree of emotional engagement to occur. This implies that making tasks sufficiently emotionally engaging is a necessary prerequisite to observe differential effects of social comparison on measures of subjective emotional experience. One explanation for the observed age-related decrease in envy might be that its occurrence might actually decrease with age. This seems very unlikely, however, because previous studies have shown that adults continue to experience envy when others perform better than them on monetary reward and punishment tasks (Dvash, Gilam, Ben-Ze'ev, Hendler, & Shamay-Tsoory, 2010) as well as personally relevant attributes (Takahashi et al., 2009) and feel Schadenfreude when others perform worse (Takahashi et al., 2009). As such, the observed decrease in envy and Schadenfreude might not reflect a decrease in the capacity to experience these emotions; instead, it might reflect a decrease in their regulation. Accordingly, children become increasingly aware of the negative consequences of social comparison (Pomerantz et al., 1995). This explanation is bolstered by the fact that emotion regulation abilities improve with age and especially during childhood (Eisenberg, 2000; Levesque et al., 2003). With the help of neuroimaging techniques, this hypothesis of age-related changes in the regulation of social emotions could be explicitly tested. Those brain regions coding for social emotions, such as the ventral striatum (Takahashi et al., 2009), should show age-related differences in activation patterns and functional connectivity profiles (Wager, Davidson, Hughes, Lindquist, & Ochsner, 2008) when there is a greater demand for regulation, as could be the case when needing to give an overt response. In the absence of such a demand, age differences would be expected to disappear.

Even though our sample of children was considerably older than those of previous studies testing for the development of inequity aversion (Fehr et al., 2008; Moore, 2009), we nonetheless replicated the developmental pattern of age-related increase in inequity aversion and decrease in spiteful decisions. The behavior of our youngest group was considerably more selfish in both the prosocial and sharing games than that of same-age children tested in prior studies (Fehr et al., 2008). One key difference between the two paradigms was the currency used (sweets vs. toys), suggesting that the nature of incentives is a sensitive and significant issue when instantiating paradigms for the study of social and economic decision making in children (Blake & Rand, 2010).

The link between social emotions and equity-related decisions was such that those individuals with strong social emotions made spiteful decisions. Those with weak social emotions, on the other hand, went for inequity-averse decisions. Our finding of a mediated age-related decrease in spiteful decisions through an age-related decrease of envy and Schadenfreude suggests that the developmental roots of equity-related behavior may lie in ontogenetic changes in the experience of social emotions during interactions with others. It is important to point out that the currently used decision-making profiles do not differentiate between advantageous inequity and disadvantageous inequity (Blake & McAuliffe, 2011) and that in the current study inequity aversion conflates the two types. Therefore, it remains an open and interesting question what the relationship between social emotions and various types of inequity aversion might be.

This study has presented the experience of social emotions as an explanatory mechanism for previously reported age-related changes in inequity aversion. In addition, these data show that children already from approximately 7 years of age appear to anticipate the affective consequences of their actions when deciding to allocate resources and act in line with individual differences in their propensity to feel envy and Schadenfreude. Interestingly, the strongest significant relationship between social emotions and decision-making patterns was observed for spiteful decisions and for inequity aversion only when extending the criteria for inclusion of weak inequity aversion. This may be partially explained by the much lower incidence of inequity-averse children, particularly in our two youngest groups (0% and 8.5%, respectively), possibly masking the existence of a strong association with social

emotions. Adjusting the incentives to obtain a greater spread of each decision-making type would help to test whether this link can be reliably extended to other decision-making profiles and whether the observed age-related increase in inequity aversion is also mediated by individual differences in social emotions.

The association between individual differences in the experience of envy and Schadenfreude and spiteful decisions also remained significant when statistically controlling for age. Thus, individual difference in our two social emotions could predict spiteful decisions above and beyond mediating the effects accounted for by age-related changes. This echoes recent findings in the development of social behavior, whereby impulse control abilities accounted for strategic social behavior as a function of both age-related changes in this ability and age-independent individual differences in impulse control (Steinbeis et al., 2012). These data imply that envy and Schadenfreude are important predictors of social behavior both as a developmental mechanism and as reflective of more general individual differences in disposition to feel these social emotions.

This study provides evidence for age-related changes in emotions arising out of social comparison and shows that both age-related and age-independent individual differences in the expression of envy and Schadenfreude were strong predictors for equity-related decisions during social exchange. This demonstrates that studying developmental changes in social emotions helps to explain choices made in social decisions, providing direct evidence of the utility of including affective processes in enriching our understanding of the development of human social behavior. Whereas the origin of the currently observed affective predispositions remains an open question, the fact that they appear relatively early in life and change throughout childhood suggests that these may be amenable to influence. This opens avenues for interventions that would help to regulate and overcome antisocial emotions in order to prevent harm to others.

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Appendix. . Experimental control questions

Envy and Schadenfreude task
Can you show me the happy smiley?
Can you show me the sad smiley?
Which smiley would you move the star to, to say that you are happy?
Which smiley would you move the star to, to say that you are sad?
What should you do when the blue dot changes size?
What should you do when the blue dot changes color?
What happens when you are faster than the other?
What happens when both of you are too slow?
Economic games
How many points do you get if you choose the first carton?
And how many does the other child get?
How many points do you get if you choose the second carton?
And how many does the other child get?

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