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Abstract

The understanding of emotions based on counterfactual reasoning was studied in children with high-functioning autism spectrum disorders (n = 71) and in typically developing children (n = 71), aged 6–12 years. Children were presented with eight stories about two protagonists who experienced the same positive or negative outcome, either due to their own action or by default. Relative to the comparison group, children with high-functioning autism spectrum disorder were poor at explaining emotions based on *downward* counterfactual reasoning (i.e. contentment and relief). There were no group differences in *upward* counterfactual reasoning (i.e. disappointment and regret). In the comparison group, second-order false-belief reasoning was related to children's understanding of second-order counterfactual emotions (i.e. regret and relief), while children in

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the high-functioning autism spectrum disorder group relied more on their general intellectual skills. Results are discussed in terms of the different functions of counterfactual reasoning about emotion and the cognitive style of children with high-functioning autism spectrum disorder.

Keywords
autism, counterfactual, downward, emotion, regret, relief, upward

Counterfactual reasoning involves imagining alternatives to one or more features of a perceived event (Epstude and Roese, 2008) and switching back and forth between a real situation and an imagined (counterfactual) one. Counterfactual reasoning is a pervasive psychological capacity influencing many domains of thinking and functioning (Roese, 1997). In recent years, the study of children's emotional understanding has moved into the domain of counterfactual reasoning. It has become clear that despite early appearing utilization of counterfactual thinking in preschool children (see Harris, 2000, but also see Beck and Guthrie, 2011, for a discussion), it is not until about 7 years of age that children reliably appreciate the emotional consequences stemming from the reflection on counterfactual possibilities. Such emotions serve various adaptive functions. They prepare us to be more cautious in future situations (e.g. "If only I had taken a different turn, I wouldn't have been caught in this traffic jam"), but also help to regulate current emotional states (e.g. "At least I wasn't in the accident [causing the traffic jam]") and are critical to properly understand people's complex, but nonetheless ordinary, emotional responses to events (Roese, 1997). Understanding these complex emotional sensitivities is likely to be difficult for children with autism, even when they show normal intelligence (see Begeer et al., 2008, for a review). In the present study, we investigate the understanding of emotions based on counterfactual reasoning in children with typical development or autism spectrum disorders (ASDs), highlighting the different functions of such counterfactually based emotions (CF-emotions) and the capacities that are needed to appreciate these functions.

There are a number of distinctions that are helpful in the analysis of emotions based on counterfactual thinking (Roese, 1997). First, an important difference has been made in the literature between *upward* and *downward* counterfactual reasonings. Upward counterfactual reasoning involves comparing a current situation with a better alternative and is typically, although not exclusively, elicited by a negative situation. This type of reasoning serves an important preparative function. Comparing a situation with a better alternative provides an incentive to improve our future condition and thus modify our behavior (Roese, 1997). In the emotional domain, considering how things could have turned out more favorably generally elicits the feelings of disappointment, or even regret when we feel a high degree of responsibility (*high agency*) for the chosen course of action (Zeelenberg et al., 1998). Upward counterfactual reasoning has been related to problem-focused coping strategies, attaining control over negative events, and planning (White and Lehman, 2005), which can inspire us to "do better" next time. In Table 1, we schematically depict the simple features of downward and upward counterfactual thinking, illustrating relationships with outcome valence and agency.

Downward counterfactual reasoning involves comparing our current situation to a worse alternative, "looking on the bright side of life" (White and Lehman, 2005). While upward counterfactual reasoning is often used to improve future outcomes, downward counterfactuals are often used to improve how we feel about our current circumstances. Reflecting on how things might have turned out worse may induce contentment, or relief when we feel a high degree of responsibility (*high agency*) for preventing the negative situation (Guttentag and Ferrell, 2004). Compared with upward

Table 1. Schematic outline of main components related to upward and downward counterfactual thinking

	Downward counterfactual	Upward counterfactual
Comparing current situation to	Worse alternative	Better alternative
Main function	Affective, improving current emotional state	Preparative, improving the future
Related coping strategies	Emotion focused	Problem focused
Related emotion if caused by "near miss" (low agency)	Contentment	Disappointment
Related emotion if caused by own action (high agency)	Relief	Regret
Usage in daily life	Less frequent	More frequent

counterfactuals and the feeling of regret, the use of downward counterfactuals and the feeling of relief are not so clearly related to future action. Rather, these latter psychological responses provide a means of dealing with the current situation, which has been related to emotion-focused coping strategies (White and Lehman, 2005), and better quality of life (Bauer and Wrosch, 2011).

While the embedded structure of downward and upward counterfactuals is similar, the adaptive role of upward counterfactual reasoning, and its commonly related emotion of regret, has been emphasized more in the literature than downward counterfactual reasoning and relief (White and Lehman, 2005). The fear of regret has a pervasive impact on decision-making (Gilbert et al., 2004). Adults (e.g. Sanna and Turley, 1996) and children (German, 1999) use upward comparisons more frequently than downward comparisons, which may be due to the strong impetus for using counterfactual thinking in negative situations (Harris, 2000).

A second distinction that is useful for understanding emotions caused by counterfactual reasoning, which has been alluded to earlier, is the extent to which an individual feels a sense of agency in bringing about a situation or outcome. When someone is presented with an outcome for which there is little feeling of personal responsibility, but there is nonetheless a basis to imagine how the situation may have unfolded differently (e.g. an alternative situation is nearly experienced; a "near miss"), this may elicit simple emotional responses based on counterfactual reasoning, like contentment or disappointment. However, when someone feels more responsibility for bringing about an outcome, second-order emotions based on counterfactual reasoning become more common, such as regret and relief. Second-order emotions (sometimes also referred to as complex or self-conscious emotions) are those emotions that normally depend on a psychological appraisal of *another person*. Thus, second-order emotions, which include pride, jealousy, and embarrassment, cannot be understood merely in terms of an individual's current first-order mental attitudes (i.e. thoughts, beliefs, and preferences) or situational determinants. Instead, second-order emotions require a *contrasting* psychological appraisal, attribution, or perspective. Second-order emotions are generally understood later in typically developing children, while the understanding of such emotions in children with ASD is relatively poor (Begeer et al., 2008).

Regret and relief may be particularly difficult to understand because they involve second-order, contrasting psychological appraisals as described earlier, but these are imaginations of *oneself at another time* and thus require counterfactual reasoning. For example, in the case of regret, an outcome (i.e. being stuck in traffic) and a protagonist's wishes/preferences (i.e. to be at work in time) need to be integrated with the intentions that underpinned the protagonist's decision at an earlier

time (i.e. choosing a particular route to get to work). During this process, one needs to appreciate the embedded nature of the protagonist's thoughts about how an alternative prior decision may have resulted in different outcomes. In the traffic example, a feeling of regret emerges when the protagonist infers events that unfold from imagining a "false" premise (e.g. having taken the *right* turn instead). When the counterfactual outcome (i.e. being on time) is inferred from the "false" premise, the resulting emotional response is positive (or neutral) and contrasts sharply with the frustration of being stuck in traffic. This contrast between two possible emotional outcomes requires second-order Theory of Mind. It is irrelevant that the protagonist is reflecting on his or her own mental states. Theory of Mind usually refers to inferring someone else's state of mind, but could just as well be directed at inferring one's own state of mind at other (imagined) times or contexts (Baron-Cohen et al., 2007). Thus, to make an emotion attribution such as regret or relief, the child needs to understand the role of the protagonist's reflection on his or her earlier intentions and decisions, which might have gone a different way and brought about a different emotional outcome. Simple emotional responses like contentment or disappointment can be inferred from the match between a person's wishes and the (positive or negative) outcome and do not require recursive inference.

In typical development, the first signs of counterfactual reasoning are seen during preschool. Two-year-olds already show some form of counterfactual understanding (Harris, 2000). For example, when a toy horse gallops toward the edge of a table and stops just in time, they can understand what "almost" or "nearly" happened (i.e. the toy horse falling off the table). By 4 or 5 years of age, children produce well-formed counterfactuals themselves (Beck et al., 2006). The ability to reason about counterfactuals has been linked to the acknowledgement of representational mental states in others, their Theory of Mind, which also occurs at about 4 years of age when children's folk psychological explanations start to explicitly refer to (false) beliefs (Baron-Cohen et al., 2007). The rationale here is that in order to be able to acknowledge the content of other people's mental states, or one's own mental states at a previous time, the *reality* of one's current mental states needs to be inhibited. This ability to disengage or suspend current knowledge can be considered a special form of counterfactual thinking (Riggs et al., 1998). While counterfactual reasoning emerges earlier than false-belief (FB) reasoning (Perner et al., 2004), both require children to understand that propositions may refer to entities (events and locations) that differ from current reality (Guajardo and Turley-Ames, 2004; Mueller et al., 2007).

In the emotional domain, there is some evidence that children as young as 5 years of age can acknowledge regret, not relief, in themselves (Weisberg and Beck, 2010), but they have considerably more difficulty explaining disappointment, regret, and relief in other people even at 7 years of age (Ferrell et al., 2009; Guttentag and Ferrell, 2004, 2008; Weisberg and Beck, 2010). At present, it is not clear whether children master simple emotions based on counterfactual reasoning (e.g. disappointment and contentment) before second-order emotions (e.g. regret and relief). From the point of view of Theory of Mind development, however, second-order emotions based on counterfactual reasoning should present a greater challenge for children because of the need to embed the imagined counterfactual possibility within an earlier psychological stance (i.e. previous intentions and decision).

While studies on the experience second-order emotions in autism are relatively scarce (but see Bauminger, 2004), children with ASD have repeatedly been shown to have limitations in their *understanding* of social or second-order emotions that are elicited by mental representations of reality or involve appraising one's self through the (imagined) evaluations of others. Thus, children with ASD show some difficulties in understanding surprise, shame, embarrassment, pride, and jealousy. Furthermore, such limitations have been consistently associated with broader deficits in

mental state reasoning (i.e. Theory of Mind; see Begeer et al., 2008). In keeping with this overall pattern, positive associations between Theory of Mind and counterfactual reasoning have also been documented in both typically developing (Guajardo and Turley-Ames, 2004) and ASD (Grant et al., 2004) children. Currently, however, it is not clear whether relations between Theory of Mind and understanding emotions based on counterfactual reasoning only entail for second-order emotions, or whether such relations are also found with simple emotions.

It is also unclear whether there is a systematic difference in children's understanding of upward (imagining a better outcome) and downward (imagining a worse outcome) counterfactuals in the context of reasoning about emotional outcomes. Of relevance to this distinction, Guttentag and Ferrell (2004) showed that 7-year-old children more readily recognized regret (upward) in a negative situation than relief (downward) in a positive or neutral situation. Furthermore, Guttentag and Ferrell (2008) report that in the context of a negative outcome, 7-year-olds and 8-year-olds could express regret and disappointment (utilizing upward counterfactuals), but there were few instances of downward counterfactual use (i.e. "things could have been worse") until 9 years of age. Such findings are in line with the adult literature, in which counterfactual reasoning is more commonly utilized when outcomes are negative (Beck and Crilly, 2009; Roese, 1997; Weisberg and Beck, 2010), and negative situations more strongly afford upward counterfactual reasoning (White and Lehman, 2005).

Interestingly, children with ASDs have been found to be quite skilled at reasoning about counterfactual realities. When asked to generate an outcome based on an explicitly presented counterfactual statement (e.g. I have a story where all cows go "Quack." Freda is a cow. In my story, does Freda say "Quack"?), intellectually disabled (ID) individuals with ASD were equally able as controls to generate the correct consequence (i.e. Yes, Freda says "Quack"), despite its stark contrast with reality (Leevers and Harris, 2000; Peterson and Bowler, 2000; Scott and Baron-Cohen, 1996). However, in these tasks, the correct answer could be inferred deductively from the premises. In contrast, when presented with stories and given open-ended questions, for which the correct answer cannot be deduced from the premises, children with ASD and ID are less able to generate novel alternative resolutions (Grant et al., 2004). It is tempting to conclude, therefore, that children with autism are capable with counterfactual reasoning so long as they do not have to speculate, imaginatively, on possible alternative outcomes that are not implied in a given scenario. However, when open-ended questions were given to 6–12-year-old normally intelligent children with ASD (high-functioning autism spectrum disorder (HFASD)), their ability to generate counterfactuals was on par with typically developing children (Begeer et al., 2009). On the basis of the extant literature, it is not known whether HFASD children are attuned to the affective consequences of comparing factual and counterfactual realities. Indeed, it is plausible that they do not experience difficulties reasoning from counterfactual premises per se, so it is important to establish how they use such capacities to understand others.

When reasoning about CF-emotion, there may be specific situational characteristics that differentiate HFASD and typically developing children, in particular when the domains of direction (upward versus downward) and agency (high versus low) are considered. First, it could be argued that children with HFASD, who are able to understand the situational components of emotions (Begeer et al., 2008), and can generate counterfactual alternatives to reality (Begeer et al., 2009), should be able to reflect on the counterfactual basis of simple emotions like disappointment and contentment. However, their widely described limitations with Theory of Mind and second-order emotion attributions would hypothetically impair their understanding of the counterfactual basis of second-order emotions like regret and relief, which requires the child to conceptualize the protagonist reflecting on the motivations and intentions that constituted his or her previous decision (Zeelenberg et al., 1998).

Furthermore, the nuanced functional features of downward CF-emotions may be less compelling to children with HFASD when compared to typically developing children. Upward comparisons are generally more common than downward counterfactuals (White and Lehman, 2005). They are usually triggered by negative situations ("if only ..."), which directly entail the modification of one's actions or circumstances in the future. This pragmatic, preparative function of upward counterfactual reasoning stands in contrast to the less pragmatic role of downward counterfactuals ("things could have been worse"), which primarily provide a mechanism for dealing with the current situation by modifying one's perspective. Generally speaking, the impetus to modify a positive outcome is not as compelling as the impetus to modify a negative outcome, which is likely the main reason for the lower prevalence of downward counterfactuals (Harris, 2000). Children with HFASD, who are usually less focused on internal psychological processes, may be less appreciative of these internal psychological mechanisms that are not related to clear outcomes (Lombardo et al., 2007).

In the present study, we focused on the understanding of CF-emotions in children with and without HFASD (6–12 years old). Following Guttentag and Ferrell (2004, 2008), we described two protagonists who experienced identical outcomes, with stories that have been previously used in the literature where possible. For one (*target*) protagonist, a counterfactual alternative was available that would have resulted in a different outcome. Depending on whether the story protagonists were responsible for the outcomes, the stories elicited simple or second-order emotions. In addition, depending on the positive or negative nature of the outcome, the stories were intended to elicit downward or upward counterfactual reasoning, respectively, as has been previously documented in the literature (Roese, 1997). In all stories, children were asked to judge whether one protagonist would feel "better," "worse," or "the same" about the outcome compared to the other protagonist, and explain why.

In line with the general literature, we expected that there would be an age-related improvement across the CF-emotion tasks. Based on their adequate understanding of counterfactual outcomes and situational causes of emotions, we expected children with HFASD to perform at similar levels to typically developing comparison children in the simple counterfactual emotion tasks. However, based on their documented limitations in second-order reasoning, we expected children with HFASD to show limitations in their explanations of second-order counterfactual emotions. Furthermore, we explored the role of negative outcomes, which are likely to provide different triggers for counterfactual reasoning in children with and without HFASD. Specifically, we predicted that HFASD children would be less likely to employ downward counterfactuals than typically developing children. Finally, the role of second-order Theory of Mind understanding in the explanation of CF-emotions was explored in children with HFASD and typically developing children separately.

Method

Participants

The participants were 71 children with HFASD (64 boys and 7 girls), and 71 typically developing children (67 boys and 4 girls), aged 6–12 years. Active parental consent was obtained for all the participating children. The HFASD group included 45 children with pervasive developmental disorder—not otherwise specified (PDD-NOS) and 26 children with Asperger's syndrome. The diagnostic classification of the children with HFASD was established by a team of clinicians working independently of the authors and blind to the outcomes of the current study. The

diagnostic assessment procedures were according to the established *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed., text revision (*DSM-IV-TR*) criteria (American Psychiatric Association (APA), 2000) of expert clinical judgment, involving multiple experienced clinicians, including child psychiatrists, psychologists, and educationalists. The diagnostic process included anamneses and examinations of psychiatric, neuropsychological, and logopedic functioning. None of the high-functioning autistic children had codiagnoses of additional disabilities (e.g. intellectual disability and deafness). Groups were similar in racial and ethnic compositions. The autistic group was 95% Caucasian, 1% Asian, and 4% African. Participants in the comparison group were also mostly Caucasian (91%), Asian (3%), and African (6%). Children were primarily from middle-class and upper-middle-class families. All children came from families whose sole, or first, language was Dutch.

Because this research involved a language-based task, groups were matched as closely as possible on the basis of their full-scale intelligence quotient (IQ) as well as gender and chronological age (Table 2). Intelligence measures were obtained in a separate session, through administration of the Dutch version of the Wechsler Intelligence Scale for Children III (WISC-III; Kort et al., 2002). There were no significant group differences in chronological age, full-scale IQ, or gender ratio.

Materials

CF-emotion tasks. Eight stories were used, two for each CF-emotion type, derived from Guttentag and Ferrell (2004, 2008) (see also Beck and Crilly, 2009). All scenarios involved two protagonists who experienced the same outcome (i.e. both either achieve or do not achieve what they desire). For the target protagonist, a counterfactual alternative was available that would have resulted in a better (upward) or worse (downward) outcome. In the simple stories, emotions were elicited by highlighting that the target protagonist *nearly* attained a positive or negative outcome. The near attainment of the outcome was intended to elicit disappointment (when a positive outcome was avoided) or contentment (when a negative outcome was avoided). In the second-order emotion stories, a target protagonist always made an *active decision* that led to the avoidance of a positive or negative outcome. This was intended to elicit regret or relief. At the end of each story, children were reminded of the outcome and of the critical element of the story that differentiated the two protagonists. Following this, children were asked whether one protagonist would feel "better," "worse," or "the same" about the outcome compared to the other protagonist and explain why (see Appendix 1 for examples).

Table 2. Participant age (years; months) and full-scale IQ

		Chronological age			Full-scale IQ		
		M	SD	Range	*M*	SD	Range
6–8 years	Comparison (*n* = 24)	7;5	0;5	6;5–8;1	100.0	13.4	79–128
	HFASD (*n* = 21)	7;2	0;6	6;1–8;0	97.4	12.4	75–117
8–10 years	Comparison (*n* = 21)	8;9	0;5	8;2–9;9	102.4	11.7	78–121
	HFASD (*n* = 21)	8;9	0;5	8;1–9;9	107.0	14.2	84–145
10–12 years	Comparison (*n* = 26)	11;2	0;7	10;1–12;2	108.9	16.9	70–139
	HFASD (*n* = 29)	11;0	0;8	10;1–12;8	104.0	15.9	78–138

IQ: intelligence quotient; SD: standard deviation.

Second-order FB task. A second-order FB story was derived from Sullivan et al. (1994). A series of probe and control questions were asked to ensure that the child was following the story. After each probe or control question was answered, feedback or correction was provided to the child. Finally, the second-order FB question was asked, and the child was prompted to justify his or her response.

Procedure

Children were tested individually in a quiet part of their school, during a 20-min session. The WISC-III was administered in a separate session, within 2 weeks before or after the CF-emotion stories. All sessions were audio taped and transcribed later. The counterfactual stories were presented in counterbalanced order. The transcriptions were scored by two independent coders (graduate students).

Scoring

CF-emotion tasks. Transcriptions were scored by two independent coders. Children who correctly judged that the protagonist who nearly attained a better or worse outcome would feel worse or better than the other protagonist, respectively, were awarded one point. When children judged that both protagonists would feel the same, or that the nontarget protagonist would feel better/worse, they received no points. Children who named the target protagonist and provided an explanation in which it was clear that they had thought about an alternative situation (i.e. what would have happened if the protagonist had not made an active decision or change in routine) were awarded an additional point. Thus, children received a score from 4 (based on two stories) for each type of CF-emotion. Interrater reliability was satisfactory (Kendall's τ ranging from .67 to .92). All disagreements were resolved by discussion.

Second-order FB task. Children were scored as passing the second-order FB task when they showed second-order reasoning, which included a response that acknowledged the understanding of the embedded thoughts of one protagonist on the thoughts of another protagonist, including an appropriate justification according to the taxonomy of Sullivan et al. (1994). Interrater reliability (Cohen's Kappa) was .99 for the second-order FB task.

Results

Results are presented in three sections. First, children's performance on the different story types and relations between stories are presented. Second, multivariate analysis of variance (MANOVA) was used to test for age and group differences in understanding CF-emotion and to examine the influence of direction and agency. Finally, relations between second-order FB understanding and CF-emotion were explored.

Mean scores for each story type (disappointment, contentment, regret, or relief) are presented in Table 3 and suggest that comparison of children performed better than their HFASD counterparts across all story types, although this difference was more marked for downward counterfactual stories (i.e. contentment and relief). Furthermore, children appeared to find the upward counterfactual stories (i.e. disappointment and regret) more difficult than the downward stories but, within each direction (i.e. upward and downward), they were better at making simple emotion attributions than second-order emotion attributions. Correlations between story types, controlling for age and full-scale IQ, revealed very different patterns for comparison and HFASD children (Table 4). For comparison children, there were robust positive associations between the upward stories (i.e.

Table 3. Mean (SD) scores for counterfactually based emotion responses (0–4)

	Disappointment	Contentment	Regret	Relief
Comparison	1.55 (1.51)	3.06 (1.39)	1.28 (1.15)	2.18 (1.46)
HFASD	1.28 (1.24)	2.35 (1.70)	1.13 (1.19)	1.45 (1.34)

HFASD: high-functioning autism spectrum disorders; SD: standard deviation.

Table 4. Correlations between different types of CF-emotion stories and second-order FB understanding, controlling for age and full-scale IQ

		Contentment	Regret	Relief	Second-order FB
Comparison	Disappointment	NS	.56**	NS	NS
	Contentment		NS	.35**	.29*
	Regret			.39**	.26*
	Relief				.31*
HFASD	Disappointment	.33**	.47**	.46**	NS
	Contentment		.43**	.48**	NS
	Regret			.42**	NS
	Relief				NS

IQ: intelligence quotient; NS: not significant; FB: false belief.
*$p < .05$, ** $p < .01$.

between disappointment and regret) and between downward stories (i.e. between contentment and relief), but not across the direction of the stories (i.e. no associations were found between disappointment and relief, or between contentment and regret). This speaks strongly to the conceptual grouping by direction. Also, the second-order emotion stories (i.e. regret and relief) were robustly positively correlated. By contrast, performance on all story types was similarly positively correlated for HFASD children, perhaps suggesting a more uniform approach to understand CF-emotions in the HFASD sample.

A 3 × 2 × 2 × 2 (age (6–8, 8–10, 10–12) × group (comparison, HFASD) × 2 direction (upward, downward) × 2 agency (simple, second order)) MANOVA showed main effects of the between-subject factors: age, $F_{(2, 136)} = 29.03$, $p < .001$, partial $\eta^2 = .30$, and group, $F_{(1, 136)} = 10.59$, $p < .01$, partial $\eta^2 = .07$. These results confirmed that older children were better able to understand CF-emotions, but that HFASD children performed less well than typically developing children. There were also main effects for the within-subjects factors direction, $F_{(1, 136)} = 93.03$, $p < .001$, partial $\eta^2 = .06$, and agency, $F_{(1, 136)} = 49.88$, $p < .001$, partial $\eta^2 = .27$, showing more adequate responses in the downward stories than the upward stories, and for the simple emotion stories than the second-order emotion stories. These main effects were, however, qualified by significant interactions between group and direction, $F_{(1, 136)} = 8.52$, $p < .01$, partial $\eta^2 = .06$, and between age and agency, $F_{(1, 136)} = 4.11$, $p < .05$, partial $\eta^2 = .06$. For the group × direction interaction, post hoc univariate ANOVAs showed that compared to the typically developing comparison group, the HFASD participants scored more poorly on the downward (contentment, $F_{(1, 136)} = 7.29$, $p < .01$, partial $\eta^2 = .05$, and relief, $F_{(1, 136)} = 9.72$, $p < .01$, partial $\eta^2 = .07$) but not the upward counterfactual stories. The age × agency interaction stemmed from a relative increase in the understanding of simple CF-emotions between the middle (8–10 years) and oldest (10–12 years) groups, whereas understanding second-order CF-emotions did not differ between these age groups, $F_{(1, 95)} = 7.41$, $p < .01$, partial $\eta^2 = .07$. Follow-up analyses were conducted to examine whether controlling for IQ,

or only analyzing participant's correct choices of protagonists, disregarding their ability to explain their response (which may be related to verbal skills), yielded the same main and interaction effects. The overall pattern of findings was unchanged.

Children generally performed well on the second-order FB task, as would be expected among these older ages. Despite the fact that comparison and HFASD children did not differ on age or IQ, HFASD children did perform more poorly on the second-order FB task ($M = .54$, standard deviation (SD) = .50) than comparison children ($M = .74$, SD = .44), $F_{(1, 139)} = 6.59$, $p < .05$, partial $\eta^2 = .05$. Table 4 shows relations between CF-emotion and second-order FB understanding, controlling for age and full-scale IQ. For comparison children, there were modest positive associations between CF-emotions and second-order FB, with the exception of disappointment. By contrast, in the HFASD group, second-order FB reasoning was not related to understanding CF-emotions.

Finally, as a follow-up analysis, relations between full-scale IQ and CF-emotions were examined, controlling for age. In the HFASD group, full-scale IQ was positively correlated with all types of CF-emotions (disappointment, $r = .30$, $p < .05$; regret: $r = .37$, $p < .01$; contentment, $r = .24$, $p < .05$; relief: $r = .24$, $p < .05$). In contrast, IQ was *not* correlated with any of the CF-emotions in the typically developing comparison group.

Discussion

While many studies have highlighted the understanding of both basic and complex emotions in children with HFASD (Begeer et al., 2008), this study is the first investigation of understanding CF-emotions in children with HFASD. Results indicated that the ability to explain emotions based on counterfactual reasoning improved with age, and all children generally found simple emotions (i.e. disappointment and contentment) easier to explain than second-order emotions (i.e. regret and relief). Furthermore, children with HFASD achieved lower overall scores than typically developing children. Importantly, these findings showed that children with HFASD were not specifically impaired in understanding second-order emotions based on counterfactual reasoning, as was predicted, despite the finding that they were performing more poorly on the second-order FB task. Rather, the lower scores for children with HFASD were moderated by direction, such that there were specific deficits in their understanding of downward emotions (i.e. contentment and relief) relative to typically developing comparison children. This confirmed the prediction that children with HFASD would have difficulty reasoning from counterfactual alternatives when the outcome was positive (i.e. comparing the outcome to a more negative situations).

In the typically developing children, it is likely that direction is a salient differentiating feature within the stories. Thus, typically developing children performed best on the downward stories when compared to the upward stories and when compared to the performance of children with HFASD (Table 3). Furthermore, regarding relations between simple and second-order CF-emotion, there were robust positive associations within the upward domain and within the downward domain, but not between domains for the typical children. In stark contrast, children with HFASD were not sensitive to the directional specificity of the domains; relations within equally valenced domains were no more likely than relations between these domains (see Table 4). Taken together, these findings suggest that typically developing children are far more sensitive to the direction of the comparison between the outcome and the counterfactual possibility than their HFASD counterparts, who seem to rely on a more general principle of counterfactual reasoning that is applied relatively independently of situational constraints (Begeer et al., 2010).

In the "Introduction," it was argued that the nuanced functional features of downward CF-emotions may be less compelling for children with HFASD because the motivation to imagine

alternative negative outcomes in the context of a positive real outcome does not serve an obvious pragmatic function. In contrast, the tendency in both children and adults to think counterfactually when outcomes are negative has a clear preparative function (Beck and Crilly, 2009; Roese, 1997; Weisberg and Beck, 2010; White and Lehman, 2005) that is likely to be perceived by children with HFASD because of the obvious benefits of avoiding future negative situations. Our findings largely support this interpretation; the features of the downward stories were acknowledged more frequently by typically developing children than children with HFASD.

Downward counterfactual reasoning generally induces adding alternative negative events that did not occur ("I'm so lucky that I wasn't in that car accident") and may be only indirectly related to the current situation. This type of reasoning also implies the possibility of proactively regulating one's emotions, which may be problematic to children with HFASD (Begeer et al., 2007; Losh and Capps, 2006). However, in order to engage in upward counterfactual reasoning about an undesirable outcome, it may suffice to simply imagine that the negative outcome did not occur, subtracting it from reality ("If only there was no traffic jam!"). Previous findings in children with HFASD have indicated specific limitations in their ability to use additive counterfactuals, that is, to add information to a given outcome, rather than to subtract information (Begeer et al., 2008), which allows one to "think within the box," narrowing one's responses down to explicitly provided information (for further discussion, see also Begeer et al., 2007). An individual can subtract elements of a given situation that are already made explicit. This strategy does not require one to initiate new alternatives to reality and may come more naturally to children with HFASD (see also Kray et al., 2006).

While typically developing children were clearly sensitive to the direction of counterfactual comparisons, they were also influenced by the second-order nature of the stories; there were significant positive associations among second-order CF-emotion stories (i.e. regret and relief), and between these stories and the second-order FB task, a finding that is consistent with the existing literature (Perner et al., 2004; Riggs et al., 1998). In the HFASD group, regret and relief stories were correlated, as were all the stories, but they were not significantly associated with the second-order FB task. By contrast, for children with HFASD, all story types were associated with their IQ scores, while associations with IQ were wholly absent in the comparison group. These distinctive patterns of relations suggest that the ability to reflect on emotions in children with HFASD is likely mediated by general cognitive skills rather than specific mind-reading abilities. They may "work their way around" to get to the adequate response, deducing their explanation without relying on a full-blown understanding of other's mental states. The use of cognitive skills to deal with affective situations was first described by Hermelin and O'Connor (1985) as the "logico-affective state" (see also Begeer et al., 2011 and Peterson et al., 2005). Typically developing children, on the other hand, likely generalize their specific mental state understanding when reflecting on complex counterfactual determinants of emotions (see also Rieffe et al., 2007).

Strengths of the current study included a carefully matched sample of children with HFASD, and the simultaneous utilization of tasks that tapped two dimensions of counterfactual reasoning about emotion (i.e. direction and agency). Nevertheless, despite matching on age and full-scale IQ, children with HFASD did perform more poorly on the second-order FB task than their typically developing counterparts, and this may have accounted for the differential relations observed in Table 4. We think this possibility is unlikely however, because 54% of children with HFASD did pass the second-order FB task, which would indicate ample variation to reveal relations with CF-emotion understanding. The more likely interpretation is that for HFASD children, general IQ to some extent underpins both mental state understanding skills (second-order Theory of Mind and CF-emotion) but for typically developing children there is a greater differentiation between general cognitive capacity and mentalistic understanding of persons.

It is also important to note that despite our efforts to tap two dimensions of counterfactual reasoning about emotion and to base our stories on the existing literature, there are of course other kinds of counterfactual reasoning about emotion that deserve attention, in particular, downward reasoning in the case of negative outcomes (i.e. "things could have been even worse"), such as has been explored by Guttentag and Ferrell (2008), and children's spontaneous use of such reasoning. It is also noteworthy that the chosen stories were designed with the pragmatic aim of facilitating counterfactually based interpretations in children, they were not designed to minimize, for example, inter-story variation. Therefore, it is important to stress that whereas group-based comparisons are relatively straightforward, comparisons based on story type need to be interpreted more cautiously.

Finally, although we were able to test a large sample of children with HFASD, who were diagnosed based on extensive procedures following *DSM-IV-TR* criteria, we did not have access to the standardized diagnostic measures to confirm their diagnoses. Moreover, the absence of measures on executive function skills did not allow for us to focus on important additional factors in the understanding of regret and relief, such as working memory and inhibition (Drayton et al., 2011). In future studies, it will be important to delineate how the understanding of regret and relief may be related to real-life experiences and behavior in children with HFASD. Although children with HFASD have often been shown to have adequate conceptual understanding of emotions, the social cognitive understanding tasks used to asses these abilities often overestimates their actual level of functioning in real-life situations (Begeer et al., 2008). Following the recent studies in typically developing children (Weisberg and Beck, 2010), highlighting the link between understanding, experience, and behavior would be a next step in this line of research.

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Appendix 1

Example relief story and questions

Bill and Pete are going on a school trip. They are allowed to choose between going on a sports day in the playing fields or to a kids' museum. Bill wants to go to the museum. Pete chooses the sports day. When the teacher asks them what they chose, Bill says he wants to go to the museum. Pete changes his mind and also says he wants to go to the museum. On the day of the trip, it is pouring with rain. Children who chose to go to the sports day in the playing fields have to stay at school.

Questions: Who is happier about choosing the museum, Bill, who chose the museum right away, or Pete, who changed his mind, or do you think they are both equally happy? Why?

Example regret story and questions

Miriam and Susan go to the same school. Miriam usually takes the bus. Susan usually goes on her bike. Today, Susan decides to take the bus. Both Susan and Miriam are waiting at the bus stop but the bus does not come, and they have to wait a long time for the next bus. They both arrive at school very late.

Questions: Who is more annoyed with being late for school, Miriam, who usually takes the bus, or Susan, who usually goes by bike, or do you think they are both equally annoyed? Why?

Example disappointment story and questions

Both Tess and Rosie love to read. They often visit the library to borrow books. Tess has been waiting for one of her favorite books on cats, which has been on loan for a long time. Rosie has also been waiting on one of her favorite books on ghosts, but that is also on loan. That afternoon Tess and Rosie visit the library again. Rosie immediately sees that her favorite ghost book has not been returned yet. Tess goes to the animal book section and sees that somebody else is just taking her favorite cat book and walking away.

Questions: Who is more disappointed about not being able to loan their book, Rosie, who immediately saw that the ghost book was not there, or Tess, who saw someone else just take the cat book, or do they both feel the same? Why?

Example expectation story and questions

Joe and Phil are participating in a sprint competition. Joe has already won a gold medal twice. Phil has never won a medal. This time, Joe and Phil finish in exactly the same time, directly behind another boy who won the race. They both are in the second place, and they both get a silver medal.

Questions: Who is happier with his medal, Joe, who has won gold medals before, or Phil, who has never won a medal before, or do you think both of them are equally happy? Why?

(The original Dutch versions of the stories may be obtained from the first author (S.B.).)