THE MECHANISM OF EXTERNALIZING BEHAVIOR UNCOVERED:

The effect of a combination of neuropsychological deficits in the development of externalizing behavior in a sample of children with an extra X chromosome

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Preface

This thesis would not have been possible without the time, effort and support of many people around me, for whom I am grateful. First of all I would like to thank my supervisor, Sophie. Having to switch projects halfway through the year took quite some (mental) flexibility from both of us. Thanks to your inventiveness and the interesting brainstorming sessions we had I still got to study exactly what I wanted: aggression in children and its relation to brain functioning. I am grateful for the freedom I got and your feedback on how to structure my thesis properly. I would also like to thank all the children and their parents for being willing to invest their time and energy into the data collection. Without them this thesis would not have been possible. Next, I want to thank my parents for making studying such a care-free period of my life and for never failing to express their support and faith in me. I also want to thank my dear friends – sometimes far in distance but always close at heart – for their thoughts, for being there for me, and for sometimes just ignoring the whole subject of my thesis altogether. Gemma and Lisette, my 'reseach-matties', thanks to you the past two years have been so much fun. The past summer would not have been the same without our endless conversations, coffee breaks, your good advice and distracting songs. Last, I want to thank Mike for keeping me grounded and for continuously enlightening me with an alternative perspective.

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Abstract

This study seeks to uncover the externalizing behavioral phenotype of extra X chromosome children, and discover the role of emotion-regulation and executive functioning (EF) deficits in its development. Participants included extra X chromosome children (N = 29, 16 girls and 13 boys) and control children (N = 84, 33 boys, 51 girls). Ages ranged between 7 and 16 (M_{age} = 10;3, SD = 1;7). Externalizing behavior was assessed with the Child Behavior Checklist, the Cognitive Emotion Regulation Questionnaire assessed emotion regulation and two tasks of the Amsterdam Neuropsychological Tasks battery measured EF. To provide a detailed picture of overall social functioning of the participants the Social Skills Rating System was used. Results showed that extra X chromosome children show more externalizing behavior, more mental flexibility deficits and nearly significantly more rumination. In extra X chromosome children, externalizing behavior was positively related to inhibition deficits and to rumination levels. Emotion regulation and EF were not related but children exhibiting less rumination were more dependent on their EF in the prediction of externalizing behavior. Implications include evidence for the role of neuropsychological deficits in externalizing behavior and possible guidelines for the treatment of children with an extra X chromosome and externalizing behavior.

Keywords: externalizing problem behavior, emotion regulation, rumination, executive dysfunctioning, extra X chromosome

Introduction

The regulation of emotions appears to be a vital factor in everyday functioning. Emotions play an important role in social functioning and may serve a regulatory purpose in social interaction (Van Rijn, Van ‘t Wout & Spikman, in press). The importance of being able to regulate both positive and negative emotions is reflected in the diagnostic criteria for several forms of psychopathology (American Psychiatric Association, 2000). In more concrete terms: having difficulty regulating emotions is often a condition for receiving a diagnosis of psychopathology. Being able to regulate or control emotions therefore appears to be fundamental to adaptive functioning. For instance, the core difficulty for children showing particular forms of aggression may be their inability to regulate strong negative emotions such as anger (Mullin & Hinshaw, 2007).

More and more research is being conducted on the complex system of emotion regulation, in an attempt to identify the exact mechanism of emotion regulation and its role in the development of psychopathology. According to a great variety of studies, executive functioning (EF) is highly important in the regulation of emotions. Many studies have been conducted on the concept and development of executive functioning, each maintaining slightly different definitions of this umbrella term. For instance, in an attempt to operationalize EF and integrate the views of several theorists, Anderson, Anderson, Northam, Jacobs and Catroppa (2001), argue that EF encompasses three distinct but integrated components: attentional control, mental flexibility, and goal setting. Moreover, according to Zelazo and Cunningham (2007) executive functioning implies the formulation of ‘rules’ about a certain situation, maintaining those rules in the working memory and consequently acting upon them (Zelazo & Cunningham, 2007). Thus, acting upon rather simple rule systems, for

instance in response to a familiar or stereotypical situation, occurs at a low level of consciousness. By contrast, a higher level of consciousness is required in situations that involve more complicated rule systems, for example in new situations that require reflection and flexibility (Zelazo & Cunningham, 2007). EF literature differentiates between 'hot' and 'cool' executive functioning. 'Hot' executive functions are connected with motivationally significant situations and situations that involve the regulation of affect. By contrast, 'cool' executive functioning is elicited in more abstract and decontextualized problems (Zelazo & Müller, 2002). In other words, hot EF is used especially when emotions are involved. One might expect, then, that the regulation of emotion is primarily related to hot EF. However, in the process of emotion regulation both hot and cool EF is involved: hot EF is employed for the thoughts concerning a reward, and cool EF facilitates the mental representation of more abstract information related to the problem (Zelazo & Cunningham, 2007).

In addition, neuroimaging studies support the idea that EF and emotion regulation are two processes that are highly related. Several studies have shown that many of the same brain regions are involved in both emotion regulation and EF. For example, it has been suggested that the orbitofrontal cortex (OFC) is involved in the appraisal of motivationally significant stimuli (Rolls, 2004). Additional research has shown that patients with damage to their OFC show a diminished capacity to adjust their behavior to social norms and inappropriate social behavior. This seems to confirm the role of the OFC in both self-monitoring and emotional processing (Beer, John, Scabini & Knight, 2006).

Zelazo and Cunningham (2007) developed a model of emotion regulation in which they highlight the role of EF in the regulation of emotions. The authors argue that emotion regulation is closely linked – and may in some situations be highly

similar – to executive functioning. They argue that when your primary goal is to regulate your emotions EF is exactly the same as emotion regulation. However, when emotion regulation is required in order to solve another problem, EF merely involves emotion regulation. Their description of emotion regulation implies that it occurs in many different ways, but mostly through the deliberate regulation of emotions involving conscious cognitive processes that can be explained in terms of EF. Furthermore, they state that "successful emotion regulation is the deliberate, goal-directed attainment of a desired emotional state" (Zelazo & Cunningham, 2007, p. 152). In their model of emotion regulation Zelazo and Cunningham describe an example in which executive functions are needed to down regulate anger. Their model includes three steps. First, a person needs to represent the problem correctly by estimating the level of anger he or she is currently experiencing, and assess the options for reducing the discrepancy between its current state and its goal state. Second, the best option for reducing anger should be selected. During the third step the selected plan is executed. For instance, you could realize that there is a high level of anger, then select the option of distracting yourself from the stressor by doing something else, and finally execute this plan. Subsequently, EF is needed to monitor whether or not the efforts did in fact result in reducing anger (Zelazo & Cunningham, 2007).

Whereas the model described above mainly focused on emotion regulation as a conscious and deliberate action, other studies on emotion regulation maintain the distinction between deliberately controlling emotions on the one hand, and a form of automatic regulation on the other. At a conscious level emotions are proposed to be regulated by 'effortful control'. According to Posner and Rothbart (2000), effortful control entails the ability to suppress a response in order to perform a response that is

less automated. Their research has shown that effortful control is inversely related to negative affectivity such as anger, and that aggression is negatively related to effortful control. In other words, children that have more effortful control, show less anger and are less aggressive. They argue that children that score high on effortful control may be able to direct their attention away from a negative cue, and in doing so reduce the influence of the negative affect the cue evokes. At an unconscious or involuntary level emotions are regulated by reactive forms of control. On this level a person redirects attention away from a certain stimulus in an automatic and uncontrolled manner (Nigg, 2000). This involuntary regulation of emotion is more closely related to impulsivity, and may be influenced by individual differences in people's tendency to pay attention to certain stimuli (Eisenberg and Spinrad, 2004). In an attempt to summarize the models of emotion regulation described above, the core difficulty for children that score low on emotion regulation appears to be their inability to consciously and deliberately direct attention towards or away from a certain stimulus. In other words, the ability to flexibly shift attention from one stimulus to another appears to be fundamental to the ability to regulate one's emotions.

Difficulties in emotion regulation have been linked to several forms of problem behavior, especially – but not exclusively – to externalizing behavioral problems. Externalizing problem behavior is contrasted with internalizing problem behavior and involves such behaviors as anger, aggression, defiance, and antisocial actions, as well as impulsive and hyperactive behaviors. Alternatively, internalizing problem behavior includes patterns such as depressive behavior, social withdrawal, and somatic complaints (Achenbach, 1991). Eisenberg et al. (2001) have found that externalizing problem behavior could be distinguished from internalizing behavior by different types of emotion regulation. They found that children classified as

‘externalizing’, when compared with children with internalizing problems and non-disordered children, experienced more anger, but had less control over their behavior and emotions. In other words, Eisenberg et al. argue that externalizing children may act out because of unregulated anger and frustration. Results showed that externalizing children scored lower on both involuntary (reactive) forms of regulation and on effortful control. In addition, Eisenberg et al. (2000) conducted a study on the role of proneness to intense emotion in the mechanism controlling the transition between low emotion regulation and externalizing problem behavior. They showed that the relationship between emotional regulation and externalizing problem behavior was moderated by negative emotionality. Negative emotionality is described as the tendency to experience intense emotions, particularly negative emotions such as anxiety or fear. Their results showed that in children with strong negative emotionality the relationship between low emotional control and externalizing problem behavior was stronger.

Additionally, the domain of externalizing behavior can be divided into several sub-domains. An important distinction to be made, especially in the light of emotion regulatory mechanisms, is that between reactive and proactive aggression. Reactive aggression is characterized by an angry or defensive response to frustration or provocation. In contrast, proactive aggression entails more deliberate behavior, motivated by external rewards and oriented towards attaining a certain goal (e.g., Crick & Dodge, 1996). In reactive-aggressive children it appears difficult to disentangle the effect of cognitive deficits or tendencies from their difficulties with emotion regulation. Both emotion and (social) cognition play an important role in social situations but they are functionally different. Emotion as well as cognition facilitates the control of behavior, but emotions have a motivational function and

involve physiological changes (Van Rijn, Van ‘t Wout & Spikman, in press). Evidence has shown that unraveling both these processes might be crucial for a complete delineation of the development of psychopathology (Mullin & Hinshaw, 2007). Research has shown that on the one hand reactive-aggressive children have trouble inhibiting aggressive responses, and on the other hand are prone to cognitive deficits leading to misinterpretation of social cues (Mullin & Hinshaw, 2007). These cognitive deficits include the tendency to attribute hostile intent to an ambiguous provocation by a peer, and to exclusively pay attention to signs of hostility in peers (Crick & Dodge, 1996).

Each of the results described above highlights the complexity of the mechanism of regulatory processes that is involved in the development of externalizing problem behavior. In short, both the model developed by Zelazo and Cunnigham (2007) and evidence derived from neuroimaging studies highlight the importance of EF, both hot and cool, in the regulation of emotions and their interrelation. Although the two concepts differ from one another in the direct prediction of externalizing behavior, EF might play an important role in the regulation of emotions and hence in the development of externalizing behavior.

An excellent way to study the details of the mechanism that describes the process leading from difficulties in emotion regulation to externalizing problem behavior is to explore the separate concepts in a clinical population. Children with an extra X chromosome, Klinefelter Syndrome in males and Triple X syndrome in females, have been reported as having increased difficulties with both emotion regulation (e.g., Van Rijn, Swaab, Aleman, & Kahn, 2006) and executive functioning (Geschwind, Boone, Miller, & Swerdloff, 2000; Temple & Sanfilippo, 2003), and show a higher incidence of psychiatric disorders (e.g., Bruining, Swaab, Kas, & van

Engeland, 2009) when compared to the general population. Surprisingly few studies have been conducted on emotion regulation within this population. This is remarkable given the fact that striking behavioral outbursts have been reported (Simpson et al., 2003), suggesting a deficit in emotion regulation. One study on Klinefelter men, comparing them to men in the general population, has shown that whereas they experience increased levels of emotional arousal as a reaction to an emotionally arousing stimulus, they may have more difficulty identifying and verbalizing, and hence regulating these emotions (Van Rijn, Swaab, Aleman, Kahn, 2006). In addition, higher rates of psychiatric disorders such as ADHD and autism spectrum disorder (ASD) have been reported (Bruining et al., 2009). This result suggests more problem behavior but not necessarily more externalizing behavior. Within the Triple X population remarkably few recent studies have investigated behavioral and emotional problems. In a recent review, Otter, Schrander-Stumpel, and Curfs (2010), do report occasional cases of temper tantrums, resistive behavior, externalizing psychiatric disorders, depressive disorders, and psychotic disorders. However, most of these reports stem from studies in the 1970s or describe small samples (e.g., Schrander-Stumpel, Otter, & Curfs, 2005).

Highly divergent results have been found concerning the executive functioning or dysfunctioning of children with an extra X chromosome. Various studies found only task-specific deficits in executive functioning. For instance, Temple and Sanfilippo (2003) demonstrated that three Klinefelter boys were unimpaired on planning, problem solving, and task shifting but that their inhibitory executive functions were impaired. Several studies found lower scores for Klinefelter men and boys only on tasks that require verbal EF, such as DeLisi et al. (2005), who found deficits only on a verbal inhibition task called the STROOP. Furthermore, Fales et al.

(2003) also argued against the hypothesis of generalized deficits in EF, because they only found impairments on a verbal working memory task but not on relational thinking. However, recently Lee et al. (2011) have shown that Klinefelter men performed significantly worse on all EF tasks than male control groups. Lee et al. (2011) matched the Klinefelter group to one group of typically developing males matched on socioeconomic status (SES), and one group matched on verbal ability. The XXY group performed less well than the two control groups, even when controlled for IQ and for vocabulary. In other words, these EF deficits could not be fully accounted for by verbal weaknesses or lower IQ scores. In contrast to previous study results, the deficits in executive functioning reported for Klinefelter children were not task specific. Studies on Triple X females investigating their executive functioning abilities are limited. In 1993, Bender, Linden, and Robinson found that their sample of 11 Triple X females showed deficits on almost all neuropsychological tests including tests that tap attention, mental flexibility, and concept formation. Scores of Triple X girls on these neuropsychological tests were even lower than the scores of their sample of Klinefelter boys. Similarly, Bender, Linden, and Harmon (2001) reported greatest impairments on problem solving and conceptualization within the Triple X population when compared to Klinefelter men and Turner (45, XO) females.

In light of the emotion regulation difficulties and the added risk of executive dysfunctioning that seems to characterize this population, one might expect to find more instances of externalizing problem behavior to be reported within the extra X chromosome population. However, whereas several studies have shown higher rates of psychiatric disorders among Klinefelter men (Bruining et al., 2009; Tartaglia, Cordeiro, Howell, Wilson & Janusz, 2010), these diagnoses mainly pertain to the area

of internalizing behavioral problems and attention-deficit disorder. For example, Tartaglia et al. (2010) found that though a significant portion of their sample confirmed concerns in the area of depression, anxiety, and social withdrawal, hyperactivity and aggression were uncommon.

One of the aims of our study is to add to the understanding of behavioral problems, specifically externalizing problem behaviors, and emotional problems within the extra X chromosome population because the current literature contains large gaps. This is especially true for research on Triple X females. Based on current knowledge about impaired executive functions and difficulties concerning emotion regulation within the extra X chromosome group, it is expected that these children also have more difficulties regulating their behavior. This difficulty is likely to result in elevated risks for externalizing behavior.

Another goal of this study is to gain a more thorough understanding of the mechanism in general that leads to the development of externalizing problem behavior, and more specifically the role of particular underlying neuropsychological deficits. To this end the combination of specific deficits in such skills as emotion regulation and executive functioning was studied, in an attempt to predict the extent of problem behavior in a clinical population. More specifically, the purpose of this study is to highlight the different ‘tools’ that are required in order to manipulate behavior in a socially adaptive manner. These insights will hopefully contribute to the knowledge base regarding the role of brain functioning, and add to the brain-behavior model.

In addition to providing an expanded theoretical knowledge-base, this study seeks to provide practical guidelines for the treatment of children with externalizing problem behavior. The results of this study may provide guidance for the treatment

and management of both children with an extra X chromosome and children coping with externalizing behavioral problems and reactive aggression. In order to do so, a detailed picture will be provided of the exact behaviors that occur more often within the extra X chromosome group and their severity. In addition, this study attempts to describe what causes these behaviors and how they can be managed.

The main hypothesis, based on the proposed model of Zelazo & Cunningham (2007), is that both EF and emotion-regulatory skills are required in order to coordinate behavior in a socially adaptive way. More specifically, it is expected that children that are low in EF and low in emotion regulation score high on externalizing problem behavior. Conversely, children scoring high on aggression and externalizing behavior are expected to have deficits in executive functioning as well as in emotion regulation. The aim of this study is to provide a more thorough insight into the role that emotion regulation plays in the relation between executive functioning and externalizing problem behavior, and in what way the two regulatory processes influence one another in the development of externalizing problem behavior. To sum up, the following three hypotheses are examined: first, externalizing problem behavior is expected to be significantly related to executive dysfunction. Second, it is hypothesized that externalizing problem behavior is related to emotion regulation difficulties. Finally, emotion regulation and executive functioning are expected to be two distinct constructs that each contribute uniquely to the level of externalizing problem behavior.

Method

Participants

The total sample consisted of 84 control children (33 boys and 51 girls) and the extra X chromosome group consisted of 16 Triple X girls and 13 Klinefelter boys.

Control children were significantly younger (M_{age} = 10.7, *SD* = 1.1) than extra X chromosome children (M_{age} = 11.8, *SD* = 2.3). Three out of the 13 Klinefelter boys received testosterone supplements at the time of data collection. The extra X chromosome children in this sample were diagnosed both prenatally and postnatally. Control children were recruited through nine elementary schools in nine different urban cities in the western part of the Netherlands. The extra X chromosome children were recruited through clinical genetics departments in the Netherlands. In addition, KS boys were recruited through the Dutch Klinefelter Association and Triple X girls through the Contact Group Triple-X-syndrome.

Procedure

Participants were informed about the project extensively after which a written informed consent was obtained from a parent or primary caretaker and from the child itself. Control children were tested at their schools or at home between November 2009 and June 2010. Extra X chromosome children were tested at the faculty of Social and Behavioral Sciences of Leiden University between April 2009 and March 2011. Testing was done on two different occasions per participant in stimulus-free rooms, during sessions lasting approximately 2.5 hours each. During these testing sessions, participants filled out questionnaires and completed several different tasks on the computer. Administration of these tasks was facilitated by trained students. Parents were also required to complete multiple questionnaires on the behavior of their child. At the end of the two sessions, each child received a small reward and the parents were provided a report containing the test results of their child.

Measurement instruments

General intelligence. General intelligence was estimated using two subtests of the Dutch version of the WISC-III; Vocabulary and Block design. These two

subtests correlate strongly (r = .90) with total scores on the entire WISC-III (Sattler, 1992) and are therefore presumed to provide a reliable estimation of a child's general intellectual abilities. The subtest Vocabulary provides an indication of a child's verbal abilities and Block design assesses visuo-spatial abilities (Wechsler, 1991).

Externalizing problem behavior. Externalizing problem behavior was assessed using the Dutch version of the Child Behavior Checklist (CBCL) for children between the ages 6-18. Good reliability and validity of the test was confirmed by Verhulst, Van der Ende, and Koot (1996). The CBCL consists of 113 items that assess behavioral and emotional problems. Primary caregivers were required to rate each of the 113 items according to the frequency of its occurrence in their child within the past six months. The answer categories include "not true" (0), "sometimes true" (1) and "often/very true" (2). The items can be scaled into eight different syndrome scales: anxious/depressed behavior, withdrawn/depressed behavior, somatic complaints, social problems, thought problems, attention problems, rule-breaking behavior and aggressive behavior. These last two scales can be subsequently regrouped to form the scale externalizing problems. The first three scales can be regrouped to represent internalizing problem behavior. *T*-scores for each of the (sub)scales were calculated using a computer program that compares the sum scores to the norm group based on gender and age. For between group comparisons, raw scores were used. For the calculation of correlations, the *T*-scores were used. Two example items for the subscales Rule-breaking behavior and Aggressive behavior are provided in Table 1.

Table 1
Example items of parent report questionnaires CBCL, SSRS and self report questionnaire CERQ

Instrument	Scale	Example item
CBCL	Aggression	"Mood and feelings change suddenly"
	Rule breaking	"Lies or cheats"
SSRS	Self control	"Can keep calm during a disagreement with peers"
CERQ	Rumination	"I want to understand why I feel like this"

Self control. The Dutch translation of the parent version of the Social Skills Rating System (SSRS; Gresham & Elliot, 1990) was used to assess the social skills of the participants. Good psychometric properties were confirmed for the Dutch translation, as well as support for the factor structure (Van der Oord, et al., 2005). The parent or primary caretaker is required to rate the child's behavior on a 3-point Likert scale ranging from 0 ("never") to 2 ("often"). The questionnaire consists of four subscales with 10 items each. Two items load on two subscales and hence the total questionnaire consists of 38 items. The subscales include 'Cooperation', 'Assertion', 'Self control', and 'Responsibility'. Cooperation taps into such behaviors as helping others and complying with rules. Assertion is a measure of initiating behaviors such as introducing oneself and asking others for information. The subscale Self control assesses behaviors that emerge in conflict situations such as responding appropriately when teased and reactions to non-conflict situations, for instance when compromising is required. An example item of this subscale is provided in Table 1. Last, the subscale Responsibility measures the child's ability to communicate with adults and its concerns for work and property. The scale for self control was of particular interest because it serves as an indication of how a child might respond in anger or frustration evoking situations.

Executive functioning. Two tasks of the Amsterdam Neuropsychological Tasks (ANT; De Sonneville, 2005) were used to assess the executive functioning

abilities of the participants. The total ANT battery consists of 32 tasks that evaluate cognitive processes including executive functioning. Based on a variety of studies (e.g., De Sonneville et al., 2002; Huijbregts, De Sonneville, Licht, Van Spronsen, Sergeant, 2002), De Sonneville (2005) concluded that sufficient evidence was found for the validity, sensitivity and test-re-test reliability of the entire ANT battery. The ANT battery is appropriate for use in research amongst toddlers, children, and adults.

Inhibition. Inhibition was measured using two different tasks of the ANT: the GoNoGo task and the Shifting set visual task. The *GoNoGo task* involves two different stimuli, as depicted in Figure 1. The child is given the instruction to click on a button as fast as possible when the Go-stimulus is presented and to refrain from any response when the NoGo stimulus is shown. The amount of times the participants clicks when shown the NoGo stimulus; the false alarms, are considered the most important variable in measuring inhibition because it requires the child to inhibit the urge to click whenever a stimulus is shown.

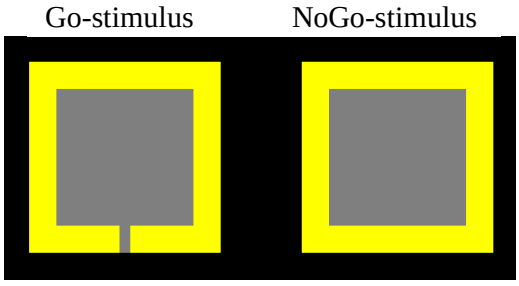

Figure 1. *The Go-stimulus and the NoGo-stimulus of the ANT GoNoGo task.*

The *Shifting set visual task* consists of three parts, each measuring a different construct. The task entails a colored square that moves right and left. During part one the child is trained to click in the same direction as the movement of a green square. Part two is considered to measure inhibition. During part two the child is instructed to follow the red square. The participant is required to click on the button in the opposite

direction from the movement of the square. For example, if the red square moved to the left, the participant should click on the right button. A schematic reproduction of this task is provided in Figure 2. The amount of errors made and the reaction time during part two are considered the most important variables of inhibition derived from this task.

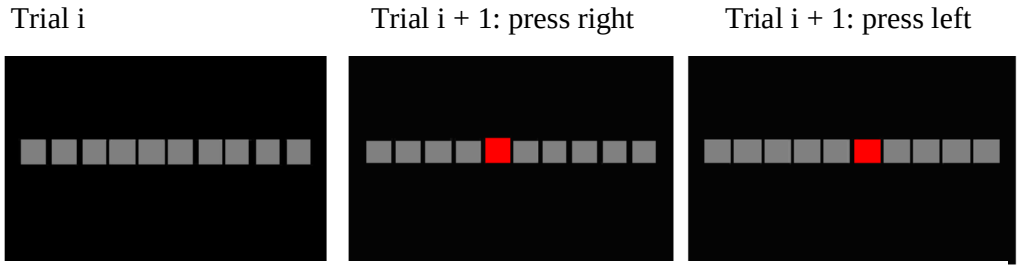

Figure 2. *Three consecutive trials of the ANT Shifting set visual part 2: press in the opposite direction from the movement of the red square.*

Mental flexibility. Mental flexibility was measured using part three of the *Shifting set visual task*. During part three the color of the moving square changes color (red or green) and the square continues to move either to the left or to the right. The participant was instructed to click in the same direction as the movement of the square if the square was green (compatible) and in the opposite direction if the square was red (incompatible). For instance, a red square moving to the right should be followed by a click on the left button whereas a green square moving to the right should be responded to with a click on the right button. A schematic reproduction of this task is provided in Figure 3. The most important parameters measuring mental flexibility derived from this task are the amount of errors made and the reaction time on compatible trails during part three.

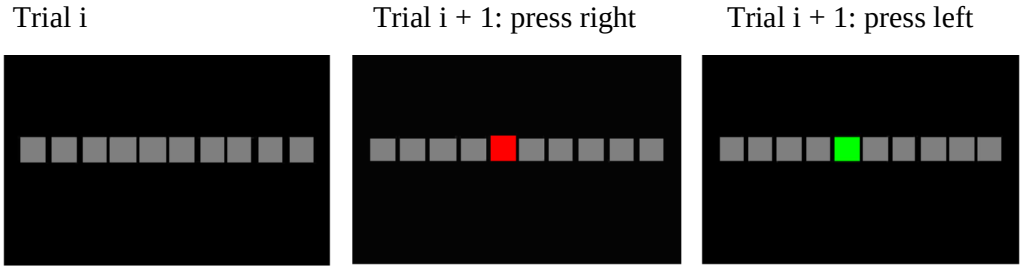

Figure 3. *Three consecutive trials of the ANT Shifting set visual part 3: colors of the squares and direction of movement change.*

Emotion regulation. The Cognitive Emotion Regulation Questionnaire (CERQ; Garnefski, Kraaij, & Spinhoven, 2002) was used to assess the emotion regulation of the participants. This questionnaire taps the cognitive coping strategies of children after a negative event in their lives. The CERQ is a self-report questionnaire consisting of 36 items that can be grouped into nine subscales. The nine scales including a description of what the scale encompasses is outlined in Table 2. The CERQ requires the child to think about a negative event in their lives and rate how often they would think about the topic described in each item. The items are rated on a five-point Likert scale ranging from 1 ("never/almost never") to 5 ("always/almost always"). The COTAN (Dutch Committee on Tests and Testing) has rated the CERQ as sufficient on reliability and construct validity (NJi, n.d.). Garnefski et al. (2002) tested the internal consistency of the nine subscales within five different populations (N = 2500) and found Crohnbach's alphas ranging between .68 and .85.

Table 2
Nine subscales of the CERQ self report questionnaire including a description of what they tap into

Subscale	Description
1. Self blame	Thoughts of holding oneself responsible for what has happened
2. Acceptance	Thoughts of accepting what has happened
3. Rumination	Continually thinking about feelings and thoughts related to the negative event
4. Positive refocusing	Thinking of other pleasant things instead of the particular event
5. Refocus on planning	Thinking about steps that have to be taken in order to deal with the event
6. Positive reappraisal	Mentally giving a positive meaning to what has happened in terms of personal growth
7. Putting in perspective	Telling yourself that there are worse things that happen in the world
8. Catastrophizing	Recurring thoughts of how horrible the event was
9. Blaming others	Thoughts in which others are held responsible for what has happened

Statistical analyses

Data were analyzed using SPSS (Statistical Package for Social Sciences; SPSS 19 for Windows, 2009) version 19.0. A check for normality was done as well as an assessment of the homogeneity of variance to be able to decide whether parametric or non-parametric methods would be required. Because the children in the control group were significantly younger than extra X chromosome children, age was controlled for in each of the analyses by adding the variable 'age' as a covariate. Multivariate analyses of co-variance (MANCOVAs) were employed to assess multivariate effects of group while controlling for the age of the participants. The significance of multivariate effects was decided based on Pillai-Bartlett's trace. Three different MANCOVAs were employed with all CBCL scales, all inhibition variables and the mental flexibility parameters as dependent variables. Gender and group were fixed factors in each of the analyses. An analysis of co-variance (ANCOVA) was used to assess the effect of group on the self-control scale of the SSRS, to get a more detailed picture of externalizing problem behavior. In addition, an ANCOVA was used on the subscales of the CERQ. Because the direction of each of these subscales was different, with scoring high on one scale meaning a lack of emotion regulation and scoring high on another meaning good emotion regulation, this effect could not be assessed using one MANCOVA. Using a MANCOVA might even out a possible group effect across the subscales because of the differential direction of the subscales. Subsequently, the direction of possible interaction effects were assessed using post hoc analyses of variance (ANOVAs). In order to get a better picture of the exact behaviors that occur more often within the extra X chromosome group and their severity raw data derived from the CBCL were assessed. Behaviors that were scored by parents with at least a '1' (occurring sometimes or often) within the subscale of

interest, externalizing behavior, was analyzed. This subscale included Rule breaking behavior and Aggressive behavior. Pearson's correlations were calculated between externalizing problem behavior and executive functioning and emotion regulation as well as between emotion regulation and executive functioning. To study the relationship between the two independent variables: executive functioning and emotion regulation and their influence on externalizing problem behavior more thoroughly, the correlation between EF and externalizing behavior was assessed separately for a group high in emotion regulation and a group low in emotion regulation. These groups were created using a median split. Effect sizes were calculated using Cohen's *d*, which represents the differences in means in terms of the amount of standard deviations. A Cohen's *d* of .50 or larger, is considered a medium effect, a Cohen's *d* of .80 or larger is considered a large effect. In all analyses *p*-values of .05 or smaller are considered to indicate statistically significant results.

Results

Background variables

The characteristics on background variables of the sample are displayed in Table 3. General intellectual ability was significantly lower in the extra X chromosome group (M_{TIQ} = 83, *SD* = 16), when compared to the control group (M_{TIQ} = 103, *SD* =14), $F(1, 111) = 42.1$, $p < .001$.

Table 3
Descriptive statistics of the sample (N =113)

	Extra X chromosome (*n* = 29)	Controls (*n* = 84)	*F*	*p*
Age	11;7 (2;4)	10;7 (1;1)	10.41	.002
Estimated IQ	83 (16)	103 (14)	42.10	<.001

Externalizing problem behavior

CBCL scales. In order to tell whether extra X chromosome children show more problem behavior a MANCOVA was run on all CBCL scales. A MANCOVA,

co-varied for age, revealed that there was a multivariate main effect of group on the CBCL scales, $F(10, 99) = 4.24$, $p < .001$, no significant main effect of gender on the CBCL scales, and no significant interaction effect between gender and group. In more detail, children with an extra X chromosome showed significantly more anxious behavior, $F(1, 108) = 11.58$, $p = .001$, more withdrawn behavior, $F(1, 108) = 27.77$, $p < .001$, have more somatic complaints, $F(1, 108) = 4.24$, $p = .003$, more social problems, $F(1, 108) = 19.87$, $p < .001$, more thought problems, $F(1, 108) = 8.16$, $p = .005$, more attention problems, $F(1, 108) = 13.24$, $p < .001$, more internalizing problems, $F(1, 108) = 21.23$, $p < .001$ and more total problems, $F(1, 108) = 17.54$, $p < .001$.

Of specific interest were the scores on CBCL scales aggressive behavior, rule breaking behavior, and externalizing behavior. Children with an extra X chromosome score significantly higher on rule breaking behavior, $F(1, 108) = 15.94$, $p < .001$, $d = .79$ and externalizing problem behavior, $F(1, 108) = 4.48$, $p = .037$, $d = .53$ but not on aggressive behavior, $F(1, 108) = 1.50$, $p = .224$. Means and standard deviations on these CBCL scales are presented in Table 4.

In order to get a better picture of the exact externalizing behaviors that occur more often within the extra X chromosome group, their raw data were analyzed on the two subscales that are included in the externalizing behavior scale: rule breaking behavior and aggressive behavior. This was done by looking at which behaviors were reported to occur at least ‘sometimes’. This subsequent study revealed that approximately 66% of the parents in the extra X chromosome group reported that their child at least sometimes exhibits stubborn behavior, 55% of parents reported that their child easily looses its temper, and 48% of the parents report arguing, lying or cheating and causing disturbance in the home.

Self control. Externalizing problem behavior was additionally assessed using the self control subscale of the SSRS. An ANCOVA, co-varied for age, revealed a significant effect of group on self control, $F(1, 107) = 13.30$, $p < .001$ and no significant effect of gender or interaction effect between gender and group. Extra X chromosome children score significantly lower and therefore have less self control when compared to the control group. Means and standard deviations of self control are also displayed in Table 4. A parametric correlation showed a significant inverse relation between self control and externalizing problem behavior: $r(110) = -.54$, $p < .001$, $R^2 = .29$. In other words, children that have more self control show less externalizing behavior.

Table 4
Separate means and standard deviations on externalizing behavior variables for Triple X and Klinefelter children and controls (N = 113)

	XXX/XXY (n = 29)	Control (n = 84)		
	M (*SD*)	*M* (*SD*)	*F*	*p*
Externalizing behavior	8.06 (5.67)	5.10 (5.45)	4.48	.037*
Rule breaking	2.69 (2.19)	1.24 (1.39)	15.94	< .001*
Aggression	5.38 (4.20)	3.86 (4.32)	1.50	.224
Self control	11.64 (3.47)	13.89 (2.97)	13.30	< .001*

* Difference in means significant at significance level $p = .05$.

Executive functioning

Inhibition. In order to assess whether there were group differences in inhibition between the control group and the extra X chromosome group, a MANCOVA was run on all parameters of inhibition. The MANCOVA, co-varied for age, with the number of false alarms on the GoNoGo task and the amount of errors made and reaction time on part two of the Shifting set visual as dependent variables, revealed no significant results. There was no multivariate group effect, no gender effect and no interaction effect between gender and group. There was however a main

effect of age, $F(1, 102) = 4.41$, $p = .006$. In other words, extra X chromosome did not score lower on

inhibition but inhibition was influenced by age.

Mental flexibility. Group differences in mental flexibility were assessed using another MANCOVA on both mental flexibility parameters. This MANCOVA, with dependent variables reaction time and amount of errors made on part three of the mental flexibility task, revealed a multivariate effect of group, $F(1, 106) = 6.52$, $p = .002$. In addition, results showed a significant group by gender interaction effect, $F(1, 106) = 4.27$, $p = .016$. This interaction was significant only on the reaction time. In more detail, children with an additional X chromosome made significantly more errors, $F(1, 106) = 5.88$, $p = .017$, $d = .47$ and had a significantly lower reaction time, $F(1, 106) = 7.86$, $p = .006$, $d = .87$. The interaction effect on the reaction time however, revealed that Klinefelter boys' means did not differ significantly from control boys', $F(1, 44) = .48$, $p = .491$ but Triple X girls did have significantly faster reaction times when compared to control girls, $F(1, 63) = 28.22$, $p < .001$. The multivariate effect of age was also significant, $F(1, 106) = 5.89$, $p = .004$. In other words, extra X chromosome children, both boys and girls made more errors but only Triple X girls have a higher reaction time. Means and standard deviations of all executive functioning parameters are depicted in Table 5.

The relation between executive functioning and externalizing problem behavior

None of the executive functioning variables were related to self control. In contrast, one of the executive functioning variables; the amount of errors made during the inhibition task, was significantly related to externalizing problem behavior, $r(27) = .40$, $p = .033$, $R^2 = .16$. Extra X chromosome children that scored lower on

inhibition showed more externalizing behavior. Correlation coefficients between the dependent and independent variables are displayed in Table 6.

Table 5
Means and standard deviations on all relevant independent variables (N = 113)

		XXY/XXX (*n* = 29) *M* (*SD*)	Controls (*n* = 84) *M* (*SD*)	*F*	*p*
EF	GoNoGo FA[a]	3.19 (3.39)	3.47 (2.91)	.03	.853
	Errors part 2[b]	8.41 (7.45)	5.94 (6.59)	3.09	.082
	RT part 2[c]	710.48 (195.65)	850.13 (262.27)	1.80	.182
	Errors part 3[d]	11.36 (8.33)	7.63 (7.41)	5.88	.017*
	RT part 3[e]	893.50 (341.31)	1174.24 (299.27)	7.86	.006*
ER	Rumination	11.40 (3.98)	9.70 (3.75)	2.95	.089

* Difference in means significant at significance level $p = .05$.
[a] The amount of false alarms on the GoNoGo task, measuring inhibition.
[b] Amount of errors on part 2 of the ANT Shifting set visual, measuring inhibition.
[c] Reaction time on part 2 of the ANT Shifting set visual, measuring inhibition.
[d] Amount of errors on part 3 of the ANT Shifting set visual, measuring mental flexibility.
[e] Reaction time on part 3 of the ANT Shifting set visual, measuring mental flexibility.

Emotion regulation

To assess group effects on emotion regulation, an ANCOVA was run with age as a covariate and each of the emotion regulation subscales as dependent variables. Results revealed that there were no significant group differences on any of the emotion regulation (ER) scales. However, the difference between groups did approach significance on the scale for rumination, $F(1, 103) = 2.95$, $p = .089$ with an effect size of $d = .44$. There was no multivariate main effect of age, of gender or gender by group interaction effect on the rumination scale. Extra X chromosome children show nearly significantly more ruminating behavior when compared to the control group. Means and standard deviations of control children and Triple X and Klinefelter children on this emotion regulation scale are displayed in Table 5.

Emotion regulation in relation to executive functioning and externalizing behavior

Within the extra X chromosome group rumination was significantly and inversely related to externalizing problem behavior, $r(23) = -.45$, $p = .025$, $R^2 = .20$ and positively

related to self control, $r(22) = .43$, $p = .038$ $R^2 = .18$. In other words, extra X chromosome children that show more ruminating behavior, have more self control and exhibit less externalizing behavior. Correlation coefficients between externalizing problem behavior, and emotion regulation, and executive functioning are depicted in Table 6. Emotion regulation was not significantly related to any of the executive functioning measures.

Table 6
Correlations among dependent and independent variables for XXY and XXX children (N = 29)

	Externalizing beh.	Self control	Rumination	Inhibition
Externalizing behavior				
Self control	-.35			
Rumination	-.45 *	.43 *		
Inhibition	.40 *	-.24	-.13	

* Correlation significant at significance level $p = .05$.

To discover more about the relation between executive functioning and emotion regulation and their combined influenced on externalizing behavior, the sample was split into a group scoring high on emotion regulation and a group scoring low on emotion regulation. To this end a median split was applied. Within the high-rumination group, there was no significant relationship between inhibition and externalizing problem behavior but this relation was significant within the group scoring low on rumination: $r(8) = .68$, $p = .031$, $R^2 = .46$. These correlations are displayed in Table 7. In other words, in children who show little ruminating behavior their ability to inhibit behavior influences their amount of externalizing behavior. Within children that do show higher amounts of ruminating, the amount of externalizing behavior was not dependent on their ability to inhibit their behavior.

Table 7
Correlations between externalizing problem behavior and executive functioning for different levels of emotion regulation in XXY and XXX children (N = 29)

		Externalizing behavior	Disinhibition
Low rumination	Externalizing behavior		.68 *
	Disinhibition	.68 *	
High rumination	Externalizing behavior		.29
	Disinhibition	.29	

* Correlation significant at significance level $p = .05$.

Emotion regulation and socially adaptive functioning

To distinguish what kinds of behaviors are influenced by the ability to regulate emotions in extra X chromosome children, correlations were calculated between emotion regulation skills and social skills. A more detailed study on the influence of scoring high on rumination within the extra X chromosome group, revealed that rumination within this group was positively related to Social Skills Rating Scale subscales Assertion, $r(22)= .48$, $p =.019$, $R^2 =.23$ and Responsibility, $r(22)= .44$, $p =.030$, $R^2 =.19$ as reported by their parents.

Discussion

The first aim of this study was to dissect the behavioral phenotype, especially that regarding externalizing problem behavior, of children with an extra X chromosome. We expected those children to show more problem behavior than control children given previous study results suggesting that extra X chromosome children have more difficulty than control children regulating their emotions. Exploratory analyses revealed that, as expected, children with an extra X chromosome show more overall behavioral problems and more internalizing behavior. Even more important in relation to the aim of this study, is the fact that our results also show that children with an extra X chromosome exhibit more externalizing problem behavior. In addition, children with an extra X chromosome scored significantly lower on self control, a construct that turned out to be significantly and negatively related to

externalizing problem behavior. Interestingly, there was no effect of gender, which implies that both Triple X girls and Klinefelter boys show more externalizing problem behavior than control children.

Our study was the first to show that children with an extra X chromosome not only show more internalizing problem behavior and more overall psychopathology, but also exhibit more externalizing problem behavior, more specifically rule-breaking behavior. Other studies, such as Tartaglia et al. (2010), have focused mainly on internalizing problem behavior or externalizing problem behavior in the form of aggression or hyperactivity (e.g., Bruining et al., 2009; Otter et al., 2010). In accordance with Tartaglia et al. (2010), we did not find elevated rates of aggression. However, a detailed study of the raw scores on the CBCL data revealed that the elevated scores on the externalizing behavior scale were predominately caused by higher rates of rule-breaking behavior. The rule-breaking behaviors reported most often include sudden loss of temper, stubborn behavior, and causing disturbance at home. These behaviors all appear to be a sign of the children's inability to control their emotions and of aggression in response to external stimuli: reactive aggression rather than proactive aggression. Together with the fact that Klinefelter boys have been found to show increased emotional arousal in response to an emotional event (Van Rijn et al., 2006), this leads to children with an extra X chromosome often showing behavioral outbursts (Simpson et al., 2003), having trouble maintaining friendships, and having difficulty functioning in school settings with many stimuli and distractions.

In order to try to uncover what causes these elevated rates of problem behavior in this sample of extra X chromosome children, the mechanism leads to the development of externalizing behavior was studied in more detail. Of particular

interest were difficulties with emotion regulation and executive dysfunctioning, defined on the basis of a model of emotion regulation proposed by Zelazo and Cunningham (2007), and previous studies indicating that these two constructs are predictive of externalizing problem behavior. Previous research had shown that both these neuropsychological functions are impaired in extra X chromosome children, and that they are both linked to externalizing problem behavior in other populations.

We expected that there would be group effects on the emotion regulation parameters, with extra X chromosome children showing more deficits. Results show that, as expected, extra X chromosome children show more 'rumination'. In addition, we expected significant differences between groups on the executive-functioning parameters, with extra X chromosome children showing more deficits on both mental flexibility and inhibition. The results show that children with an extra X chromosome score significantly lower on mental flexibility. There was a group by gender effect showing that Triple X girls worked significantly faster than control girls on the mental flexibility task. This implies that even though the task became increasingly more difficult and the Triple X girls made more errors than control girls, the Triple X girls did not adjust their speed to the difficulty level. Mental flexibility deficits might thus be more pronounced in Triple X girls when compared to Klinefelter boys. No group effect was found on any of the inhibition parameters, which seems to indicate that in children with an extra X chromosome the ability to inhibit a well-learned response is not impaired. The fact that extra X chromosome children do perform poorer on the mental flexibility task than control children but not on the tasks that measure inhibition, suggests a task-specific deficit in executive functioning. This result is in line with previous studies (e.g., Temple & Sanfilippo, 2003; DeLisi et al., 2005; Fales et al., 2003). A possible explanation for the discrepancy in task performance between

the inhibition tasks and the mental flexibility task may be the difficulty of the response. During the mental flexibility task the child is required to pay attention to both the color of the square and its movement, and has to respond by clicking one of two buttons. Perhaps this amount of information creates a so-called ‘overload’, causing the child to randomly click on the buttons. The inhibition task, especially the GoNoGo, is much simpler, requiring the child to process less information at the same time. Another difference between the tasks is that they require a different level of adaptation. The inhibition tasks require the child to suppress an ‘overlearned response’. The mental flexibility task requires the child to respond flexibly to an unknown situation. Moreover, because the inhibition tasks are easier, they may also require a lower level of attention. Directing and redirecting attention may be the aspect of executive functioning that is most impaired in children with an extra X chromosome. This was also suggested earlier by Ross et al. (2008) for children under 10 years of age.

Subsequently, we expected that deficits in both emotion regulation and in executive functioning would be related to the rate of externalizing behavior. First, results show that externalizing problem behavior is significantly related to the emotion regulation strategy rumination. More specifically, children that show more rumination show less externalizing problem behavior and have more self control. This salient result deserves attention because it suggests that, whereas in the general population rumination is considered to be an inadequate strategy of emotion regulation, it is apparently an effective strategy within the extra X chromosome population. Clearly, continually thinking about and reflecting upon feelings related to a negative event helps these children to adjust their behavior in a socially adaptive manner. This conclusion is confirmed by additional analyses that show that

rumination in the extra X chromosome population is positively related to two other social skills measured by the SSRS: assertion and responsibility. In other words, children that show more rumination also show more behaviors such as initiating behaviors and the ability to communicate with adults. Previous studies using identical measures of emotion regulation to ours, more specifically the rumination scale, have suggested that ruminating is an inadequate emotion-regulation strategy. In their manual of the emotion regulation questionnaire Garnefski et al. (2002) state that a certain amount of rumination is not unusual in case of a negative life event. However, they also say that a high score on the rumination scale is almost certainly related to having emotional problems or symptoms of psychopathology. For instance, they found significant positive correlations between high scores on this scale on the one hand and sleep problems, psycho-neuroticism, hostility, depression, and fear on the other. Other studies have also found rumination to be related to depression symptoms (Ehring, Fischer, Schnülle, Bösterling, & Tuschen-Caffier, 2008), physical and verbal aggression, and hostility (Anestis, Anestis, Selby, & Joiner, 2008). Ehring et al. (2008) and Anestis et al. (2008) conducted their studies on a population of university students and undergraduate students, and four of the five norm groups investigated by Granefski et al. (2002) were also from a general population. It therefore seems likely that the difference in results between these studies and our research can be attributed to the fact that our sample contained clinical patients. Apparently, a strategy that was previously considered a sign of inadequate emotion regulation in normal populations may actually serve the opposite purpose in a clinical population of children with an extra X chromosome. In more general terms, this result shows that specific skills may serve quite different purposes in a normal and in a clinical population. It is likely that children from a clinical population search for ways to adjust to their environment

while dealing with their own deficits and difficulties. These compensation strategies may result in an increase in behavior that is otherwise viewed as negative. This should be kept in mind in future studies, and researchers should consider not only whether or not a certain skill is impaired, but also what the consequences are on a behavioral level.

The second hypothesis with regard to the mechanism of externalizing behavior was that externalizing problem behavior is related to executive dysfunctioning. The results of our study show that externalizing problem behavior is related to one of the executive functioning measures: the amount of errors made on a task requiring inhibition. In other words, children who are less capable of inhibiting a response show more externalizing problem behavior. Surprisingly, the fact that these children have more difficulty with mental flexibility does not explain the elevated rates of externalizing behavior because mental flexibility and externalizing problems were not related to each other. Apparently, inhibition, the aspect of executive functioning that is related to externalizing problem behavior, is not the aspect that is impaired in the group of extra X chromosome children. Rather, it varies within the group, with some children showing severe problems in inhibition, which contributes to externalizing behavior. In other words, inhibition is only one of the factors contributing to externalizing behavior. Attempts to grasp the extent of externalizing problem behavior by focusing only on executive functioning clearly result in an incomplete picture.

The third and last hypothesis concerning the mechanism leading to externalizing problem behavior was that executive functioning and emotion regulation are two distinct constructs each contributing uniquely to the extent of externalizing problem behavior. The results of this study show that indeed none of the scores on emotion regulation scales are related to any of the executive functioning measures.

Externalizing problem behavior appears to be related to both executive functioning skills and emotion regulation but within this sample the two were not related to each other. Thus it can be argued that the two regulatory skills represent two different mechanisms. It appears that both emotion regulation and executive skills are required in order to regulate behavior in a socially adaptive manner. These results do not entirely confirm the model proposed by Zelazo and Cunningham (2007), in which it is suggested that emotion regulation is a deliberate process that may be highly similar to executive functioning.

Several factors should be taken into consideration in order to understand the lack of confirmation for this emotion regulation model. First of all, it is possible that emotion regulation and executive functioning actually are two distinct constructs, and represent two separate mechanisms leading to externalizing behavior. This argument would be in line with Hinshaw's (2003) reasoning that EF deficits and emotion dysregulation really are 'disconnected'. Hinshaw and colleagues conducted two experiments with two groups of children: one with an ADHD diagnosis, and one with an ADHD diagnosis and a co-morbid oppositional defiant disorder or conduct disorder (ODD/CD). The first experiment revealed that the rates of EF deficits were identical within the ADHD group and the co-morbid ODD/CD group. Hinshaw concludes that EF deficits are independent of externalizing co-morbidity. A second experiment revealed that emotion dysregulation occurred exclusively in the co-morbid ODD/CD group, suggesting that externalizing problem behavior is solely related to emotion regulation difficulties.

However, the interplay between emotion regulation and executive functioning in the development of externalizing problem behavior may be more complicated than previously suggested by authors such as Zelazo and Cunningham (2007) and Hinshaw

(2003). Our study has shown that emotion regulation may indeed influence the relation between executive dysfunctioning and externalizing problem behavior. A more detailed study of the connection between executive functioning and externalizing behavior revealed that within children with an extra X chromosome that show a low amount of rumination, there is a significant relation between deficits in inhibition and externalizing problem behavior. This relation is non-significant within the group of extra X chromosome children that show a high level of rumination. In other words, in these children the ability to reflect upon their feelings compensates for the inability to inhibit a response. For instance, children who are able to think about something that has made them angry are able to refrain from an aggressive response. In contrast, children that are unable to take a step back and think about how they feel are more dependent on their ability to inhibit an aggressive response.

This is further proof of the idea that children with an extra X chromosome may use rumination as an alternative strategy to regulate their behavior to compensate for their lack of executive-functioning abilities. Controlling emotions and behavior at an unconscious or reactive level may be the core difficulty for these children. In order to compensate for this impairment, children with a tendency to ruminate about events and feelings might have learned to regulate their behavior in a more conscious, effortful way. This touches upon the distinction made in the literature between two components of emotion regulation: reactive control and effortful control (Posner & Rothbart, 2000). We thus hypothesize that children with an extra X chromosome have difficulty regulating their emotions reactively, so that emotion regulation loads heavily on the ability to effortfully control emotions.

Possible limitations of this study include the fact that emotion regulation was only measured by a self-report questionnaire assessing cognitive emotion regulation.

It remains to be discovered if this self-report is a good reflection of what children would actually do when provoked. It would be interesting to see how children with emotion regulation difficulties react in real-life situations. This may unravel the difference between reactive emotion regulation and effortful control in extra X chromosome children a bit more. Another limitation of this study may be the fact that executive functioning was only measured in a test setting without a reward. This may have led to only testing 'cool' executive functioning. Perhaps 'hot' executive functioning, or EF that is connected with motivationally significant situations and situations that involve the regulation of affect, plays a different role in the development of externalizing problem behavior, and is more similar to emotion regulation. Future studies should focus on this distinction between hot and cool EF in order to unravel the relationship of these two types of EF to both externalizing problem behavior and emotion regulation strategies. In addition, the distinction between reactive and effortful emotion regulation should be studied in more detail by looking at both conscious, cognitive coping strategies and reactive emotion regulation for instance through the study of behavioral reactions under stress.

The implications of this study's results are of both a theoretical and a practical nature. On a theoretical level the results of this study show that both emotion regulation and executive functioning may be related to the rates of externalizing problem behavior displayed by the extra X chromosome children. The two constructs are not directly related to one another, but do interact with each other in the development of externalizing problem behavior. This describes not only the behavioral phenotype of children with an extra X chromosome but also contributes to more general models of externalizing problem behavior characterized by emotional dysregulation. Another salient result was that children who are less capable of

consciously controlling emotions by ruminating suffer more from deficits in executive functioning. Apparently, a strategy that was previously considered an inadequate emotion regulation strategy proved to be an effective strategy in this clinical population. This underlines the importance of not only studying whether or not children possess a certain skill, but also what the consequences are on a behavioral level. On a practical level, our study was the first to show the elevated risks of externalizing problem behavior in a population of children with an extra X chromosome. Previous literature has mainly focused on the cognitive and medical consequences of having an extra X chromosome, but perhaps more attention should be paid to the behavioral consequences. After all, problem behavior in the form of temper tantrums and difficulties functioning in a socially adaptive manner are the reasons why parents refer their children to clinics and need help. Finally, guidelines for the treatment of children with an extra X chromosome can be derived from the results of our study. For instance, possessing the ability to reflect upon feelings and events leads to less externalizing problem behavior, and is related to more self control. Children with an extra X chromosome that do not posses this ability, suffer more from their inability to reactively regulate their behavior and inhibit responses. In order to avoid a high dependency on executive functions, which are clearly impaired in children with an extra X chromosome, it would be sensible to focus the treatments of these children on adequate emotion-regulation strategies. Teaching children with an extra X chromosome to consciously focus on and think about how they feel and why they feel a certain way, may help them to adequately regulate their emotions and adapt to their environment.

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