Reward- and punishment sensitivity in reactive and proactive aggression

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Preface

This study was conducted under supervision of dr. S.C.J. Huijbregts at Leiden University, Department of Clinical Child and Adolescent Studies. The study has resulted in my master thesis of the research master 'Developmental Psychopathology in Education and Child Studies'.
I would like to thank my supervisor Stephan for his valuable advice, his flexible way of supervising this project, the freedom he gave to me in writing the thesis and his positive view on the whole process. I have learned a lot from all the aspects of performing a study. Of course I would like to thank the participating children, their parents and the mental health services for their cooperation. Also I would like to thank Ralph Rippe and Joost van Ginkel for their advice in performing the statistical analyses. Finally, I would like to thank my parents for giving me the opportunity to study both educational sciences and psychology and for supporting me through the years.

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Abstract

It is known from earlier studies that children with psychiatric disorders, like ADHD and ODD, show alterations in reward- and punishment sensitivity. Reactive and proactive aggression frequently occur in those disorders, and therefore altered reward- and punishment sensitivity may be associated with these behaviours as well. This study investigated the relationship between reward- and punishment sensitivity and reactive and proactive aggression in a sample of 385 boys (mean age 14,5 years). In addition the effectiveness of the behavioural therapeutic program Minder Boos en Opstandig in reducing behavioural problems and improving reward- and punishment sensitivity was assessed in a sample of 12 children (mean age 10,1 years). Participants performed tasks measuring reward- and punishment sensitivity and completed questionnaires measuring behavioural problems, callous and unemotional traits and reward- and punishment sensitivity. Parents also completed questionnaires about behavioural problems and reward- and punishment sensitivity in their children. Results show a relationship between both types of aggression and sensitivity to reward. Proactive aggressive children were found to be more likely to show sensation-seeking behaviour than reactive aggressive children. No significant associations with sensitivity to punishment were found. The results show that the Minder Boos en Opstandig program is effective in reducing behavioural problems. The reduction of delinquent behaviour was found to be related to a diminished sensitivity to social reward. The results of this study may be useful for improving treatments such as the Minder Boos en Opstandig program, in which a greater emphasis on reward- and punishment sensitivity could be introduced.

Introduction

It is common for many children to express aggressive behaviours occasionally (Hubbard, McAuliffe, Morrow & Romano, 2010). However some children are chronically and highly aggressive and aggression is frequently associated with child psychiatry (Merk, Orobio de Castro, Koops, & Matthys, 2005). Aggression is a defining feature of Conduct Disorder (CD) and Oppositional Defiant Disorder (ODD), but it also has been associated with Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), mood disorders, mental retardation, personality disorders and substance abuse (Bihm, Poindexter & Warren, 1998; Angold & Costello, 2001; Parikh, Kolevzon & Hollander, 2008; Latalova & Prasko, 2010; Hofvander et al., 2011).

Aggression is a heterogeneous phenomenon, which cannot be studied as a uniform concept (Merk et al., 2005). Therefore aggression has been divided into different subtypes, such as physical aggression, verbal aggression and relational aggression (Van de Wiel, Hoppe & Matthys, 2003). Another way of sub typing aggression is by distinguishing reactive and proactive aggression. When children are aggressive, they sometimes seem driven by anger and impulsivity (reactive aggression), whereas at other times they appear cool, deliberate and purposeful (proactive aggression) (McCauliffe, Hubbard, Rubin, Morrow, & Dearing, 2007). The distinction between reactive and proactive aggression has already been made in 1991 by Dodge and in 1997 by Vitiello and Stoff. Although proactive- and reactive aggression have found to be correlated with one another, these two types of aggression appear to be distinct (Dodge, 1991; Day, Bream, & Pal, 1992; Little, Jones, Henrich, & Hawley, 2003; Merk et al., 2005). Reactive- and proactive aggression are most clearly distinguished by behavioural observations and questionnaires that make a difference between form and functions of aggression (Polman, Orobio de Castro, Koops, Van Boxtel, & Merk, 2007).

Proactive aggressive behaviour is characterized by control and can be called a calculating form of aggression or cold-tempered aggression (Van de Wiel, Hoppe and Matthys, 2003; Scarpa, Haden & Tanaka, 2010). This offensive aggression is goal-oriented and motivated by external reward (Dodge, 1991). According to the social learning theory aggression serves the function of helping one obtain a desired goal (Bandura, 1973). This theory could help in understanding the mechanisms underlying proactive aggression. It posits that aggression is regulated by learned reinforcement contingencies (Bandura, 1973). So reinforcement and the anticipated advantages of aggression (for example, to attain a better position within a group) play an important role in proactive aggression (Merk et al., 2005). Callous and unemotional traits have found to be related to proactive aggression (Marsee & Frick, 2007). Those traits are often related to low cortisol levels regardless of the level of conduct problems and to altered

amygdale functioning (Loney, Butler, Lima, Counts, & Eckel, 2006; Amaral, 2003). The Inventory of Callous and Unemotional Traits makes a difference between a callous factor (lack of empathy, guilt and remorse for misdeeds), an uncaring factor (lack of caring about one's performance in tasks and for the feelings of others), and an unemotional factor (absence of emotional expression) (Kimonis et al., 2008).

Reactive aggression, the other type of aggression, is a hostile, angry response to a perceived frustration and can be called affective aggression, or hot-tempered aggression (Fite, Colder, Lochman, & Wells, 2007; Scarpa, Haden & Tanaka, 2010). Reactive aggression may be explained by the frustration–aggression model, which posits that aggression is an angry and hostile reaction to frustration (Berkowitz, 1978). So this impulsive form of aggression can be seen as a kind of defence against something threatening or frustrating (Van de Wiel, Hoppe & Matthys, 2003). Reactive aggression is likely to occur in the presence of cues associated with anger via classical conditioning (Anderson & Bushman, 2002). Children can be expected to behave in a reactive aggressive manner if they are quickly aroused, if they have been subjected to frustrating or threatening situations in their early years or currently find themselves in such a situation, or if they can be characterized as having a pattern of information processing that leads to quicker attributions of hostility or threat to other people (Merk et al., 2005). Children with reactive aggression are likely to have cognitive deficiencies in the domains of social information processing and problem-solving skills (Crick & Dodge, 1996). These children often have difficulties generating alternative solutions to problems, making decisions, and enacting solutions (Kendall, Ronan, & Epps, 1991). They are considered to be more impulsive, less capable of self-control, and driven to aggression by poor frustration tolerance, negative affects such as anger and fear, and cognitive distortions of environmental circumstances as compared to children with proactive aggression (Vitiello & Stoff, 1997).

Several studies have been performed to examine the relationship between proactive and reactive aggression and different variables, such as peer relations and long term outcomes (Fite et al., 2007). In terms of social-cognitive correlates, reactive aggression relates positively to hostile attributional biases and aggressive social problem solving in middle childhood, whereas proactive aggression relates positively to constructive outcome expectations for aggression and the tendency to prioritize instrumental goals over social goals in the same age group (Day, Bream, & Pal, 1992; Smithmyer, Hubbard, & Simons, 2000; De Castro, Merk, Koops, Veerman, & Bosch, 2005; Salmivalli, Ojanen, Haanpaa, & Peets, 2005; McCauliffe et al., 2007). With respect to behavioural correlates, reactive aggression relates positively to social withdrawal, hyperactivity and poor social skills in middle childhood and dating violence in adolescence (Dodge, Lochman, Harnish, Bates, & Pettit, 1997; Waschbusch, Willoughby, & Pelham, 1998; Poulin & Boivin, 2000; Brendgen, Vitaro, Tremblay, & Lavoie, 2001; Prinstein &

Cillessen, 2003; McCauliffe et al., 2007). In contrast, proactive aggression relates positively to juvenile delinquency (Vitaro, Brendgen, & Tremblay, 2002; McCauliffe et al., 2007). Regarding social correlates, reactive aggression relates positively to peer rejection and peer victimization in middle childhood, whereas proactive aggression relates positively to having deviant friends in adolescence (Dodge, Coie, Pettit, & Price, 1990; Vitaro, Gendreau, Tremblay, & Oligny, 1998; McCauliffe et al., 2007).

Preliminary evidence suggests that proactive aggression is associated with more negative long-term behavioural outcomes relative to reactive aggression (Fite et al., 2007). In terms of etiology, reactive aggression relates to earlier harsh parenting, whereas proactive aggression relates to family history of substance abuse and violence (Dodge et al., 2003; Connor, Steingard, Cunningham, Anderson, & Melloni, 2004; McCauliffe et al., 2007). Those data illustrate the differing etiologies, mechanisms, and developmental trajectories of the subtypes of aggression (McCauliffe et al., 2007). Children who begin to display primarily reactive aggression may engage in more proactive aggression over time, because of their parents modeling the efficacy of proactive aggressive behaviour. Eventually, the pattern may result in sustained proactive aggression in the form of juvenile delinquency or adult criminality (McCauliffe et al., 2007).

With respect to the treatment of aggressive children it is critical to realise that the two forms of aggression have different causes (Merk et al., 2005). For example, it has been stated that reactive aggression may be caused by an interaction between classical conditioning and personal characteristics, while proactive aggression may be the result of operant conditioning (Merk et al., 2005). Children with those different types of aggression are likely to respond differently to treatment (Vitaro, Brendgen & Barker, 2006; Wolff, Greene and Ollendick, 2008). It has been suggested that proactive aggressive children, whose aggression and oppositional behaviour are aimed at securing rewards, may be more responsive to contingency management procedures that support non-aggressive behaviours, because such children are sensitive to environmental reinforcers, are more goal-oriented, and are able to adjust their behaviour in response to extrinsic contingencies (Vitiello & Stoff, 1997). For these children it may be important to learn about the negative consequences of their aggressive acts for themselves, which can be called social cognitive restructuring (Kempes, Matthys, de Vries, & van Engeland, 2005). Proactive aggressive children may also benefit from exposure to non-aggressive peers (Kempes et al., 2005).

By contrast, children with reactive aggression, whose aggression is characterized more by cognitive and socio-emotional deficits, are considered less capable of self-control and less able to adjust their behaviour in response to environmental contingencies (Vitiello & Stoff, 1997). Therefore, theoretically, these children may be more likely to respond to psychosocial treatments aimed at simultaneously increasing social information processing and decreasing high-levels of hostility, impulsivity, and emotional arousal

(Crick & Dodge, 1996; Vitiello & Stoff, 1997). According to Vitaro, Brendgen and Barker (2006) the focus should be on anger management and social cognitive reconstruction in reactive aggressive children. Cue selection and attributional biases are important aspects of these interventions. The use of medication such as methylphenidate could have positive effects as well, since reactive aggression is related to impulsivity and poor self-regulation (Kempes, et al., 2005; Klein et al., 1997). In addition, interventions with parents and peers to reduce harsh discipline and victimization or rejection could also be effective (Kempes, Matthys, de Vries, & van Engeland, 2005).

According to findings reported in the literature there is sufficient evidence for reactive- and proactive aggression being two distinct constructs (Poulin & Boivin, 2000; Connor, Steingard, Anderson, & Melloni, 2003; Juujärvi, Kaartinen, Pulkkinen, Vanninen, & Laitinen, 2006; Fite & Vitulano, 2011). The underlying mechanisms of both subtypes of aggression appear to be distinct (Bandura, 1973; Berkowitz, 1978). Different variables have been assessed in their relationship to reactive- and proactive aggression, such as peer relations and behavioural outcomes (Prinstein & Cillessen, 2003; Fite et al., 2007). However until now little attention has been given to the relationship between reactive and proactive aggression and reward- and punishment sensitivity which will be the main focus of the current study. It is known for example that children with ADHD react differently to punishment and reward (Luman, Oosterlaan, & Sergeant, 2005). Since children with ADHD have some similarities with reactively aggressive children, this may also be the case for reactively aggressive children. This will be explained in more detail in the next section. Also children with ODD, in which reactive and proactive aggression are common, are likely to react differently to punishment and reward, which will be explained in the next section as well (Luman, Van Meel, Oosterlaan, & Geurts, 2011). In the next section the concepts sensitivity to punishment and sensitivity to reward and their underlying mechanisms will be elaborately discussed.

Reward- and punishment sensitivity

Many educational programs use explicit rewards and ignore inappropriate behaviour to promote adequate behaviour (Luman et al., 2011). However anecdotal reports of parents suggest that children with developmental problems such as attention deficit hyperactivity disorder (ADHD) or other psychiatric conditions that frequently co-occur with ADHD, such as oppositional defiant disorder (ODD) and autism spectrum disorder (ASD) respond differently to those strategies than their normal peers and show alterations in reward- and punishment sensitivity (Luman et al., 2011). It therefore seems likely that proactive- and reactive aggressive children react differently to reward and punishment as well.

In 1972 Gray proposed his theory of brain functions and behaviour, in which anxiety and impulsivity are being distinguished as two dimensions (Carver & White, 1994). Those two dimensions represent two

neurological systems with different responses to environmental cues. Both aversive motivation and appetitive motivation are represented by these two systems. The aversive motivational system is called the behavioural inhibition system (BIS) (Carver & White, 1994; Quay, 1997). The BIS is sensitive to signals of punishment, nonreward and novelty. It inhibits behaviour that may lead to negative consequences and by doing that it causes inhibition of movement toward goals (Carver & White, 1994). The BIS is responsible for negative feelings such as sadness, fear, anxiety or frustration in response to negative cues. Persons that have a greater BIS sensitivity do have greater proneness to anxiety. The BIS comprises the septohippocampal system, its monoaminergic afferents from the brainstem, and its neocortical projection in the frontal lobe (Carver & White, 1994).
The other motivation system, appetitive motivation, has been called the behavioural approach system or the behavioural activation system (Gray, 1990). This system is sensitive to signals of reward, nonpunishment and escape from punishment. Activation of this system leads to movement towards goals (Carver & White, 1994). The BAS is also responsible for the experience of positive feelings, such as hope and happiness (Carver & White, 1994). Greater BAS sensitivity is reflected in a greater proneness to engage in goal-directed behaviour and in the experience of positive feelings when exposed to cues of impending reward (Carver & White, 1994). The neural basis of the BAS is less clearly specified than that of the BIS, though catecholaminergic, especially dopaminergic, pathways are believed to play a central role (Carver & White, 1994). In short it can be stated that the BAS is related to positive affect and the BIS to negative affect (Carver and White, 1994). However it is likely that across the population people exist with all combinations of high and low BIS and BAS sensitivity.

More recently Gray has published a revised version of this theory, according to which there are three interactive, neurologically valid systems that influence behaviour (Gray & McNaughton, 2000; McNaughton & Corr, 2004; Smillie, Pickering & Jackson, 2006). The added system within this theory is the Flight, Fight and Freezing System (FFFS), which is activated by conditioned and unconditioned aversive stimuli, novel stimuli, or non-rewards (Luman et al., 2011). The FFFS results in either behavioural activation of ‘Fight’ or ‘Flight’ responses or in ‘Freezing’ and it has been associated with feelings of rage and fear (Luman et al., 2011). According to the revised theory the BIS is activated by conflict between the BAS and FFFS. In the presence of reward the BIS inhibits the FFFS, favouring approach behaviour, while in the presence of aversive stimuli the BIS inhibits the BAS, favouring escape behaviour (Luman et al., 2011). According to Gray (Gray & McNaughton, 2000; McNaughton & Corr, 2004; Smillie, Pickering & Jackson, 2006), the BIS is particularly related to conflict resolution and behavioural modulation of anxiety, rather than active avoidance in response to punishment signals (associated with FFFS). When both rewarding and aversive stimuli are present in the same environment,

the BIS directs attention to the source of conflict (Smillie, Pickering & Jackson, 2006). Children with ADHD often have difficulties with conflict resolution when both signals of reward and punishment are available, which is often the case in daily life (Luman et al., 2011). Reward sensitivity is represented by the BAS and punishment sensitivity by the FFFS (Luman et al., 2011).

From the literature it is known that children with Attention Deficit Hyperactivity Disorder (ADHD) are more impulsive than children without ADHD (Barkley, 1997b; Iaboni, Douglas & Ditto, 1997; Tripp & Alsop, 1999). They also show difficulties in paying attention, run around and do not seem to listen when spoken to (APA, 2000). Those children might have a lack of concentration because of a boring task or because of attractive alternative activities they could do at that moment (Luman et al., 2005). During the past decades several studies into the nature of reward- and punishment sensitivity in ADHD have been performed (Rapport, Tucker, DuPaul, Merlo, & Stoner, 1986; Sonuga-Barke, Taylor, Sembi, & Smith, 1992). It appeared that children with ADHD prefer small, immediate rewards over larger, delayed rewards (Luman et al., 2005). Tripp and Alsop have studied sensitivity to reward in boys with ADHD. The boys, aged 6 to 14, had to complete a signal-detection task in which correct identification of one stimulus was rewarded three times as often as correct identification of the other. It appeared that children with ADHD are more sensitive to individual instances of reward compared to controls. The Response bias of the controls is governed more by their reinforcement history. Methylphenidate had a positive influence on the responses of boys with ADHD in that it improved the ability to discriminate between the stimuli and reduced sensitivity to individual instances of reward (Tripp & Alsop, 1999). Children with ADHD also displayed larger improvements than controls in performance on cognitive tasks in which responses were coupled with rewards (Carlson & Tamm, 2000; Konrad, Gauggel, Manz, & Scholl, 2000; McInerney & Kerns, 2003). The value of reinforcement decreases over time among those children and they have a strong preference for immediate rewards, which results in higher levels of impulsive behaviour in those children (Luman et al., 2011). The hyperactive and chaotic behaviour of children with ADHD can be explained by the small impact of the extinction of rewards. According to Sonuga-Barke's delay aversion hypothesis (2002; 2003) children with ADHD show difficulties in dealing with delay rich environments resulting in negative emotional reactions to delay, like avoidance or escape of the delay. According to Quay (1997) ADHD involves a persistent underactive BIS system. Current theoretical models suggest that ADHD is related to altered meso-limbic dopamine responsivity in reward-related circuits (Sagvolden, Johansen, Aase, & Russell, 2005; Tripp & Wickens, 2008).

Other psychiatric conditions, such as oppositional defiant disorder (ODD) and autism spectrum disorder (ASD), frequently co-occur with ADHD (Spencer, 2006; Sturm, Fernell, &Gillberg, 2004), and have also

been associated with alterations in reward- and punishment sensitivity (Luman et al., 2011). The alterations might result from a disturbed interaction between the FFFS and BAS (Beauchaine, Katkin, Strassberg, & Snarr, 2001). Children with ODD are thought to have a predominant BAS, which makes them focus on reward and ignoring signals of punishment (Newman & Wallace, 1993). Those children would have a lack of fear and low autonomic arousal during antisocial behaviours, which leads to a decreased attention to punishment and other stimuli that are related to threat (Raine, 1996). Antisocial individuals show sensation-seeking behaviour to boost psychophysiological arousal (Zuckerman & Neeb, 1979). This has been demonstrated by several experimental studies that used tasks in which the rate of winning decreased and the rate of loosing increased (Van Goozen et al., 2004; Matthys, Van Goozen, Snoek & Van Engeland, 2004). The children with ODD ignored the increasing chance of punishment and kept responding to reward (Matthys et al., 2004). In the study of Luman and colleagues (2010) the Iowa Gambling Task was used to investigate decision making in children with ODD. Decision-making abilities are thought to be influenced by sensitivity to reinforcement and functioning of the autonomic nervous system (Luman, Sergeant, Knol & Oosterlaan, 2010). Children with ODD, compared to their typically developing peers, made more risky choices that were associated with large rewards, but also with large punishments (Luman, et al., 2010). Results of studies into reward- and punishment sensitivity among children with Autism Spectrum Disorder (ASD) are conflicting (Luman et al., 2011). Children with ASD seem to profit from reinforcement in behavioural modification programs aimed at reducing their dysfunctional behaviour, but that may only be true for tangible reinforcement (Garretson, Fein, & Waterhouse, 1990; Matson, Benavidez, Compton, Paclawskyj, & Baglio, 1996). In some studies ASD children showed less efficient learning of reinforcement compared to controls in a decision-making paradigm (Johnson, Yechiam, Murphy, Queller, & Stout, 2006), but in other studies no difference between ASD children and controls was found (Antrop, Stock, Verte, Wiersema, Baeyens, & Roeyers, 2006).

Torrubia and colleagues (2001) have developed a measure to assess reward- and punishment sensitivity, which is the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ). The SPSRQ consists of four scales, which are Sensitivity to Punishment, Impulsivity/Fun-seeking, Drive and Reward responsivity (Colder & O'Connor, 2004). Sensitivity to punishment is represented by the scale Sensitivity to Punishment, while the other three scales represent sensitivity to reward. According to Gray's theory the Sensitivity to Punishment scale is unrelated to the three Sensitivity to Reward scales as found by Colder and O'Connor in 2004. Drive is significantly correlated to Impulsivity/Fun-seeking and with Reward Responsiveness. Impulsivity/Fun-seeking and Reward Responsiveness are unrelated in their study (Colder & O'Connor, 2004). They also studied the relationship between the four subscales of the

SPSRQ and externalising- and internalising behavioural problems (Colder & O'Connor). High levels of Impulsivity/Fun-seeking were associated with high levels of externalising behavioural problems. On the other hand high levels of Sensitivity to Punishment were associated with high levels of internalising problems. About the differences between the three sensitivity to reward scales, Colder and O'Connor state that Impulsivity/Fun seeking may represent a more risky temperament than reward responsiveness or drive because it increases the likelihood of frequent coercive social transactions, which is known to be an important process in the development of disruptive behavioural problems (Patterson, Reid, & Dishion, 1992). They also state that Impulsivity/Fun-seeking may represent a more pure behavioural expression of BAS activation than the other SR scales (Colder & O'Connor, 2004).

Luman and colleagues (2011) have studied the validity of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire for children (SPSRQ-c) using a Dutch sample of 1234 children between 6-13 years of age. They have performed a factor analysis, which determined that a 4-factor and a 5-factor solution showed the best fit. The 4-factor solution and the SPSRQ factors found in adults (Punishment Sensitivity, Reward Responsivity, Impulsivity/Fun-Seeking, and Drive) are very much alike. The 5-factor solution was more closely related to the reinforcement model of Gray, since Punishment Sensitivity was subdivided in a 'social-fear' factor and 'general anxiety' factor (Gray & McNaugton, 2000). From the perspective of parsimoniousness one would select the 4-factor model as the optimal solution, but from the perspective of construct validity the 5-factor model would be preferred. To assess the external validity of the SPSRQ-C three subgroups of children with ADHD were being compared (ADHD-only, ADHD and Autism Spectrum Disorder (ASD) and ADHD and Oppositional Defiant Disorder (ODD)). It appeared that in comparison with typical controls all ADHD groups scored higher on Reward Responsiveness and on general anxiety. The ADHD-ASD group scored higher than the other groups on Punishment Sensitivity. This difference disappeared in the 5-factor solution when groups were compared on the FFFS factor that included only the 'social fear' items. The higher score of the ADHD-ASD group on punishment signals appears to be related to a higher score on the 'general anxiety' (BIS) items. The ADHD-only and ADHD-ODD groups scored both higher than the ADHD-ASD group and the typical developing children on Impulsivity/Fun-Seeking and Drive (Luman et al., 2011).
More information about the relationship between type of aggression (reactive vs. proactive) and reward- and punishment sensitivity could be useful for the development of effective interventions in reducing behavioural problems. 'Minder Boos en Opstandig' is a Dutch behavioural therapeutic program aimed at reducing behavioural problems among aggressive children. More information about this program will be given in the next section.

The intervention 'Minder boos en opstandig'

In this section the behavioural therapeutic program 'Minder boos en opstandig' will be discussed. Aim of this intervention is reducing behavioural problems in aggressive children and reducing stress of their parents (Van de Wiel, Hoppe and Matthys, 2003). The 'Minder boos en opstandig' program has been derived from previous developed programs, like the Coping Power Program and the Utrecht Coping Power Program (Van de Wiel, Hoppe and Matthys, 2003). Minder Boos en Opstandig is used for children of 8-12 years of age with a disruptive behaviour disorder (Oppositional Defiant Disorder (ODD) or Conduct Disorder (CD), possibly in combination with ADHD (Van de Wiel, Hoppe and Matthys, 2003). The program could also be used for children at risk for the development of one of those disorders, but who do not yet satisfy all necessary diagnostic criteria (Van de Wiel, Hoppe and Matthys, 2003). The intervention is aimed at improving parenting skills and improving problem solving skills of children in social situations (Van de Wiel, Hoppe and Matthys, 2003). Minder Boos en Opstandig is based on different interventions, which are the so called 'Anger Coping Program', the 'Stop&Think program', cognitive behavioural therapies and Parent Management Training (Van de Wiel, 2002).

Coping Power Program

Lochman and Wells have developed the Coping Power Program (CPC) in 1996. The main aim of this program is preventing delinquency and substance abuse among adolescents. The Coping Power Program itself has been derived from the Anger Coping Program, which consists of 12 sessions, during which children learn different skills to cope with their anger, using concepts such as inner speech and the recognition of body sensations linked to anger. They also learn to recognize perceptions and feelings of others and to solve problems in a reflective way. The Anger Coping Program had proved to be effective in a study by Lochman and colleagues in 1981, resulting in lower rates of alcohol- and drug use, a higher self-esteem and an improvement in social problem solving skills among the participants. However the long term effects of the program regarding reductions in antisocial behaviour were somewhat disappointing (Van de Wiel, Hoppe and Matthys, 2003). It was decided to change the number of sessions from 12 to 18 sessions, because the effects of this extended version of the Anger Coping Program appeared to be larger than those of the original version (Lochman and Wells, 1996). Because of the disappointing effects of the program in the long term, Lochman and Wells (1996) decided to extend the program with a parent component in which parenting skills were trained. This program was called the Coping Power Program. The program consists of 18 sessions for the parents and 33 for the children. The Coping Power Program is effective in reducing (self- reported) delinquency among adolescents, (parent-

reported) substance abuse and (teacher-reported) improvements of behaviour, measured during a one-year follow-up (Lochman & Wells, 2002a, Lochman & Wells, 2002b).

Utrecht Coping Power Program

For use of the Coping Power Program in the Netherlands a Dutch version of the program has been developed by Van de Wiel, Hoppe and Matthys (2003). The so called Utrecht Coping Power Program included a parent training and a training for children. The difference between the Coping Power Program and the Dutch version is the fact that the first one is used only at schools and the last one is used in mental health services. In the Utrecht Coping Power Program the parent- and child training are integrated and attuned to each other. The same trainers are used for both components, which is important for informing the parents about the functioning of their children. The parent training starts a bit earlier than the training for the children, so the parents have the initiative in working on the aims of the program. Parents are supposedly more involved in the treatment of their child, because they receive a lot of information about the child training during the earlier parent sessions.

In both the Coping Power Program and the Utrecht Coping Power Program children are treated in groups of approximately four children. This makes it possible for children to learn from their peers, which makes generalization to their own environment less difficult. In the Utrecht Coping Power Program the children also have to do some exercises at home, which was not the case in the original Coping Power Program. This may also be important for improving the generalization of the learned skills. Parents are asked to reinforce their children in a positive way when learned skills are used by them. Some new topics were added to the Dutch version of the Coping Power Program. Parents learned to give structure to their households and children learned communicative skills and skills to cope with quarrels they were involved in. Children also became familiar with the term ‘Stop’, which helps them to think about their behaviour beforehand, which is important for impulsive children. The Utrecht Coping Power Program consists of 15 parent sessions and 23 sessions for the children. All parent sessions start with a review of the previous session, then the weekly home exercise is discussed, and after that the new topic is introduced. Finally, the new home exercise is explained. To explain new topics to the parents, examples, videos and role playings are used. Every child session has the same structure as that of the parents with the addition of a game and the distribution of rewarding points.

Effectiveness of the Utrecht Coping Power Program

Van de Wiel has studied the effect of the Utrecht Coping Power Program in clinical practice (2002). In other studies, researchers have investigated the effect of elements that are used in the Utrecht Coping Power Program, like parenting skills trainings for parents (Serketich & Dumas, 1996) and cognitive behavioural therapy for children (Bennett & Gibbons, 2000). Those studies have shown the effectiveness of both elements, but their results cannot be generalized to the daily clinical practice (Weisz. Weiss, Donenberg & Han, 1995). A difference can be made between the 'efficacy' of treatments within research settings and the 'effectiveness' of those treatments in daily clinical practice (van de Wiel, Hoppe & Matthys, 2003). In their study van de Wiel and colleagues (2003) have compared the Utrecht Coping Power Program with 'Care as Usual', like family therapy, individual behavioural therapy and parent coaching, for their effectiveness in reducing behavioural problems. 77 Children, aged 8-12 years, with a diagnosis of oppositional defiant disorder (ODD) or conduct disorder (CD), were involved in the study. The amount of behavioural problems was measured directly after the Utrecht Coping Power Program, at a six-month follow-up and at a two-year follow-up. In both groups there was a reduction of behavioural problems. This means that there were no differences in effectiveness of both treatment conditions (Utrecht Coping Power Program and Care as Usual). Four years after the treatment, substance abuse among adolescents that had participated in the research was studied. The Utrecht Coping Power Program group again was compared to the 'Care as Usual' group. This study also involved a control group. The Utrecht Coping Program was able to prevent substance abuse among the adolescents, whereas 'Care as Usual' was not. Predictors of the treatment effect of the Utrecht Coping Power Program and Care as Usual have also been studied by Van de Wiel and colleagues (2003). It appeared that the 'Care as Usual' group is more sensitive to the influence of factors such as age and intelligence than the Utrecht Coping Power Program group. Among the 'Care as Usual' group, older children showed less disruptive behaviour than the younger children at the post-test and at the six-month follow-up. Also children with a high intelligence showed less disruptive behaviour at the two-year follow-up (Van de Wiel, 2002).

In 2003, Van de Wiel and colleagues studied the costs of both treatments (Utrecht Coping Power Program and 'Care as Usual'). The Utrecht Coping Power Program appeared to be less expensive than 'Care as Usual' but still resulted in similar outcomes compared to Care as Usual. To summarize the results of the study it can be stated that both the Utrecht Coping Power Program and 'Care as Usual' lead to a reduction in disruptive behaviour among the children. Advantages of the Utrecht Coping Power Program in comparison to 'Care as Usual' are the fact that the Utrecht Coping Power Program is able to prevent substance abuse among adolescents, the fact that this program is not being influenced by intelligence and age of the children and lastly the fact that this program is cheaper than 'Care as Usual'.

Minder Boos en Opstandig

The Utrecht Coping Power Program has been changed slightly and the new version is called the 'Minder Boos en Opstandig' program (van de Wiel, Hoppe & Matthys, 2003). Based on clinical experience the number of sessions of the Utrecht Coping Power Program has been changed. Twenty-three sessions appeared to be too much for the children, because of their desceasing motivation and 15 sessions for the parents appeared to be too little, because parents wanted to have more time to practice the learned skills. So the new version of the program included 18 sessions for the children and 18 sessions for the parents. Role plays are being used to practice skills and to make parents and children aware of their own behaviour. Both parents and children get home assignments to let them practice with the learned theories.

In the first session the parents receive some psycho-education about disruptive behaviour disorders. In the second session general behaviour rules are being discussed. Then there is some attention to the formulation and maintenance of rules that parents would like to use at home. It is explained to parents that it is important to have notice of the activities of their children. Also some attention is given to the observed behaviour of their children. Parents are taught to hand their children assignments in a way that will not invoke a stubborn or refusive reaction. An important aspect of the 'Minder Boos en Opstandig' program is repetition of learned behaviour and the sharing of experiences, which is incorporated in the seventh session. In the next session parents are being taught to praise and reward their child for showing positive behaviour. The following three sessions are about punishing the child by ignoring the child's behaviour, by taking away something nice for the child or by setting the child apart from the parents. After that again there is some attention to repetition of learned behaviour and sharing of experiences. In the subsequent sessions the following themes are discussed: dealing with social problems, dealing with secret behaviour of the child, stress management, taking care of oneself as an individual and creating a positive environment in the family. Also there is some attention for problems the parents experience during the program and the evaluation of the program.

The child training starts with an introduction in which the children will get information about the aim of the training. The following two sessions are about recognising one's own feelings. More specific angry feelings are discussed during the fourth session. After that, convenient and less convenient ways to cope with anger are explained in a couple of sessions. The children are also introduced to the theory of the resolution of social problems. This theory includes five steps which have to be taken to solve a problem. Those steps are (1) What is the problem? (2) Which solutions can be thought of? (3) Which are the consequences of those solutions? (4) Choose the most appropriate solution, (5) Carry out this solution and evaluate the effectiveness of the solution (Dodge, Pettit, McClakey & Brown, 1986). In the following four sessions the children are taught some skills to cope with social problems, like contacting other

children and coping with quarrels with their parents. There is room for repetition and evaluation in the last two sessions.

The sessions of the parents and those of the children are much alike in terms of their structure. Every session starts with a review of the previous session. Then the home assignment is discussed. After that the new topic is introduced. Exercises and examples are used to teach the parents and the children new things. Each session ends with a short summary and the explanation of the new home assignment. For the parents the child sessions are discussed to inform the parents about their children's progress. During the children's sessions a game is played if time admits.

Some aspects of Minder Boos en Opstandig are likely to be main causes of its effectivity (Van de Wiel, Hoppe and Matthys, 2003). First of all the strict protocol that is followed during the intervention (manualized treatment) and the use of well-trained performers of the intervention, which makes the intervention structured and makes sure that all aspects will be applied during the sessions (treatment integrity). Second aspect is the working method on two domains (sessions for the parents and sessions for the children), which makes it a very complete intervention. Lastly the use of specific activities that connect very well to the problems of the children that are involved in the intervention (Van de Wiel, Hoppe and Matthys, 2003).

The Minder Boos en Opstandig program is based on the thought that social interaction processes between parents and children play an important role in the maintenance of the antisocial behaviour of the child. Reason why one of the aims of Minder Boos en Opstandig is changing those social interaction processes by learning the parents to approach their children in a different way. Elements of operant conditioning are used to establish that kind of changes in social interaction processes (Van de Wiel, Hoppe & Matthys, 2003). This method of working is based on the Parent Management Training and this is one of the best researched and validated methods for the treatment of oppositional and aggressive behaviour among children (Kazdin & Weisz, 1998). Children with behavioural problems often have automatic perceptions of their environment and their problem solving skills (Orobio de Castro, 2001). They are less capable of recognizing their anger and controlling their reactions, but are likely to neglect their feelings. Therefore another aim of Minder Boos en Opstandig is to improve the problem solving skills of children in social situations by teaching them to reflect on themselves and on the situation before they act (Van de Wiel, Hoppe & Matthys, 2003). After some time this way of reacting should be an automatic and internalised response. Elements of 'cognitive problem-solving skills' are used to reach this goal (Van de Wiel, Hoppe & Matthys, 2003).

The current study

The aim of the current study is to investigate the relationship between reactive and proactive aggression on the one hand and reward- and punishment sensitivity on the other. The question is whether type of aggression (reactive vs. proactive) is predicted by reward- and punishment sensitivity. The underlying factor structure of the SPSRQ-C will be used to be able to give a more precise answer to the research questions of this study. In addition, the relationship between callous and unemotional traits and type of aggression will be studied. It can be questioned whether the prediction of different types of aggression by reward and punishment factors is mediated by callous and unemotional traits. Also, the influence of the intervention 'Minder boos en opstandig' on behavioural outcomes and on sensitivity to punishment and reward will be studied. The question is whether the intervention 'Minder boos en opstandig' is able to reduce behavioural problems among the participating children and whether this treatment is able to improve reward- and punishment sensitivity and callous and unemotional traits, which might mediate any behavioural improvement.

Study 1

Since there is a lack of research into the specific relationship between type of aggression and reward- and punishment sensitivity, it is difficult to base hypotheses on the results of existing studies. The main characteristics of reactive aggression are impulsivity, lack of self-control, weak frustration tolerance and cognitive deficits in social information processing and problem solving skills (Vitiello & Stoff, 1997). Those characteristics can also be found among children with ADHD (APA, 2000). Therefore a relationship between ADHD and reactive aggression is assumed. From the literature it is known that children with ADHD show some alterations in reward- and punishment sensitivity (Luman et al., 2011). They are more sensitive to individual instances of reward and do not give much attention to their reinforcement history (Tripp & Alsop, 1999). Children with ADHD have a strong preference for immediate rewards and show difficulties in dealing with delay-rich environments (Sonuga-Barke, 2002, 2003; Luman et al., 2011). They also displayed larger improvements than controls in performance on cognitive tasks in which responses were coupled with rewards (Carlson & Tamm, 2000; Konrad, Gauggel, Manz, & Scholl, 2000; McInerney & Kerns, 2003). So from a global point of view it is expected that reactive aggressive children show alterations in sensitivity to reward. When the different subscales of reward sensitivity are taken into account, the following relationships are being expected. Since reactive aggression can be called a form of externalising problem behaviour, and since high levels of Impulsivity/Fun-seeking are associated with high levels of externalising behavioural problems (Colder & O'Connor, 2004), it is expected that high levels of reactive aggression are associated with high levels

of Impulsivity/Fun-seeking. This has also been found in the study of Luman and colleagues (2011). Because Impulsivity/Fun-seeking is highly correlated with Drive and Reward Responsiveness ($r = .35$, $p < .01$) (Colder & O'Connor, 2004), also a positive relationship between reactive aggression and Drive and Reward Responsiveness is expected. No relationship between reactive aggression and Sensitivity to Punishment is expected (Colder & O'Connor). Because reactive aggressive children are expected to be impulsive and to be more likely to show approach behaviour (BAS) than avoidance behaviour (FFFS), no relationship is expected between the FFFS (representing fear and discomfort and active avoidance behaviour) and reactive aggression (Vitiello & Stoff, 1997). A positive relationship is expected between reactive aggression and the BIS (representing general anxiety and difficulty with the modulation of anxiety), because it is known that reactive aggressive children have a lack of self-control and as result might also have difficulties with the modulation of anxiety (Vitiello & Stoff, 1997). In addition no relationships are expected between callous and unemotional traits and reactive aggression, since reactive aggression is not characterized by a lack of empathy, a lack of caring for one's own performance and a lack of emotional expression (Fite et al., 2007; Kimonis et al., 2008).

Both reactive- and proactive aggression are common characteristics of Oppositional Defiant Disorder (ODD) (APA, 2000; Orobio de Castro, 2001). This means that part of the proactive aggressive children might show ODD-related behaviours, which indicates that there would be a relationship between proactive aggression and ODD. Children with ODD are thought to have a predominant BAS, which makes them focus on reward and ignoring signals of punishment (Newman & Wallace, 1993). Those children would have a lack of fear and low autonomic arousal during antisocial behaviours, which leads to a decreased attention to punishment and other stimuli that are related to threat (Raine, 1996). Therefore a negative relationship between proactive aggression and sensitivity to punishment is expected. Antisocial individuals show sensation-seeking behaviour to boost psychophysiological arousal and they score high on Impulsivity/Fun-seeking and Drive (Zuckerman & Neeb, 1979; Luman et al., 2011). That is why a positive relationship between proactive aggression and Impulsivity/Fun-seeking and Drive is expected as well. Proactive aggressive children are also expected to be more responsive to reward, because of the high correlation between Impulsivity/Fun-seeking and Drive on the one hand and Reward Responsiveness on the other. No relationship is expected between proactive aggression and FFFS (representing fear or discomfort and active avoidance in social situations), because proactive aggressive children are thought to have a predominant BAS, which makes them focus on reward and ignoring signals of punishment and which makes them more likely to show approach behaviour (Newman & Wallace, 1993). No relationship is expected between proactive aggression and BIS (representing general

anxiety) as well, because anxious behaviour is not expected to occur a lot among proactive aggressive children (Raine, 1996).

So a lot of similar results are expected in reward- and punishment sensitivity among proactive and reactive aggressive children, the exception being punishment sensitivity, which is only expected to be related to proactive aggression. This could be explained by the fact that proactive- and reactive aggression have found to be correlated as well. Information about reward- and punishment sensitivity in proactive and reactive aggression could help in distinguishing both types of aggression in a better and more specific way. Concerning the callous and unemotional traits, relationships with proactive aggression are expected (Marsee & Frick, 2007), and therefore associations with both punishment- and reward sensitivity (Impulsivity/Fun-seeking, Drive, and Reward Responsiveness) as well.

Study 2

For the second study the following hypotheses were developed. It is expected that Minder Boos en Opstandig is more effective in reducing behavioural problems in proactive aggressive children than in reactive aggressive children, because those children have more capabilities to change their behaviour. For example it has been suggested that proactive aggressive children, whose aggression and oppositional behaviour are aimed at securing rewards, may be more responsive to contingency management procedures that support non-aggressive behaviours, because such children are sensitive to environmental reinforcers, are more goal-oriented, and are able to adjust their behaviour in response to extrinsic contingencies (Vitiello & Stoff, 1997). Minder Boos en Opstandig uses such environmental reinforcers, like presents for the child (Van de Wiel, Hoppe & Matthys, 2003). This might work very well among proactive aggressive children. Furthermore it has been stated that proactive aggression may be the result of operant conditioning (Merk et al., 2005). Minder Boos en Opstandig uses operant conditioning techniques to improve the social interaction process between the parents and the child (Van de Wiel, Hoppe & Matthys, 2003). Proactive aggressive children are capable of reflecting on themselves and on their behaviour, which is very important to establish an improvement of behaviour (Kempes, Matthys, de Vries, & van Engeland, 2005). Reactive aggressive children are expected to be less sensitive to the Minder Boos en Opstandig program. They are impulsive and hyperactive and they are considered less capable of self-control and less able to adjust their behaviour in response to environmental contingencies (Vitiello & Stoff, 1997). One of the techniques that is used in Minder en Boos en Opstandig is rewarding the child for its positive behaviour, but those rewards are often delayed rewards (Van de Wiel, Hoppe & Matthys, 2003). Both reactive- and proactive aggressive children are expected to be sensitive to reward, but the reactive aggressive children have a strong preference for immediate rewards (Luman et al., 2011).

That is another reason why the training may be more effective in improving the behaviour of proactive aggressive children in comparison to reactive aggressive children. Minder Boos en Opstandig also uses some forms of punishment to invoke positive behaviour, but the main focus is on reward (Van de Wiel, Hoppe & Matthys, 2003).

Lastly, concerning the improvement in sensitivity to punishment and reward, it is expected that reactive aggressive children will learn to deal with delayed rewards and proactive aggressive children will learn to be more sensitive to punishment. Those improvements are likely to go along with improvements in behaviour.

Method

Sample

For the first study 385 boys with a mean age of 14 years and 5 months (range 12 to 17 years, *SD* = 1 year and 2 months) were recruited from 11 schools of secondary education in the Netherlands (Dataset A). For the second study 26 children (23 boys, 3 girls) with a mean age of 10 years and 1 month (range 8 to 12 years, *SD* = 1 year and 9 months) were recruited from seven mental health services in the Netherlands (Dataset B).

Measurement instruments

Study 1: Relationship between type of aggression and reward- and punishment sensitivity.

Reactive and proactive aggression

Reactive and Proactive Questionnaire (RPQ). The Reactive Proactive Questionnaire (RPQ) is a 23-item measure for children between the ages 7 and 16, which yields subscale scores for the reactive (11 items) and proactive (12 items) subscale (Tharp et al., 2011). The 23 behavioural items are rated on a 3-point scale (0 = never; 1 = sometimes; 2 = often). Scores are summated to form measures of reactive or proactive aggression together with an overall score of total aggression (Fung, Raine & Gao, 2009). It takes approximately three minutes to fill in the questionnaire and it has a minimal reading age of eight years (Fung, Raine & Gao, 2009). The items of the different dimensions were highly correlated in a study by Raine and colleagues (2006) (Cronbach's alpha of .86 for proactive aggression, .84 for reactive aggression and .90 for total aggression). Although both subscales are significantly correlated with each other (r = .67, Brown, Atkins, Osborne & Milnamow, 1996), factor analysis has confirmed the two-factor structure of the RPQ (Raine et al., 2006).

Sensitivity to punishment and sensitivity to reward

Sensitivity to Punishment and Sensitivity to Reward Questionnaire for children (SPSRQ-c). The children's version of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire has to be filled in by the parents (Luman et al., 2011). It contains 33 items and it is divided in a Punishment Sensitivity or BIS scale (15 items), and three Reward Sensitivity or BAS scales, which are Reward Responsiveness (7 items), Impulsivity/Fun-Seeking (7 items), and Drive (4 items) (see Appendix 1 for the items) (Torrubia et al., 2001; Luman et al., 2011). The items are scored on a 5-point Likert scale (1 =

strongly disagree, 5 = strongly agree). The questionnaire has proved to be reliable in a study of Colder and O'Connor (2004) with a Cronbach's alpha of .87 for Punishment Sensitivity, .69 for Reward Responsiveness, .76 for Impulsivity/Fun-Seeking and .73 for Drive. Luman and colleagues (2011) have found two optimal factor structures for the SPSRQ-C, which consist of four and five factors respectively. The five-factor- model was theoretically most closely related to Gray's reinforcement theory and allowed separation of the Flight, Fight and Freezing System (FFFS) and the Behavioural Inhibition System (BIS) (Gray & McNaughton, 2000; Luman et al., 2011). This five-factor-model offers a more encompassing picture of reward and punishment sensitivity in children, than the four-factor-model (Luman et al., 2011). However from the perspective of parsimoniousness one would have selected the four-factor-model as the optimal solution. The five-factor-model is almost identical to the original four-factor solution, except for the Punishment Sensitivity factor that is divided in two separate factors, which are FFFS and BIS (Luman et al., 2011).

Callous and Unemotional Traits

Inventory of Callous and Unemotional Traits (ICU). The ICU is a measure that is an extension of the Antisocial Process Screening Device (APSD) (Frick & Hare, 2001), which has proved to be a useful measure of psychopathic traits (Frick & White, 2008; Vaughn & Howard, 2005). It consists of 24 items that are rated on a four-point Likert scale ranging from 0 (Not at all true) to 3 (Definitely true). The ICU was designed to surmount the weaknesses of the APSD, which are the lack of items- and the lack of reliability of callous-unemotionality (Vaughn et al., 2011). A recent study of the ICU using confirmatory methods indicated a three factor structure consisting of a callous factor (lack of empathy, guilt and remorse for misdeeds), an uncaring factor (lack of caring about one's performance in tasks and for the feelings of others), and an unemotional factor (absence of emotional expression) (Kimonis et al., 2008). Dimension reduction techniques used in the study of Vaughn and colleagues (2011) also supported a three factor structure consisting of callous (a = .94), uncaring (a = .93), and unemotional factors (a = .89). The total score internal consistency reliability was
excellent (a = .92).

Study 2: Effectivity of Minder Boos en Opstandig in reducing behavioural problems and improving reward- and punishment sensitivity.

Decision making

Iowa Gambling Task (IGT). The Iowa Gambling Task (IGT) was created to assess decision making in a laboratory setting and has been used for assessments in various clinical populations in addition to those with orbitofrontal cortex damage, for whom it was originally developed (Buelow & Suhr, 2009). The construct validity appears to be good according to Buelow and Suhr (2009). It is a computerised task in which participants have to make a series of choices from a set of four 'decks of cards', labelled 'A', 'B', 'C' and 'D' to maximize financial profit (Upton, Bishara, Ahn & Stout, 2011). Each deck is associated with a fixed immediate reward for every selection (A and B, $ 100; C and D, $ 50), as well as an occasional penalty which differs in frequency and magnitude across the decks (Upton et al., 2011). At the start participants received $2000 and the test consists of 100 trials in which the participants can select a card from one of four decks (Buelow & Suhr, 2009). After 10 selections from Decks A and B, individuals have incurred a net loss of $250, whereas after 10 selections from Decks C and D, individuals have incurred a net gain of $250 (Buelow & Suhr, 2009). Decks A and B have been termed "disadvantageous," and selection from these decks is deemed risky, while Decks C and D are termed "advantageous" (Yamano et al., 2011). The behavioral performance for the one hundred card selections were sub-divided into five blocks of 20 cards each (Buelow & Suhr, 2009). The net score for each block was calculated by subtracting the number of good from bad card selections [(C+D)–(A+B)]. A net score above zero implied that the participants were selecting cards advantageously, and a net score below zero implied disadvantageous selection (Evans, Bowman & Turnbull, 2005).

Behaviour problems

Child Behaviour Checklist (CBCL). The Child Behaviour Checklist (Achenbach 1991) is a parent-rating scale to assess competences, emotional and behavioural problems in children and adolescents aged 4–18. It is easy to administer and takes about 20–30 min to complete (Galli et al., 2007). The measure consists of statements about child behaviours to which parents respond on a three-point scale, ranging from "not true of my child" to "very true or often true of my child" (Schroeder, Hood & Hughes, 2010). The CBCL distinguishes several syndrome scales, which are Withdrawn (9 items), Anxious/Depressed (14 items), Somatic Complaints (9 items), Delinquent Behaviour (13 items), Aggressive Behaviour (20 items), Social Problems (8 items), Attention Problems (11 items), and Thought Problems (7 items). In addition, these syndrome scales are combined to create three index scales: the Internalizing scale (Withdrawn,

Anxious/Depressed, and Somatic Complaints scales), the Externalizing scale (Delinquent Behaviour and Aggressive Behaviour scales), and the Total Problems scale (includes all 8 scales) (Schroeder, Hood & Hughes, 2010). The 1 week stability coefficient is .93 for the Externalizing score and .89 for the Internalizing score. Internal consistency coefficients for the narrow band scales and the three index scales range from .76 to .92 (Schroeder, Hood & Hughes, 2010).

Additional measures

For the second study the SPSRQ-C and the RPQ are used as well. A description of those measures can be found above.

Procedure

Study 1

To test the relationship between type of aggression (reactive vs. proactive) and reward- and punishment sensitivity, several schools in the Netherlands were asked to participate in the study. The parents of the children were asked permission to let their children fill in the questionnaires and the parents themselves were also asked to fill in some questionnaires.

Study 2

To test the effect of the 'Minder Boos en Opstandig' (MBO) program mental health services in the Netherlands that are familiar with the 'Minder Boos en Opstandig' program were asked to take part of the study. Parents following the MBO program were asked to participate in the study by master students who visited the parents at the mental health service. Before the start of the MBO program children and their parents were being tested. The children had to perform 5 computerised tests, 4 paper and pencil tests and they had to fill in two questionnaires and the parents had to fill in six questionnaires about their child. It took approximately two hours for the children to perform the tests and the questionnaires and it took about one hour for the parents to fill in the questionnaires. The questionnaires on the children were filled in by one of the parents. Directly after the MBO program, the second test-session took place (post test).

Statistical Analyses

The analyses are conducted with the Statistical Package for the Social Sciences (IBM SPSS Statistics) version 19 and with the Structural Equation Modeling Software EQS.

Missing data:

Study 1

To deal with the missing values in the dataset, different Multiple Imputation (MI) methods were used (Rubin, 1987; Van Ginkel, 2010). For the Principal Component Analysis a Mean Correlation Matrix was calculated on which Principal Component Analyses could be performed (see for more information Van Ginkel, Van der Ark, Sijtsma & Vermunt, 2007). The Full Information Maximum Likelihood (FIML) method was used to deal with the missing values in EQS, when performing a Confirmatory Factor Analysis (see for more information Sanchez, Sotorrio & Diez, 2011). Lastly the option 'Impute missing data values' was used to deal with these missing values in calculating correlations and performing regression analyses in SPSS (Blanker, Koeter & Schippers, 2010). This method generates several complete datasets, each with a different set of replacement values, by predicting the missing values based on characteristics of the data. Those individual datasets can be modeled and 'pooled' results are given, that show the final parameter estimates. The hierarchical regression analyses were performed on the non-imputed dataset.

Study 2

In the second study only the participants that were involved in the pretest and the posttest were involved in the analyses. No missing values were found among them.

Statistical Analyses

Study 1

For the purpose of finding an optimal factor structure for the Sensitivity to Punishment Sensitivity to Reward Questionnaire for Children (SPSRQ-C), a Principal Component Analysis (PCA) was conducted on the first dataset (Dataset A). Factors were identified that would optimally explain the covariation among the items belonging to the SPSRQ-C. In order to determine which PCA-models were retained and used in the Confirmatory Factor Analysis (CFA), the PCA-models were evaluated against the theoretical model of Gray (Gray et al., 2000; Luman et al., 2011). Confirmatory factor analyses were conducted to investigate which of the selected PCA-models gave the best description of the current data.

The models were fitted using the Confirmatory Factor Analysis (CFA) in EQS. Multiple fit indices were used, since no clear consensus exists regarding the best goodness-of-fit indices for the evaluation of the CFA (Luman et al., 2011). In the current study, we present six frequently reported indices (see for details Steiger, 1990; Browne & Cudeck, 1993; Byrne, 1994; Bollen 2002; Schumacker & Lomax, 2004; Schermelleh- Engel, Keith, Moosbrugger, & Hodapp, 2004; Luman et al., 2011): χ^2 goodness of fit test,

the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), the Akaike Information Criterion (AIC), the Normed Fit Index (NFI) and the Root Mean Square Residual (RMR). A non-significant χ^2 indicates an adequately fitting model, although this test is sensitive to sample size (which is large in the current study). An RMSEA value of 0.05 or smaller indicates a close fit, values between 0.05 and 0.08 represent a reasonable fit, values between 0.08 and 0.10 a mediocre fit, whereas values >.10 are not acceptable. CFI values greater than .90 are considered as indicative of a good fit and higher values indicate a better fit. The lower the AIC value, the better a model fits. NFI values should be between .90 and .95, which is acceptable. A value of above .95 is good. For RMR a value between .05 and .07 indicates a good model fit. Finally, reliability indices (coefficient alpha) of the model factors were explored, a higher reliability indicating a lower error variance.

The four- and the five-factor-models of the study of Luman and colleagues (2011) were fitted as well in order to evaluate whether those models fit the data of our study as well. Finally the best fitting model and the models that theoretically make sense were chosen to retain and use in subsequent analyses.

First, Pearson Correlations were calculated to assess the relation between the predictors and the outcome variables. After that simple linear regression analyses were performed in order to assess the separate influence of each of the predictors on the dependent variables (reactive- and proactive aggression). Multiple regression analyses were performed to assess the influence of the complete models on reactive and proactive aggression.

Hierarchical multiple regression analyses with significant correlations were conducted in order to assess the combined contribution of the predictors to the outcome variables (reactive- and proactive aggression). We forced the factors of the different PCA-models in the first block of the hierarchical regression analysis, after which reactive or proactive aggression was entered, to assess the unique contribution to proactive and reactive aggression respectively. To assess the unique contribution of the ICU scales to proactive and reactive aggression, the ICU scales were entered in the third block.

Study 2

To assess whether the ‘Minder Boos en Opstandig’ program led to a diminishment of behavioural problems and an improvement of reward- and punishment sensitivity, non-parametric Wilcoxon Signed Rank Tests were used to compare the means of the pretest and the posttest. Also Spearman’s rho correlations were used to assess the relationships between the difference scores (between pretest and posttest) of the reward- and punishment sensitivity scores and the behaviour problem scores and between the difference scores of the reward- and punishment sensitivity scores and the aggression scores.

Results

Study 1: Relationship between type of aggression and reward- and punishment sensitivity.

Principal Component Analysis on Dataset A

The dimensionality of the 33 items of the SPSRQ-C was explored using factor analysis in SPSS. The number of factors was determined using the scree-test and a parallel analysis as well as the substantive meaning of the factors and theoretical background. The scree-test indicated that a three- or four-factor-solution would explain the highest percentage of item variance. The parallel analysis pointed at a four-factor solution being the most optimal solution in explaining the item variance. According to the theory of Gray (1976, 1982; Gray & McNaughton, 2000) there are three interactive, neurobiologically valid systems that influence two kinds of behaviour, which are approach behaviour and avoidance behaviour. For those reasons it has been decided to derive three interpretable factor models (with 2, 3 and 4 factors, respectively), which are described below. Item loadings on each of the factors is reported in the Appendix (factor loading >0.10 are included). Also the four- and five factor solutions, which came out as most optimal solutions in the study of Luman and colleagues (2011), are discussed below.

A model with 2 factors (called model PCA-2) explained 34.4% of the item variance. Factor 1 may be labeled Reward Sensitivity and consisted of 12 (out of 18) items from the original Reward Sensitivity Scale described by Colder and O'Connor (2004), although two items loaded somewhat higher on Factor 2 of the PCA-2 model and although six items of the original Reward Sensitivity Scale loaded much higher on Factor 2 of the PCA-2 model (see Appendix 1). Factor 2 may be labeled Sensitivity to Punishment and consisted of 12 (out of 15) items from the original Sensitivity to Punishment scale described by Colder and O'Connor (2004), although four items of the original Punishment Sensitivity scale loaded higher on Factor 1 of the PCA-2 model (see Appendix 1). This model could differentiate between sensitivity to punishment (avoidance behaviour) and sensitivity to reward (approach behaviour) (Gray & McNaughton, 2000).

A model with 3 factors (called model PCA-3) accounted for 39.4% of the item variance. Factor 1 may be labeled 'Sensitivity to Social Punishment', because social anxiety and fear are the main topics of most of its items. Factor 2 may be labeled as 'Sensitivity to Reward', because most of its items are about getting a reward. Factor 3 consisted of items that were mostly about winning and social power and may be labeled as 'Sensitivity to Power'.

A model with 4 factors (called model PCA-4) accounted for 43.4% of the item variance. Factor 1 may be labeled 'Sensitivity to Social Punishment' and consisted mainly of items about social anxiety and fear in

general. Factor 2 may be labeled 'Sensitivity to Social Reward' and consisted of some items about being evaluated as nice and funny. Factor 3 consisted mainly of items about getting a quick reward and may be labeled 'Sensitivity to Immediate Reward'. The last factor may be labeled as 'Sensitivity to Power' and consisted of items that were almost all about winning and social power.

The four-factor solution of Luman and colleagues (2011) consisted of the following factors. Factor 1 was labeled Punishment Sensitivity, factor 2 Reward Responsivity, factor 3 Impulsivity/Fun-seeking and factor 4 Drive.

The factors of the five-factor solution from the same study of Luman and colleagues (2011) as mentioned above were factor 1 labeled FFFS (fear or discomfort and active avoidance in social situations) factor 2 labeled Reward Responsivity, factor 3 labeled Impulsivity/Fun-seeking, factor 4 labeled Drive and factor 5 labeled BIS (general anxiety and difficulty with the modulation of anxiety).

The models of Luman and colleagues (2011) differ from the PCA models derived in our study in their distributions of the items over the factors. Therefore different labels have been given to the factors, based on the content of the items of those particular factors and based on the theory of Gray (Gray & McNaughton, 2000).

Model selection

Two models were selected. The first model was the PCA-2 model with two factors (Punishment Sensitivity and Reward Sensitivity). This model was selected based on the theory that there are three interactive, neurobiologically valid systems that influence two kinds of behaviour, which are approach behaviour and avoidance behaviour. (Gray & McNaughton, 2000). The PCA-2 model should be able to differentiate between those two kinds of behaviour. The PCA-2 model is also highly similar to the 2-factor solution derived by Colder and O'Connor (2004).

Secondly, the PCA-4 model was selected that consisted of four factors (Sensitivity to Social Punishment (SSP), Sensitivity to Social Reward (SSR), Sensitivity to Power (SPOW) and Sensitivity to Immediate Reward (SIR)). This model was selected based on the fact that this 4-factor model explained the highest amount of item variance and because the factor structure does fit existing theories about sensitivity to punishment- and reward (Dodge, 1991; Gray & McNaughton, 2000; Van de Wiel, Hoppe & Matthys, 2003; Merk et al., 2005; Luman et al., 2005), although it is somewhat different from factor structures that have been found before (Luman et al, 2011). Proactive aggressive children are likely to be goal-oriented and the advantages of aggression play an important role in this type of aggression (Dodge, 1991). These children might be very sensitive to power and they often use aggression to obtain their goals (for example to obtain a better position in a group) (Merk et al., 2005). Reactive aggressive is an

impulsive form of aggression, which can be seen as a kind of defence against something threatening or frustrating (Van de Wiel, Hoppe & Matthys, 2003). A lot of children with ADHD show reactive aggression and those children have a strong preference for immediate rewards (Luman et al., 2005). Based on this knowledge the distinction between sensitivity to power and sensitivity to immediate reward could be made. The more global distinction between sensitivity to social punishment and social reward is based on the theory of Gray (Gray & McNaughton, 2000) in which a distinction is made between FFFS, BAS and BIS. The BAS initiates approach behaviour or active avoidance and results in positive emotional experiences. The FFFS is activated by aversive stimuli, novel stimuli or non-rewards. The FFFS results in either behavioural activation of 'Fight' of 'Flight' responses or in 'Freezing'. This system has been associated with feelings of rage and fear. Reward sensitivity is represented by the BAS and punishment sensitivity by the FFFS (Luman et al., 2011). The BIS is activated by conflict between the BAS and the FFFS. In the presence of a reward the BIS inhibits FFFS, favoring approach behaviour, while in the presence of aversive stimuli the BIS inhibits the BAS, favoring escape behaviour (Gray & McNaughton, 2000). Because most of the items of the first and second factor of the PCA-4 model were about social situations, the term 'social' has been added to it.

Confirmatory Factor Analysis on Dataset A

To investigate whether the 2 selected PCA models and the two models of Luman and colleagues (2005) provided a good fit to the data, A CFA was conducted with these models. If an item had an absolute loading of 0.30 or higher on a particular factor, then this item was assigned to that factor. This implied that some items were assigned to more than one factor. When an item had no absolute factor loading higher than 0.30, this item was assigned to the factor for which it had the highest absolute loading (see Appendix) (Luman et al., 2011).

The fit indices RMSEA, CFI, NFI and RMR were slightly better for the PCA-4 model than for the PCA-2 model, the Luman-4 model and the Luman-5 model (see Table 1). Coefficient alpha's of the PCA-4 model were .88 for Sensitivity to (Social) Punishment, .71 for Sensitivity to (Social) Reward, .64 for Sensitivity to Power and .74 for Sensitivity to Immediate Reward. It can be concluded that the PCA-4 model is the best fitting model.

For PCA-4 there were positive correlations between the Sensitivity to Social Punishment scale and the Sensitivity to Social Reward scale (r=.30), the Sensitivity to Social Punishment scale and the Sensitivity to Immediate Reward scale (r=.28), the Sensitivity to Social Reward scale and the Sensitivity to Immediate Reward scale (r=.67), the Sensitivity to Power scale and the Sensitivity to Social Punishment scale (r=.14) and lastly between the Sensitivity to Power scale and the Sensitivity to Social Reward scale

(*r*=.59). Those positive correlations could be explained by the fact that all scales represent some form of reward- and punishment sensitivity, which, in turn, are driven by interacting or overlapping underlying mechanisms (Gray & McNaughton, 2000).

Table 1. *Results of the confirmatory factor analyses of four different models.*

Model	***df***	χ^2	***p*-value**	**RMSEA**	**CFI**	**AIC**	**NFI**	**RMR**
PCA-2	491	1528.488	<0.001	0.072	0.752	3724.166	0.677	0.088
PCA-4	481	1183.761	<0.001	0.060	0.831	3724.166	0.749	0.069
Luman-4	424	1246.347	<0.001	0.069	0.799	3695.947	0.728	0.085
Luman-5	420	1190.177	<0.001	0.068	0.809	3627.536	0.736	0.088

Descriptive and preliminary analyses

Means, standard deviations and range of all independent variables, as well as correlations between al variables can be found in Table 2. Proactive and reactive aggression were significantly correlated (r = .57, $p < .001$). Many of the scales of the different models were significantly correlated as well, which makes sense because they all measure the same kinds of constructs.

Table 3 presents the simple linear regressions of all independent variables upon reactive aggression and proactive aggression, the dependent variables. As shown, proactive aggression ($\beta = .571$, $p < .001$) is a significant predictor of reactive aggression. The factors Sensitivity to Social Reward, Sensitivity to Immediate Reward and Sensitivity to Social Power of the PCA-4 model are significant predictors of reactive aggression as well ($\beta = .292, .261, .295$ respectively) ($p < .001$). Of the PCA-2 model only Sensitivity to Punishment significantly predicts reactive aggression ($\beta = .341$, $p < .001$). Of the Luman-4 model Reward Responsiveness, Impulsivity/Fun-Seeking and Drive are significant predictors of reactive aggression ($\beta = .316, .272, .263$ respectively) ($p < .001$).

Table 2. *Correlations among all dependent and independent variables.*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	Mean	SD	Min	Max
1. Reactive aggression	-	-	-	-	-	-																8.52	3.937	0	20
2. Proactive aggression	.57**	-	-	-	-	-																3.00	2.807	0	17
3. PCA-4_SSP	.04	-.02	-	-	-	-																36.11	9.443	17	68
4. PCA-4_SSR	.29**	.29**	.30**	-	-	-																21.93	6.281	10	54
5. PCA-4_SPOW	.30**	.17**	.14**	.59**	-	-																23.88	4.741	6	46
6. PCA-4_SIR	.26**	.11*	.28**	.67**	.54**	-	-															20.82	5.446	8	33
7. PCA-2_SR	.04	-.02	.98**	.38**	.19**	.38**	-	-														38.27	9.374	18	68
8. PCA-2_SP	.34**	.24**	.26**	.89**	.82**	.83**	.34**	-	-													52.05	10.817	25	85
9. Luman4_SP	.05	-.01	.97**	.35**	.21**	.34**	.98**	.32**	-	-												33.78	8.365	15	62
10. Luman4_RR	.32**	.19**	.39**	.86**	.64**	.86**	.45**	.91**	.44**	-	-											33.82	7.394	15	58
11. Luman4_IF	.27**	.29**	.30**	.79**	.54**	.53**	.35**	.76**	.32**	.59**	-	-										9.76	2.987	4	20
12. Luman4_D	.26**	.19**	-.07	.55**	.78**	.36**	-.03	.72**	-.02	.52**	.47**	-	-									10.58	3.874	2	46
13. Luman5_FFFS	.02	-.00	.95**	.28**	.09	.23**	.94**	.22**	.96**	.34**	.26**	-.08	-	-								21.84	6.124	9	43
14. Luman5_RR	.21**	.12*	.40**	.80**	.51**	.86**	.49**	.81**	.45**	.88**	.54**	.32**	.38**	-	-							16.12	4.349	6	28
15. Luman5_IF	.27**	.29**	.30**	.79**	.54**	.53**	.35**	.76**	.32**	.59**	1.00	.47**	.26**	.54**	-	-						9.76	2.987	4	20
16. Luman5_D	.25**	.18**	.18**	.54**	.82**	.37**	-.04	.73**	-.03	.52**	.46**	.97**	-.10*	.33**	.46**	-						13.63	4.254	2	46
17. Luman5_BIS	.24**	.06	.06	.50**	.40**	.54**	.80**	.54**	.83**	.67**	.41**	.15**	.72**	.53**	.41**	.14**						26.40	5.854	10	45
18. ICU_callous	.30**	.43**	.05	.17**	.14**	.04	.04	.16**	.02	.15**	.22**	.07	.04	.10*	.22**	.05	.07					9.40	3.885	1	28
19. ICU_uncaring	.27**	.35**	.04	.25**	.22**	.16**	.05	.26**	.04	.21**	.30**	.18**	.04	.18**	.30**	.16**	.11*	.37**				8.93	3.318	0	22
20. ICU unemotional	.13**	.10	.17**	.12*	.12*	.09	.17**	.12*	.15**	.12*	.12*	.03	.14**	.13*	.12*	.03	.13*	.19**	.15**			7.17	2.294	1	15

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Reward Responsiveness, Impulsivity/Fun-seeking, Drive and BIS of the Luman-5 model are significant predictors of reactive aggression as well (β = .210, .272, .250, .237 respectively) (p < .001). Of the ICU the Callous scale (β = .304, p < .001), the Uncaring scale (β = .270, p < .001), the Unemotional scale (β = .130, p = .008) and the Total Score (β = .348, p < .001) are significant predictors of reactive aggression.

Table 3. *Simple linear regressions of all independent variables.*

		Reactive aggression				*Proactive aggression*			
	Independent variable	*F*	*β*	*p*	R^2	*F*	*β*	*p*	R^2
Aggression	reactive/proactive aggression	197.6	.571	.000	.33	197.5	.571	.000	.33
PCA-4	Sensitivity to social punishment (SSP)	.623	.038	.430	.00	.194	-.024	.660	.00
	Sensitivity to social reward (SSR)	38.5	.292	.000	.09	35.9	.284	.000	.08
	Sensitivity to immediate reward (SIR)	29.0	.261	.000	.07	4.8	.108	.029	.01
	Sensitivity to Power (SPOW)	39.0	.295	.000	.087	12.0	.171	.001	.03
PCA-2	Sensitivity to Reward (SR)	.64	.040	.423	.00	.15	-.021	.698	.00
	Sensitivity to Punishment (SP)	54.4	.341	.000	.12	24.3	.237	.000	.06
Luman-4	Sensitivity to Punishment (SP)	1.1	.052	.293	.00	0.1	-.013	.813	.00
	Reward Responsivity (RR)	46.0	.316	.000	.10	15.0	.188	.000	.04
	Impulsivity/Fun-seeking (IF)	32.6	.272	.000	.07	36.0	.287	.000	.08
	Drive (D)	30.2	.263	.000	.07	15.7	.195	.000	.04
Luman-5	FFFS	0.2	.020	.689	.00	0.0	-.004	.960	.00
	Reward Responsivity (RR)	18.6	.210	.000	.04	5.7	.118	.017	.01
	Impulsivity/Fun-seeking (IF)	32.6	.272	.000	.07	36.0	.287	.000	.08
	Drive (D)	27.3	.250	.000	.06	13.3	.180	.000	.03
	BIS	24.4	.237	.000	.06	1.5	.061	.226	.00
ICU	ICU_callous	40.7	.304	.000	.09	89.8	.423	.000	.18
	ICU_uncaring	30.5	.270	.000	.07	57.5	.353	.000	.13
	ICU_unemotional	7.0	.130	.008	.02	3.8	.094	.051	.01
	ICU_total	55.8	.348	.000	.12	100.9	.444	.000	.20

Reactive aggression, in turn, is a significant predictor of proactive aggression (β = .392, p < .001). Other significant predictors of proactive aggression are Sensitivity to Social Reward (β = .284, p < .001), Sensitivity to Immediate Reward (β = .108, p = .029) and Sensitivity to Power (β = .171, p = .001) of the PCA-4 model. Of the PCA-2 model Sensitivity to Punishment significantly predicts proactive aggression (β = .237, p < .001). Reward Responsivity, Impulsivity/Fun-seeking and Drive of the Luman-4 model are significant predictors of proactive aggression (β = .188, .287, .195 respectively) (p < .001). Of the Luman-5 model Reward Responsivity (β = .118, p = .017), Impulsivity/Fun-seeking (β = .287, p < .001) and Drive (β = .180, p < .001) significantly predict proactive aggression. Lastly of the ICU the Callous scale, the Uncaring scale and the Total Score are significant predictors of proactive aggression (β = .423,

.353, .444 respectively, $p < .001$). In addition a trend was found for an effect of the Unemotional scale on proactive aggression ($\beta = .094$, $p = .051$).

Table 4 presents the multiple regression analyses of the PCA-4 model, the PCA-2 model, the Luman-4 model and the Luman-5 model on reactive aggression and Table 5 presents the multiple regression analyses of those models on proactive aggression. As shown, the explained variances are almost similar, which would indicate that there are no significant differences in predictive qualities of those models in predicting reactive and proactive aggression.

Table 4. *Multiple regression analyses of the four models on reactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
PCA 4	(constant)	13.1 (4, 360)*	.13	2.199	1.130		.052
	Sensitivity to Social Punishment (SSP)			-.020	.022	-.047	.359
	Sensitivity to Social Reward (SSR)			.126	.049	.161	.010
	Sensitivity to Immediate Reward (SIR)			.134	.047	.172	.005
	Sensitivity to Power (SPOW)			.093	.052	.110	.076
PCA 2	(constant)	28.1 (2, 359)*	.14	2.647	1.075		.014
	Sensitivity to Reward			-.040	.021	-.104	.053
	Sensitivity to Punishment			.146	.020	.397	.000
Luman 4	(constant)	13.0 (4, 361)*	.13	3.164	1.046		.003
	Sensitivity to Punishment			-.043	.027	-.091	.118
	Reward Responsiveness			.129	.038	.240	.001
	Impulsivity/Fun-seeking			.151	.083	.115	.070
	Drive			.088	.063	.088	.160
Luman 5	(constant)	12.6 (5, 361)*	.15	2.607	1.058		.014
	FFFS			-.177	.048	-.275	.000
	Reward Responsiveness			.018	.058	.020	.753
	Impulsivity/Fun-seeking			.169	.083	.128	.042
	Drive			.108	.052	.119	.041
	BIS			.241	.053	.354	.000

**Significant at the 0.05 level (2-tailed).*

Table 5. *Multiple regression analyses of the four models on proactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
PCA 4	(constant)	12.2 (4, 363)*	.12	.962	.798		.229
	Sensitivity to Social Punishment (SSP)			-.034	.015	-.115	.026
	Sensitivity to Social Reward (SSR)			.200	.034	.358	.000
	Sensitivity to Immediate Reward (SIR)			-.037	.036	-.063	.306
	Sensitivity to Power (SPOW)			.021	.033	.038	.523
PCA 2	(constant)	15.6 (2, 362)*	.08	.337	.785		.668
	Sensitivity to Reward			-.037	.015	-.136	.013
	Sensitivity to Punishment			.080	.014	.306	.000
Luman 4	(constant)	10.9 (4, 364)*	.11	.651	.745		.383
	Sensitivity to Punishment			-.045	.019	-.137	.020
	Reward Responsiveness			.027	.027	.071	.316
	Impulsivity/Fun-seeking			.251	.059	.266	.000
	Drive			.037	.044	.053	.400
Luman 5	(constant)	7.6 (5, 364)*	.10	.807	.764		.292
	FFFS			-.029	.034	-.063	.400
	Reward Responsiveness			-.003	.041	-.005	.943
	Impulsivity/Fun-seeking			.272	.060	.289	.000
	Drive			.039	.038	.062	.297
	BIS			-.016	.038	-.034	.674

**Significant at the 0.05 level (2-tailed).*

PCA-4 model predicting type of aggression

A multiple hierarchical regression of three factors of the PCA-4 model and proactive aggression on reactive aggression (Table 6) shows that the introduction of proactive aggression significantly increases the explained variance (R^2-*change* = .28, F (1,361) = 165.5, p <.001). Sensitivity to Immediate Reward (β = .15, p = .004) and Sensitivity to Power (β = .14, p = .004) significantly predict reactive aggression, above and beyond the effect of proactive aggression. High levels of Sensitivity to Immediate Reward and high levels of Sensitivity to Power significantly predict high levels of reactive aggression.

Table 6. *Hierarchical regression analyses: PCA-4 model predicting reactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	16.3 (3, 362)*	.12	1.873	1.004		.063
	Sensitivity to Social Reward (SSR)			.118	.048	.150	.015
	Sensitivity to Immediate Reward (SIR)			.079	.051	.094	.124
	Sensitivity to Power (SPOW)			.136	.047	.174	.004
Model 2	(constant)	59.2 (4, 361)*	.40	1.622	.832		.052
	Sensitivity to Social Reward (SSR)			-.029	.042	-.036	.491
	Sensitivity to Immediate Reward (SIR)			.126	.043	.149	.004
	Sensitivity to Power (SPOW)			.112	.039	.144	.004
	Proactive aggression			.800	.062	.556	.000

**Significant at the 0.05 level (2-tailed).*

A multiple hierarchical regression on proactive aggression (Table 7) shows that the introduction of reactive aggression significantly increases the explained variance (R^2-*change* = .28, F (1,361) = 1765.5, p < .001). Sensitivity to Social Reward (β = .25, p < .001) significantly predicts proactive aggression, above and beyond the effect of reactive aggression. High levels of Sensitivity to Social Reward significantly predict high levels of proactive aggression. Also Sensitivity to Immediate Reward (β = -.15, p = .003) significantly predicts proactive aggression, above and beyond the effect of reactive aggression. Low levels of Sensitivity to Immediate Reward significantly predict high levels of proactive aggression.

Table 7. *Hierarchical regression analyses: PCA-4 model predicting proactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	13.9 (3, 362)	.10	.315	.704		.655
	Sensitivity to Social Reward (SSR)			.183	.034	.335	.000
	Sensitivity to Immediate Reward (SIR)			-058	.036	-.099	.108
	Sensitivity to Power (SPOW)			.029	.033	.054	.377
Model 2	(constant)	56.5 (4, 361)	.39	-.422	.586		.472
	Sensitivity to Social Reward (SSR)			.137	.028	.250	.000
	Sensitivity to Immediate Reward (SIR)			-.089	.030	-.152	.003
	Sensitivity to Power (SPOW)			-.024	.028	-.045	.381
	Reactive aggression			.393	.031	.566	.000

**Significant at the 0.05 level (2-tailed).*

PCA-2 model predicting type of aggression

A multiple hierarchical regression of the factors of the PCA-2 model and proactive aggression on reactive aggression (Table 8) shows that the introduction of proactive aggression significantly changes the explained variance (R^2-*change* = .27, F (1,364) = 158.5, $p < .001$). Sensitivity to Punishment significantly predicts reactive aggression, above and beyond the effect of proactive aggression ($\beta = .21$, $p < .001$). High levels of Sensitivity to Punishment significantly predict high levels of reactive aggression.

Table 8. *Hierarchical regression analyses: PCA-2 model predicting reactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	47.7 (1, 365)*	.12	1.982	.959		.039
	Sensitivity to punishment (SP)			.124	.018	.340	.000
Model 2	(constant)	113.4 (2, 364)*	.38	2.214	.802		.006
	Sensitivity to punishment (SP)			.077	.015	.212	.000
	Proactive aggression			.768	.061	.534	.000

**Significant at the 0.05 level (2-tailed).*

A multiple hierarchical regression analysis predicting proactive aggression (Table 9) shows that the introduction of reactive aggression significantly changes the explained variance (R^2-*change* = .29, F (1,364) = 158.5, $p < .001$). After the introduction of reactive aggression Sensitivity to Punishment no longer significantly predicts proactive aggression.

Table 9. *Hierarchical regression analyses: PCA-2 model predicting proactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	22.4 (1, 365)*	.06	-.303	.688		.660
	Sensitivity to punishment (SP)			.061	.013	.241	.000
Model 2	(constant)	95.3 (2, 364)*	.34	-1.086	.578		.061
	Sensitivity to punishment (SP)			.012	.011	.047	.295
	Reactive aggression			.395	.031	.568	.000

**Significant at the 0.05 level (2-tailed).*

Luman-4 model predicting type of aggression

A multiple hierarchical regression analysis of the factors of the Luman-4 model and proactive aggression on reactive aggression (Table 10) shows that the introduction of proactive aggression significantly changes the explained variance (R^2-*change* = .27, F (1,366) = 158.5, $p < .001$). Reward Responsiveness significantly predicts reactive aggression, above and beyond the effect of proactive aggression ($\beta = .20$, $p < .001$). High levels of Reward Responsiveness significantly predict high levels of reactive aggression.

Table 10. *Hierarchical regression analyses: Luman-4 model predicting reactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	15.8 (3, 367)*	.11	2.556	.922		.006
	Reward Responsiveness (RR)			.104	.035	.195	.003
	Impulsivity/Fun-seeking (IF)			.114	.083	.086	.168
	Drive (D)			.121	.059	.122	.041
Model 2	(constant)	56.5 (4, 366)*	.38	2.473	.772		.001
	Reward Responsiveness (RR)			.109	.029	.204	.000
	Impulsivity/Fun-seeking (IF)			-.065	.071	-.049	.360
	Drive (D)			.066	.050	.066	.185
	Proactive aggression			.782	.062	.542	.000

**Significant at the 0.05 level (2-tailed).*

A multiple hierarchical regression analysis on proactive aggression (Table 11) shows that the introduction of reactive aggression significantly changes the explained variance (R^2*-change* = .28, F (1,366) = 158.5, $p < .001$). Impulsivity/Fun-seeking significantly predicts proactive aggression above and beyond the effect of reactive aggression ($\beta = .20$, $p < .001$). High levels of Impulsivity/Fun-seeking significantly predict high levels of proactive aggression.

Table 11. *Hierarchical regression analyses: Luman-4 model predicting proactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	12.0 (3, 367)	.09	.106	.648		.870
	Reward Responsiveness (RR)			-.006	.024	-.017	.799
	Impulsivity/Fun-seeking (IF)			.229	.058	.248	.000
	Drive (D)			.071	.041	.102	.089
Model 2	(constant)	52.5 (4, 366)	.36	-.881	.548		.109
	Reward Responsiveness (RR)			-.046	.021	-.125	.025
	Impulsivity/Fun-seeking (IF)			.185	.049	.200	.000
	Drive (D)			.024	.035	.035	.494
	Reactive aggression			.386	.031	.557	.000

**Significant at the 0.05 level (2-tailed).*

Luman-5 model predicting aggression

A multiple hierarchical regression analysis of the factors of the Luman-5 model and proactive aggression on reactive aggression (Table 12) shows that the introduction of proactive aggression significantly changes the explained variance (R^2*-change* = .28, F (1,361) = 168.4, $p < .001$). Drive ($\beta = .14$, $p = .004$) and BIS ($\beta = .19$, $p < .001$) significantly predict reactive aggression, above and beyond the effect of proactive aggression. High levels of Drive and of BIS significantly predict high levels of reactive aggression.

Table 12. *Hierarchical regression analyses: Luman-5 model predicting reactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	11.6 (4, 362)*	.11	1.894	1.047		.071
	Reward Responsiveness (RR)			.000	.059	.000	.997
	Impulsivity/Fun-seeking (IF)			.156	.085	.116	.069
	Drive (D)			.162	.051	.179	.002
	BIS			.109	.040	.161	.008
Model 2	(constant)	47.3 (5, 361)*	.40	1.383	.866		.111
	Reward Responsiveness (RR)			.020	.049	.022	.682
	Impulsivity/Fun-seeking (IF)			-.069	.073	-.051	.344
	Drive (D)			.123	.042	.136	.004
	BIS			.131	.034	.193	.000
	Proactive aggression			.804	.062	.558	.000

**Significant at the 0.05 level (2-tailed).*

A multiple hierarchical regression analysis on proactive aggression (Table 13) shows that the introduction of reactive aggression significantly changes the explained variance (R^2-*change* = .27, F (1,367) = 158.3, $p < .001$). Reward Responsiveness (β = -.11, p = .022) and Impulsivity/Fun-seeking (β = .20, $p < .001$) significantly predicts proactive aggression, above and beyond the effect of reactive aggression. Low levels of Reward Responsiveness predict high levels of proactive aggression and high levels of Impulsivity/Fun-seeking predict high levels of proactive aggression.

Table 13. *Hierarchical regression analyses: Luman-5 model predicting proactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	12.2 (3, 368)*	.09	.304	.602		.614
	Reward Responsiveness (RR)			-.043	.037	-.069	.244
	Impulsivity/Fun-seeking (IF)			.261	.058	.284	.000
	Drive (D)			.054	.035	.085	.131
Model 2	(constant)	52.6 (4, 367)*	.36	-.945	.514		.066
	Reward Responsiveness (RR)			-.072	.031	-.114	.022
	Impulsivity/Fun-seeking (IF)			.185	.049	.201	.000
	Drive (D)			-.002	.030	-.004	.935
	Reactive aggression			.380	.030	.552	.000

**Significant at the 0.05 level (2-tailed).*

Callous and unemotional traits predicting type of aggression

A multiple hierarchical regression analysis of the callous scale of the ICU on reactive aggression (Table 14) shows that the introduction of ICU callous does not significantly change the explained variance (R^2-*change* = .005, F (1,341) = 2.8, p = .096). ICU callous (β = .08, p = .096) does not significantly predict reactive aggression, above and beyond the effects of proactive aggression and the factors of the PCA-4 model that correlated significantly to reactive aggression. Sensitivity to Immediate Reward (β = 14, p =

.009) and Sensitivity to Power (β = 16, p = .002) significantly predict reactive aggression, above and beyond the effects of proactive aggression and ICU callous.

Table 14 *Hierarchical regression analyses: ICU callous predicting reactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	15.0 (3,343)*	.12	2.218	1.004		.028
	Sensitivity to Social Reward (SSR)			.105	.048	.136	.030
	Sensitivity to Immediate Reward (SIR)			.080	.051	.098	.118
	Sensitivity to Power (SPOW)			.135	.046	.179	.004
Model 2	(constant)	50.5 (4, 342)*	.37	1.783	.849		.036
	Sensitivity to Social Reward (SSR)			-.024	.042	-.032	.562
	Sensitivity to Immediate Reward (SIR)			.124	.043	.153	.004
	Sensitivity to Power (SPOW)			.115	.039	.152	.004
	Proactive aggression			.747	.063	.530	.000
Model 3	(constant)	41.1 (5, 341)	.38	1.207	.914		.188
	Sensitivity to Social Reward (SSR)			-.024	.042	-.031	.566
	Sensitivity to Immediate Reward (SIR)			.114	.043	.141	.009
	Sensitivity to Power (SPOW)			.121	.039	.160	.002
	Proactive aggression			.704	.068	.499	.000
	ICU callous			.083	.050	.078	.096

**Significant at the 0.05 level (2-tailed).*

A multiple hierarchical regression analysis of the uncaring scale of the ICU on reactive aggression (Table 15) shows that the introduction of ICU uncaring significantly changes the explained variance (R^2*-change* = .007, F (1,353) = 4.0, p = .047). ICU uncaring (β = .09, p = .047) significantly predicts reactive aggression, above and beyond the effects of proactive aggression and the factors op the PCA-4 model that correlated significantly to reactive aggression. High levels of uncaring traits significantly predict high levels of reactive aggression. Sensitivity to Immediate Reward (β = .14, p = .009) and Sensitivity to Power (β = .14, p = .007) significantly predict reactive aggression, above and beyond the effects of proactive aggression and ICU uncaring.

Table 15 *Hierarchical regression analyses: ICU uncaring predicting reactive of aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	16.4 (3,355)*	.12	1.911	1.005		.058
	Sensitivity to Social Reward (SSR)			.134	.048	.171	.006
	Sensitivity to Immediate Reward (SIR)			.076	.051	.091	.137
	Sensitivity to Power (SPOW)			.124	.047	.159	.009
Model 2	(constant)	57.0 (4, 354)*	.39	1.604	.838		.057
	Sensitivity to Social Reward (SSR)			-.017	.042	-.022	.685
	Sensitivity to Immediate Reward (SIR)			.124	.043	.149	.004
	Sensitivity to Power (SPOW)			.107	.039	.137	.007
	Proactive aggression			.786	.063	.550	.000
Model 3	(constant)	46.8 (5, 353)*	.40	1.028	.883		.245
	Sensitivity to Social Reward (SSR)			-.018	.042	-.023	.666
	Sensitivity to Immediate Reward (SIR)			.113	.043	.135	.009
	Sensitivity to Power (SPOW)			.106	.039	.136	.007
	Proactive aggression			.741	.066	.518	.000
	ICU uncaring			.111	.056	.090	.047

**Significant at the 0.05 level (2-tailed).*

A multiple hierarchical regression analysis of the unemotional scale of the ICU on reactive aggression (Table 16) shows that the introduction of ICU unemotional does not significantly change the explained variance (R^2-*change* = .004, F (1,350) = 2.4, p = .120). ICU unemotional (β = .07, p = .120) does not significantly predict reactive aggression, above and beyond the effects of proactive aggression and the factors op the PCA-4 model that correlated significantly to reactive aggression. Sensitivity to Immediate Reward (β = .14, p = .008) and Sensitivity to Power (β = .14, p = .007) significantly predict reactive aggression, above and beyond the effects of proactive aggression and ICU unemotional.

Table 16 *Hierarchical regression analyses: ICU unemotional predicting reactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	14.8 (3,352)*	.11	2.114	1.029		.041
	Sensitivity to Social Reward (SSR)			.121	.049	.154	.014
	Sensitivity to Immediate Reward (SIR)			.069	.052	.082	.187
	Sensitivity to Power (SPOW)			.133	.048	.170	.006
Model 2	(constant)	56.5 (4, 351)*	.39	1.755	.853		.040
	Sensitivity to Social Reward (SSR)			-.023	.042	-.029	.592
	Sensitivity to Immediate Reward (SIR)			.119	.043	.141	.007
	Sensitivity to Power (SPOW)			.109	.040	.140	.006
	Proactive aggression			.798	.063	.557	.000
Model 3	(constant)	45.9 (5, 350)*	.40	1.082	.955		.258
	Sensitivity to Social Reward (SSR)			-.023	.042	-.029	.583
	Sensitivity to Immediate Reward (SIR)			.116	.043	.137	.008
	Sensitivity to Power (SPOW)			.107	.040	.137	.007
	Proactive aggression			.792	.063	.552	.000
	ICU unemotional			.112	.072	.065	.120

**Significant at the 0.05 level (2-tailed).*

A multiple hierarchical regression analysis of the callous scale of the ICU on proactive aggression (Table 17) shows that the introduction of ICU callous significantly changes the explained variance (R^2*-change* = .05, F (1,341) = 30.5, $p < .001$). ICU callous ($\beta = .24$, $p < .001$) significantly predicts proactive aggression, above and beyond the effects of reactive aggression and the factors op the PCA-4 model that correlated significantly to proactive aggression.

Table 17 *Hierarchical regression analyses: ICU callous predicting proactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	11.5 (3,343)*	.09	.583	.723		.421
	Sensitivity to Social Reward (SSR)			.173	.035	.317	.000
	Sensitivity to Immediate Reward (SIR)			-.059	.037	-.103	.105
	Sensitivity to Power (SPOW)			.028	.033	.051	.411
Model 2	(constant)	46.8 (4, 342)*	.35	-.275	.615		.655
	Sensitivity to Social Reward (SSR)			.132	.029	.243	.000
	Sensitivity to Immediate Reward (SIR)			-.090	.031	-.156	.004
	Sensitivity to Power (SPOW)			-.025	.029	-.046	.387
	Proactive aggression			.387	.033	.545	.000
Model 3	(constant)	46.8 (5, 341)*	.41	-1.490	.629		.018
	Sensitivity to Social Reward (SSR)			.122	.028	.223	.000
	Sensitivity to Immediate Reward (SIR)			-.102	.030	-.176	.001
	Sensitivity to Power (SPOW)			-.007	.028	-.014	.789
	Reactive aggression			.337	.033	.475	.000
	ICU callous			.183	.033	.243	.000

**Significant at the 0.05 level (2-tailed).*

High levels of callous traits significantly predict high levels of proactive aggression. Sensitivity to Social Reward (β = .22, p < .001) and Sensitivity to Immediate Reward (β = -.18, p = .001) significantly predict proactive aggression, above and beyond the effects of reactive aggression and ICU callous.

A multiple hierarchical regression analysis of the uncaring scale of the ICU on proactive aggression (Table 18) shows that the introduction of ICU uncaring significantly changes the explained variance (R^2-*change* = .04, F (1,353) = 21.0, p < .001). ICU uncaring (β = .20, p < .001) significantly predicts proactive aggression, above and beyond the effects of reactive aggression and the factors op the PCA-4 model that correlated significantly to proactive aggression. High levels of uncaring traits significantly predict high levels of proactive aggression. Sensitivity to Social Reward (β = .24, p < .001) and Sensitivity to Immediate Reward (β = -.18, p = .001) significantly predict proactive aggression, above and beyond the effects of reactive aggression and ICU uncaring.

Table 18 *Hierarchical regression analyses: ICU uncaring predicting proactive aggression.*

	Predictor	*F (df,df)*	R^2	*B*	*SE*	*β*	*p*
Model 1	(constant)	14.3 (3,355)*	.11	.391	.709		.582
	Sensitivity to Social Reward (SSR)			.192	.034	.351	.000
	Sensitivity to Immediate Reward (SIR)			-.061	.036	-.150	.089
	Sensitivity to Power (SPOW)			.022	.033	.040	.515
Model 2	(constant)	54.7 (4, 354)*	.38	-.356	.594		.549
	Sensitivity to Social Reward (SSR)			.139	.029	.256	.000
	Sensitivity to Immediate Reward (SIR)			-.091	.030	-.157	.003
	Sensitivity to Power (SPOW)			-.027	.028	-.049	.344
	Proactive aggression			.391	.031	.559	.000
Model 3	(constant)	50.4 (5, 353)*	.42	-1.197	.606		.049
	Sensitivity to Social Reward (SSR)			.130	.028	.238	.000
	Sensitivity to Immediate Reward (SIR)			-.102	.029	-.175	.001
	Sensitivity to Power (SPOW)			-.025	.027	-.045	.370
	Reactive aggression			.352	.032	.503	.000
	ICU uncaring			.172	.038	.199	.000

**Significant at the 0.05 level (2-tailed).*

Study 2: Effectivity of Minder Boos en Opstandig in reducing behavioural problems and improving reward- and punishment sensitivity.

Descriptive statistics

Table 19 presents descriptive statistics of the pretest scores and the posttest scores on the CBCL, the RPQ, the IGT, the ICU and the PCA-4 model of the 12 participants.

Table 19. *Descriptives of the pretest- and posttest scores on several measurement instruments*

	Pretest			*Posttest*		
Instruments	Mean	Median	SD	Mean	Median	SD
CBCL Anxious/Depressed	6.8	5.0	6.7	4.4	4.0	4.1
CBCL Withdrawn	5.6	3.0	9.8	3.4	2.0	3.4
CBCL Somatic Complaints	5.9	3.0	16.1	2.0	1.5	1.9
CBCL Social Problems	9.2	7.0	7.2	5.8	5.0	4.0
CBCL Attention Problems	10.1	10	5.7	8.3	8.5	3.9
CBCL Delinquent Behaviour	10.9	7.0	18.4	5.3	6.0	3.2
CBCL Aggressive Behaviour	21.7	20.0	17.0	13.4	12.5	7.3
CBCL Sum Internalizing Problems	18.6	10.0	33.0	9.8	8.5	7.8
CBCL Sum Externalizing Problems	32.6	26.5	35.3	18.7	18.0	9.5
RPQ Reactive	13.7	13.3	4.3	8.8	8.0	6.6
RPQ Proactive	5.5	5.5	3.3	3.1	3.5	3.0
RPQ Total	19.2	18.5	7.3	11.9	12.0	8.6
ICU Callous	11.7	12.0	5.1	10.9	9.0	7.1
ICU Uncaring	9.4	9.5	5.3	11.7	12.0	6.4
ICU Unemotional	7.3	8.0	2.0	8.0	9.0	4.1
ICU Total	28.5	30.5	9.9	30.6	30.0	16.1
IGT Total Gain first quarter	1907.7	1825.0	626.4	1912.5	1850.0	427.0
IGT Total Gain second quarter	1828.8	1825	262.3	1662.5	1575.0	424.9
IGT Total Gain third quarter	1700.0	1600.0	715.5	2079.2	2100.0	508.8
IGT Total Gain fourth quarter	1715.4	1825.0	778.8	1700.0	1650.0	565.7
IGT Total Gain	7151.9	7225.0	1742.4	7354.2	7750.0	962.1
Sensitivity to Social Punishment	39.2	37.0	9.8	37.9	16.0	36.9
Sensitivity to Social Reward	31.8	31.5	6.1	29.8	30.5	8.9
Sensitivity to Immediate Reward	26.4	28.0	4.1	26.7	26.5	6.0
Sensitivity to Power	31.2	31.0	4.7	29.9	28.5	7.1

N=12

Behaviour problems

Related samples wilcoxon signed rank tests on the different subscales of the CBCL (Table 20) show that the difference between the pretest scores and the posttest scores of Social Problems (Z = -2.558, p = .011, r = -.74), of Delinquent Behaviour (Z = -2.139, p = .032, r = -.62), of Aggressive Behaviour (Z = -2.803, p = .005, r = -.81) and of Externalizing Problems (Z = -2.937, p = .003, r = -.85) is significant.

As shown in Table 19 the scores on the posttest were lower than those of the pretest. In addition a trend was found for a difference between the pretest score and the posttest score on Internalizing Problems (Z = -1.797, p = .072, r = -.52).

Table 20. *Related Samples Wilcoxon Signed Rank Test: difference between pretest and posttest of the CBCL.*

	Z	*p*
Anxious/Depressed	-1.719	.086
Withdrawn	-.679	.497
Somatic Complaints	-.933	.351
Social Problems	-2.558*	.011
Attention Problems	-.539	.590
Delinquent Behaviour	-2.139*	.032
Aggressive Behaviour	-2.803*	.005
Internalizing Problems	-1.797	.072
Externalizing Problems	-2.937*	.003

*Significant at 0.05 level (2-tailed). N=12

Type of aggression

Related samples wilcoxon signed rank tests on the different subscales of the RPQ (Table 21) show that there is a significant difference between the pretest scores and the posttest scores of RPQ reactive (Z = -2.632, p = .008, r = -.76), of RPQ proactive (Z = -2.150, p = .032, r = -.62) and of the total scale of the RPQ (Z = -2.628, p = .009, r = -.76). As shown in Table 19 the posttest scores were lower than the pretest scores.

Table 21. *Related Samples Wilcoxon Signed Rank Test: difference between pretest and posttest of the RPQ.*

	Z	*p*
RPQ reactive	-2.632*	.008
RPQ proactive	-2.150*	.032
RPQ total	-2.628*	.009

*Significant at 0.05 level (2-tailed). N=12

Callous and Unemotional traits

Related samples wilcoxon signed rank tests on the different subscales of the ICU (Table 22) show that there are no significant differences between the pretest scores and the posttest scores of the three scales and the total score of the ICU. This means that there is no reduction of callous and unemotional traits after the Minder Boos en Opstandig program.

Table 22. *Related Samples Wilcoxon Signed Rank Test: difference between pretest and posttest of the ICU.*

	Z	*p*
Callous	-.865	.387
Uncaring	-.563	.574
Unemotional	.910	.363
Total	-.760	.448

*Significant at 0.05 level (2-tailed). N=12

Sensitivity to punishment and reward

Related samples wilcoxon signed rank tests on the IGT (Table 23) show that there is a trend for a difference between the pretest score and the posttest score of the Total Gain of the third quarter of the test ($Z = 1.805$, $p = .071$, $r = 0.52$). The posttest scores of Total Gain of the third quarter were higher than the pretest scores (Table 19).

Table 23. *Related Samples Wilcoxon Signed Rank Test: difference between pretest and posttest of the four quarters of the IGT.*

	Z	*p*
Total Gain first quarter	-.667	.505
Total Gain second quarter	-.785	.433
Total Gain third quarter	1.805	.071
Total Gain fourth quarter	.825	.409
Total Gain	.941	.347

*Significant at 0.05 level (2-tailed). N=12

Related samples wilcoxon signed rank tests on the scales of the PCA-4 model (Table 24) show that there are no significant differences between the pretest score and the posttest score of the four scales of the PCA-4 model. However like shown in table 19, there is a slight reduction of sensitivity to social punishment, sensitivity to social reward and sensitivity to power.

Table 24. *Related Samples Wilcoxon Signed Rank Test: difference between pretest and posttest of the four scales of the PCA-4 model.*

	Z	*P*
Sensitivity to Social Punishment (SSP)	-1.159	.247
Sensitivity to Social Reward (SSR)	-.623	.533
Sensitivity to Immediate Reward (SIR)	-.565	.572
Sensitivity to Power (SPOW)	-1.415	.157

*Significant at 0.05 level (2-tailed). N=12

Correlations between pretest-posttest differences of the RPQ and the PCA-4 model

Table 25 presents the correlations between the pretest-posttest differences of the PCA-4 model and those of the RPQ. As shown, no significant correlations were found. This means that a reduction of reactive- and proactive aggression after the MBO-program does not go together with an improvement of sensitivity to punishment and sensitivity to reward.

Table 25. *Spearman's rho correlations between the pretest-posttest differences of the PCA-4 model and of the RPQ.*

	RPQ Reactive	RPQ Proactive	RPQ Total
PCA-4 Sensitivity to Social Punishment (SSP)	-.346	-.290	-.383
PCA-4 Sensitivity to Social Reward (SSR)	.041	.124	.136
PCA-4 Sensitivity to Immediate Reward (SIR)	.093	.209	.255
PCA-4 Sensitivity to Power (SPOW)	-.039	.281	.161

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Correlations between pretest-posttest differences of the PCA-4 model and the CBCL

Table 26 presents the correlations between the pretest-posttest differences of the CBCL and those of the PCA-4 model. As shown, a significant correlation between delinquent behaviour and sensitivity to social reward was found. This means that a reduction of delinquent behaviour after the Minder Boos en Opstandig program goes together with a reduction of sensitivity to social reward.

Table 26. *Spearman's rho correlations between the pretest-posttest differences of the CBCL and of the PCA-4 model.*

	PCA-4 Sensitivity to Social Punishment (SSP)	PCA-4 Sensitivity to Social Reward (SSR)	PCA-4 Sensitivity to Immediate Reward (SIR)	PCA-4 Sensitivity to Power (SPOW)
CBCL social problems	-.450	.137	-.431	.022
CBCL delinquent behaviour	-.355	.629*	.137	.530
CBCL aggressive behaviour	-.311	-.232	-.123	-.007
CBCL sum externalizing problems	-.299	.410	.037	.172

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Discussion

This study investigated the relationship between reward- and punishment sensitivity and type of aggression (reactive vs. proactive). Different models that split up several elements of sensitivity to punishment and sensitivity to reward were used to get a more precise picture of the relationship between reward- and punishment sensitivity and type of aggression. In addition the relationship between callous and unemotional traits and type of aggression was investigated.

The Principal Component Analysis of the Dutch SPSRQ-C resulted in a factor solution that contained 2-4 factors and explained 34 and 43% of variance. From these models, two models (PCA-2 model and PCA-4 model) were retained based on their theoretical validity. Also the Luman-4 and the Luman-5 model were tested in the Confirmatory Factor Analysis. The Confirmatory Factor Analysis determined that the PCA-4 model was best fitting, explaining 43% of the item variance. However because of the theoretical validity of both PCA-models and the four- and five factor models of Luman and colleagues (2005), those models were retained and used in the hierarchical regression analyses as well.

Predictors of reactive aggression, when controlling for proactive aggression, were Sensitivity to Immediate Reward and Sensitivity to Power of the PCA-4 model, Sensitivity to Punishment of the PCA-2 model, Reward Responsiveness of the Luman-4 model and Drive and BIS of the Luman-5 model. When controlling for proactive aggression and the factors of the PCA-4 model that correlated significantly to reactive aggression, the Callous and Uncaring scales of the ICU were also found to be significant predictors of reactive aggression. When controlling for proactive aggression and the ICU scales, Sensitivity to Immediate Reward and Sensitivity to Power of the PCA-4 model were found to be significant predictors of reactive aggression.

Predictors of proactive aggression, when controlling for reactive aggression, were Sensitivity to Social Reward and Sensitivity to Immediate Reward of the PCA-4 model, Impulsivity/Fun-seeking of the Luman-4 model and Reward Responsiveness and Impulsivity/Fun-seeking of the Luman-5 model. After controlling for reactive aggression and the factors of the PCA-4 model that correlated significantly to proactive aggression, the Callous scale and Uncaring scale of the ICU were significant predictors of proactive aggression as well. When controlling for reactive aggression and ICU callous and ICU uncaring, Sensitivity to Social Reward and Sensitivity to Immediate Reward of the PCA-4 model were found to be significant predictors of proactive aggression.

Social problems, delinquent behaviour, aggressive behaviour and externalizing problems were reduced after the Minder Boos en Opstandig program. Also the reactive aggression and proactive aggression scores were diminished after the intervention.

Study 1: Relationship between type of aggression and reward- and punishment sensitivity.

The models

The best fitting models in the study of Luman and colleagues (2011), the Luman 4-factor model and the Luman 5-factor model, did not provide the best fit on our data. This might be explained by the difference in age between the two datasets. Luman and colleagues (2011) included a sample of children between 6 to 13 years of age in their study, whereas in our study children aged 12 to 17 years old were involved. The fact that the models of Luman and colleagues (2011) did not fit our data very well, could indicate that the factors that are distinguished in those models are not applicable to older children. In their 4-factor model Luman and colleagues (2011) distinguish Reward Responsiveness, Sensitivity to Punishment, Impulsivity/Fun-seeking and Drive and in their 5-factor model they use the same factors but split up the Sensitivity to Punishment factor in the Flight, Fight and Freezing System (FFFS) and the Behavioural Inhibition System (BIS). Those factors might account for sensitivity to reward and sensitivity to punishment in children younger than 14 years of age very well, but they might be less useful for adolescents aged 14 years and older. It is known that adolescents are more aware of themselves and of their relationships with others (Lansford, Killeya-Jones, Miller & Costanzo, 2009; Sentse, Lindenberg, Omvlee, Ormel & Veenstra, 2010). For them it might be more important to get social rewards, like being praised by their peers, being evaluated as funny or getting a compliment about their looks. They might also be very sensitive to social punishments, like being rejected or ignored by their peers. The fact that the PCA-4 model makes a distinction between Sensitivity to Social Reward and Sensitivity to Social Punishment, might explain why this model fits the data in a better way than the two models of Luman and colleagues (2011). The other factors of the PCA-4 model are Sensitivity to Power representing the need for power, which can often be found among proactive aggressive children, and Sensitivity to Immediate Reward representing impulsive behaviour, which is often found among reactive aggressive children (Bandura, 1973; Van de Wiel, Hoppe & Matthys, 2003).

PCA-4 model predicting aggression

In line with our hypothesis that reactive aggressive children will be more sensitive to reward (and not to punishment) and are more likely to be impulsive, we found positive relationships between reactive aggression and sensitivity to social reward and between reactive aggression and sensitivity to immediate reward, whereas no relationship was found between reactive aggression and sensitivity to social punishment. In addition when controlling for proactive aggression, a positive effect was found for sensitivity to immediate reward on reactive aggression. These results are in line with previous research

that has shown that children with ADHD, who are likely to show reactive aggressive behaviour, are being more impulsive than children without ADHD and that children with ADHD prefer small, immediate rewards over larger, delayed rewards (Tripp & Alsop, 1999; Luman et al., 2005). In contrast to our expectations also a relationship was found between reactive aggression and sensitivity to power and, when controlled for proactive aggression, an effect was found for sensitivity to power on reactive aggression. This relationship might be explained by the fact that also power is some form of reward and since reactive aggressive children are sensitive to reward, they might also be sensitive to power, especially when such a reward would be immediate (Luman et al., 2005). This would indicate that not the content of the reward is important for reactive aggressive children, but the time it takes before they will get their reward. This need for immediate rewards may be explained by their underactive BIS system (Quay, 1997).

In line with our hypothesis that proactive aggressive children are impulsive, sensitive to reward and sensitive to power, we found positive relationships between proactive aggression and sensitivity to social reward, between proactive aggression and sensitivity to immediate reward and between proactive aggression and sensitivity to power. These results are in line with previous studies that have shown that children with ODD, who are likely to show some proactive aggressive behaviour, are thought to have a predominant BAS, which makes them focus on reward (Newman & Wallace, 1993). Antisocial individuals show sensation-seeking behaviour to boost psychophysiological arousal, which could explain their impulsive behaviour (Zuckerman & Neeb, 1979). Furthermore proactive aggression is characterized by goal-oriented behaviour and it is motivated by external reward (Dodge, 1991). In addition, as expected, when controlling for reactive aggression, a positive effect was found for sensitivity to social reward on proactive aggression. Proactive aggressive children are goal-oriented and motivated by external reward (Dodge, 1991). In proactive aggression, reinforcement and the anticipated advantages of aggression play an important role (Merk et al., 2005). This could explain the fact that they are sensitive to social reward, because that is some kind of reinforcement and it can help them in obtaining a goal. In contrast to our expectations a negative effect was found for sensitivity to immediate reward on proactive aggression. This might be explained by the fact that proactive aggressive children are able to adjust their behaviour in response to extrinsic contingencies and to control themselves and as a result show less impulsive behaviour (Vitiello & Stoff, 1997).

PCA-2 model predicting aggression

In contrast to our expectations, we found a positive relationship between reactive aggression and sensitivity to punishment, whereas no relationship was found between reactive aggression and sensitivity

to reward. Furthermore a positive effect of sensitivity to punishment on reactive aggression was found, when controlled for proactive aggression. This result indicates that higher levels of sensitivity to punishment lead to higher levels of reactive aggression and is in contrast to the expectation that there is no relationship between reactive aggression and sensitivity to punishment. It could be explained by the fact that the 2-factor model is not specific enough and does not distinguish both types of behaviour (sensitivity to reward and sensitivity to punishment) in a proper way. The 2-factor model might not differentiate very well between both types of behaviour in reactive- and proactive aggressive children.

In contrast to our hypothesis that proactive aggressive children are less sensitive to punishment, a positive correlation was found between proactive aggression and sensitivity to punishment. No correlation was found between proactive aggression and sensitivity to reward, which is different from our expectations. In addition no effects of sensitivity to reward or sensitivity to punishment were found on proactive aggression, when controlled for reactive aggression. Those somewhat unexpected findings could be due to the lack of specificity of the 2-factor model. Carver & White (1994) have developed a questionnaire (SPSRQ-C) with four different scales, one for measuring the BIS dimension (Sensitivity to Punishment) and three measures of the BAS dimension (Reward Responsiveness, Drive and Impulsivity/Fun-seeking) for measuring sensitivity to punishment and reward, which has proved to be reliable (Colder & O'Connor, 2004). More than two scales might be needed to get an appropriate and precise picture of sensitivity to punishment and sensitivity to reward in adolescents.

Luman-4 model predicting aggression

In line with our hypothesis that reactive aggressive children are sensitive to reward, show impulsive behaviour, are quickly aroused and driven to aggression by poor frustration tolerance, we found positive correlations between reactive aggression and Reward Responsiveness, Impulsivity/Fun-seeking and Drive and not between reactive aggression and Sensitivity to Punishment (Vitiello & Stoff, 1997). In addition a positive effect was found of Reward Responsiveness on reactive aggression, when controlled for proactive aggression.

As expected, positive correlations between proactive aggression and Reward Responsiveness, Impulsivity/Fun-seeking and Drive were also found. In contrast to our expectation no (negative) correlation was found between proactive aggression and Sensitivity to Punishment. When controlled for reactive aggression, an effect of Impulsivity/Fun-seeking was found on proactive aggression, which is in line with our expectation. The fact that no (negative) relationship was found between proactive aggression and Sensitivity to Punishment may be explained by the lack of fit of the model to the data. This model might not be useful among adolescents.

Remarkable is the fact that for the 4-factor models (PCA-4 model and Luman-4 model) the sensitivity to punishment scales (SP and SSP) do not relate to reactive- and proactive aggression. It seems like those scales are not appropriate for measuring sensitivity to punishment. Perhaps some items of the sensitivity to reward scales (SSR, SPOW, SIR, RR, IF, D) should belong to the Sensitivity to Punishment scale. For the 2-factor model, with the more global difference between BIS and BAS, there are relationships between Sensitivity to Punishment and type of aggression. The same is true for the BIS scale of the Luman-5 model.

Luman-5 model predicting aggression

In line with our hypotheses, positive correlations were found between reactive aggression and Reward Responsiveness, Impulsivity-Fun-seeking and Drive and no correlation was found between reactive aggression and FFFS, which represents fear and discomfort and active avoidance in social situations (Luman et al., 2011). As expected, also a positive correlation was found between reactive aggression and BIS, which represents general anxiety and difficulty with the modulation of anxiety. This in line with the thought that reactive aggressive children are less capable of self-control and as a result also have difficulties in modulating their anxiety (Vitiello & Stoff, 1997). In addition positive effects were found of BIS and Drive on reactive aggression, when controlled for proactive aggression.

As expected, positive correlations were found between proactive aggression and Reward Responsiveness, Impulsivity/Fun-seeking and Drive. In line with our expectations, when controlled for reactive aggression, effects were found of Reward Responsiveness and Impulsivity/Fun-seeking on proactive aggression.

ICU predicting aggression

In contrast to our expectations, positive relationships were found between reactive aggression and the Callous scale, the Uncaring scale, the Unemotional scale and the Total scale of the ICU. In addition, when controlled for proactive aggression, effects were found for the Callous scale and the Uncaring scale of the ICU on reactive aggression. Those effects might be explained by the fact that there is some overlap between the definitions of reactive aggression and proactive aggression. This could mean that callous and uncaring traits are also found in reactive aggressive children, perhaps because of their cognitive deficiencies in the domains of social information processing and problem-solving skills (Crick & Dodge, 1996).

In line with our hypothesis that proactive aggressive children show callous and uncaring traits, positive relationships were found between proactive aggression and the Callous scale and the Uncaring scale. In

addition effects were found of the Callous scale and the Uncaring scale on proactive aggression, when controlled for reactive aggression.
Unexpectedly no relationship was found between proactive aggression and the Unemotional scale. This could be explained by the fact that proactive aggressive children are able to adjust their behaviour in response to extrinsic contingencies, because they learn that expressing emotions may be more helpful in reaching a goal (Vitiello & Stoff, 1997).

Study 2: Effectivity of Minder Boos en Opstandig in reducing behavioural problems and improving reward- and punishment sensitivity.

Social problems, delinquent behaviour, aggressive behaviour and externalizing problems were reduced after the Minder Boos en Opstandig (MBO) program. The children also showed less reactive and proactive aggression after the intervention. In addition trends were found for diminished anxious/depressed symptoms and internalizing problems. This indicates that Minder Boos en Opstandig is partly effective in reducing some of the behavioural problems of the participating children. However no significant improvement was found in reward- and punishment sensitivity among those children.
A significant correlation was found between reduction of delinquent behaviour and reduction of sensitivity to social reward. Children often show delinquent behaviour to get a better position in a group or to become more popular among their peers (Childs, Sullivan & Gulledge, 2011). When children become less sensitive to this social reward, they might also show less delinquent behaviour.

Limitations

Study 1:

Several limitations should be considered when interpreting these results. First, it was difficult to hypothesize the results of the study, because of the overlap in the definitions of reactive aggression and proactive aggression. It might be helpful to involve some other subdivisions of aggression in the study as well, like for example overt and covert aggression or physical aggression, verbal aggression and relational aggression (Van de Wiel, Hoppe & Matthys, 2003). Second, the instrument that was used to assess reward and punishment sensitivity has not yet been used in (older) adolescents (as were the participants in this study). There are some indications that the sensitivity to punishment and sensitivity to reward of adolescents is different from that of younger children. Future research should split up the age groups to be able to draw stronger conclusions or add age as a predictor of type of aggression, to control for age in the effects of sensitivity to punishment and sensitivity to reward on type of aggression. Third,

our sample only consisted of boys, which makes it difficult to generalize the results to the complete population. The inclusion of girls in the study could have changes the results, which is important to keep in mind. Fourth, the results concerning the relationship between reward- and punishment sensitivity and type of aggression appeared to be very different for the different models that were used in the analyses. This indicates that the kind of model that is used is of great importance, because of its large influence on the results. Fifth, for both of the studies one of the parents (often the mother) filled in the questionnaires. This could lead to biased results, because the other parent could have a different view on the behaviour of their child. Sixth, it is very well possible that parents and children gave social desirable answers to some questions. This could lead to biased results as well.

To get a more precise picture of the relationship between reward- and punishment sensitivity and type of aggression, it might be interesting to take clinical diagnoses of the children into account, when assessing this relationship. The study of Luman and colleagues (2011) showed that aggressive children who are diagnosed with an autism spectrum disorder react differently to reward and punishment than aggressive children diagnosed with ADHD or ODD. It might also be interesting to look for a possible mediating role of callous and unemotional traits in the relationship between reward- and punishment sensitivity and type of aggression.

Study 2:

The very small sample of the study makes the results less reliable and makes it harder to find significant effects (Field, 2009). Our study can be seen as kind of a pilot study and it gives some information about the effectiveness of Minder Boos en Opstandig, but future research should replicate the study with a larger sample to get a better picture of the effectiveness of the program and to make it possible to generalize the results to the population. With a larger sample size it would be possible to control for gender, age, additional diagnoses or socioeconomic status. It may be interesting to compare the Minder Boos en Opstandig program to other treatments aimed at reducing behavioural problems, to get more information about the specific effectiveness of Minder Boos en Opstandig. Another limitation of our study is the lack of a control group, which makes it harder to draw strong conclusions.

Conclusion

To conclude, the results of this study provide some evidence for positive relationships between sensitivity to reward and both reactive and proactive aggression. Proactive aggressive children appear to be more likely to show sensation-seeking behaviour than reactive aggressive children. The hypothesis that proactive aggressive children would also be less sensitive to punishment could not be confirmed in this

study. Positive relationships were found between callous and uncaring traits and reactive and proactive aggression. Concerning the effectiveness of Minder Boos en Opstandig, it can be concluded that there are indications that Minder Boos en Opstandig is effective in reducing behavioural problems. The reduction of delinquent behaviour might be a result from a diminished sensitivity to social reward. More information about the relationship between reward- and punishment sensitivity and type of aggression could be used to improve the Minder Boos en Opstandig program and for the development of other intervention programs.

Appendix 1

Factor solutions	PCA-2		PCA-4				Luman-4*				Luman-5*				
Items	1	2	1	2	3	4	1	2	3	4	1	2	3	4	5
1. The good prospect of obtaining a reward motivates your child strongly to do some things (a)	0.23	**0.54**	0.17	0.20	**0.60**	0.17		**0.61**			0.11	**0.78**	-0.12		-0.11
2. Your child prefers not to ask for something when they are not sure they will obtain it (b)	0.19	.	0.23			0.13	0.20		0.17		0.26	0.17	0.18		-0.15
3. Your child often does things to be praised (a)	0.28	**0.52**	0.29	**0.34**	0.23	**0.33**		**0.60**				**0.65**			
4. Your child enjoys being the center of attention (b)	-0.22	**0.61**	-0.20	**0.49**		**0.44**	**-0.35**	**0.48**		0.17	**-0.47**	0.11		0.25	**0.34**
5. Your child is a shy person (a)	**0.69**	-0.18	**0.71**	-0.16		-0.10	**0.68**		-0.17		**0.69**		-0.18		
6. When your child is in a group, they try to stand out as the smartest or the funniest (b)	-0.19	**0.41**	-0.18	**0.43**		0.26	-0.12	**0.42**		**0.33**	-0.17	0.15		**0.40**	0.23
7. Whenever possible, your child avoids demonstrating their skills for fear of being embarrassed (a)	**0.68**		**0.66**	-0.10	0.20	-0.13	**0.52**			-0.11	**0.45**	0.12		-0.14	
8. When your child gets something they want, they feel excited and energized (b)	0.13	**0.42**		0.15	**0.56**			**0.60**	-0.25			**0.45**	-0.25		0.23
9. When in a group, your child has difficulty thinking of something to say (a)	**0.70**		**0.68**		0.15	-0.11	**0.68**				**0.60**				0.15
10. Your child does a lot of things for approval (b)	0.29	**0.55**	0.26	**0.48**	0.25	0.21		**0.52**	0.13			**0.46**	0.14		
11. The possibility of obtaining social status moves your child to action, even if this involves not playing fair (a)	0.14	**0.53**		**0.73**					**0.64**	0.13			**0.65**	0.13	-0.22
12. Your child is often afraid of new or unexpected situations (b)	**0.50**		**0.50**	0.19			**0.61**	0.26			**0.32**				**0.62**
13. Does your child generally prefer activities that involve immediate reward (c)	**0.31**	**0.60**	0.22	**0.41**	**0.56**			**0.58**	0.16			**0.61**	0.17		
14. Your child often had trouble resisting the temptation of doing forbidden things (b)	0.14	**0.56**		**0.68**	0.21				**0.59**		-0.11		**0.60**	0.11	
15. Whenever they can, your child avoids going to unfamiliar places (a)	**0.61**		**0.60**	0.23	-0.13	-0.13	**0.60**	0.12			**0.39**				**0.43**
16. Your child likes to compete and do everything they can to win (b)		**0.36**		0.12	0.14	**0.39**		0.18		**0.58**	0.11			**0.65**	
17. Your child often worries about things they said or did (c)	**0.44**	0.21	**0.54**			**0.35**	**0.35**	0.27		0.10	0.22			0.13	**0.30**
18. It is difficult for your child to talk with someone they do not know (b)	**0.75**		**0.76**				**0.84**	-0.16	-0.11	0.23	**0.82**		-0.11	0.23	
19. Your child generally tries to avoid speaking in groups (d)	**0.77**		**0.76**			-0.12	**0.80**	-0.24		0.15	**0.82**			0.13	
20. Your child has a lot of difficulty ending a fun activity (b)	0.20	**0.37**	0.15	-0.04	**0.62**	0.14	0.14	**0.40**		0.15				0.21	**0.41**
21. Your child could do more things if it were not for their fear (c)	**0.73**	0.12	**0.68**	0.14	0.22	-0.14	**0.54**	0.23		-0.12	0.29			-0.12	**0.47**
22. Your child sometimes does things for quick reward (b)	0.23	**0.66**	0.15	**0.46**	**0.54**	0.15		**0.54**	0.21			**0.56**	0.22		
23. Your child is afraid of many things compared to other children their age (c)	**0.71**	0.13	**0.66**	0.26	0.12	-0.15	**0.49**		0.23	-0.20	0.20	-0.14	0.25	-0.21	**0.49**
24. Your child has difficulty staying focused on their school work in the presence of an attractive alternative (b)		**0.48**		0.12	**0.62**	0.13		**0.35**	0.15			0.11	0.15		**0.35**

a.)Item of the original Reward Responsivity (RR) scale; b.)Item of the original Sensitivity to Punishment (SP) scale; c.)Item of the original Impulsivity/Fun-seeking (IF) scale; d.)Item of the original Drive (D) scale as derived by Colder & O'Connor (2004).

* As derived by Luman and colleagues in their study (2011

Appendix 1 (continued)

Factor solutions	PCA-2		PCA-4				Luman-4*				Luman-5*				
Items	1	2	1	2	3	4	1	2	3	4	1	2	3	4	5
25. Your child engages in risky behaviour to obtain a reward (c)	0.23	**0.57**	0.14	**0.71**	0.21				**0.75**				**0.76**		
26. Your child often refrains from doing something they like in order not to be rejected or disapproved of by others (b)	**0.38**	**0.41**	**0.34**	**0.46**	0.17		0.27		**0.58**		0.20		**0.60**		
27. Your child likes competitive activities (c)	-0.23	**0.44**	-0.10			**0.72**	0.13	-0.10		**0.77**	0.23	-0.12		**0.82**	-0.11
28. Your child would like to be a socially powerful person (b)	-0.19	**0.35**				**0.56**		0.29		0.28		0.18		**0.32**	
29. Your child often refrains from doing something because of fear of being embarrassed (d)	**0.69**	0.11	**0.69**		0.16		**0.51**	0.11	0.22	-0.15	**0.42**	0.16	0.24	-0.18	0.13
30. Your child likes displaying their physical abilities even though it may involve danger (b)	-0.16	**0.53**		0.14	0.15	**0.65**			**0.35**	**0.41**		-0.11	**0.35**	**0.46**	
31. If your child thinks that something unpleasant is going to happen, they got pretty worked up (d)	**0.53**	0.26	**0.55**	0.13	0.19	0.17	**0.36**	**0.43**	-0.17				-0.19		**0.64**
32. Your child craves excitement and new sensations (d)	**-0.32**	**0.49**	-0.28		**0.34**	**0.48**	**-0.33**	0.17		0.22	-0.18	0.23		0.25	-0.22
33. Criticism or scolding hurts your child very much (c)	0.26	**0.34**	**0.32**	0.13	0.14	**0.34**	0.25	**0.42**			0.13	0.24			**0.31**

a.)Item of the original Reward Responsivity (RR) scale; b.)Item of the original Sensitivity to Punishment (SP) scale; c.)Item of the original Impulsivity/Fun-seeking (IF) scale; d.)Item of the original Drive (D) scale as derived by Colder & O'Connor (2004).

* As derived by Luman and colleagues in their study (2011)

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