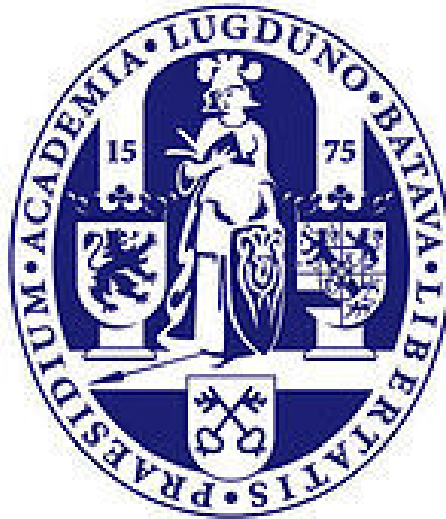# Master thesis

The association between disruptive behavior disorders with co-existing symptoms of autism or anxiety and markers of physiological arousal during resting state in boys at age 8-12

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Preface

This thesis would not have been written the way it is done without several persons that were present at the time I was writing this thesis. I will start of course with mentioning the persons who helped and supported me during all steps within a master project that need to be taken. Furthermore, I would like to thank some persons for just being there, not knowing anything of the project in which I was involved or the things I wrote down in this thesis. Sometimes you would like to win an Oscar, not to be famous or to do something with the opportunities that it will provide you with for your further career, but to be able to thank persons for who they are. Each time the awards are presented, persons feel free to thank, for instance, their grandfather for letting them play with a screwdriver and broken watch all day long when they were young, for it was one of the happiest moments of their life. It sounds strange for the audience, but they laugh and applaud, only a few persons know what is really said. I will never win an Oscar that gives me the opportunity to thank these few in an official way, but now I am young and though enough to feel free to spend the preface of this thesis on these, maybe not customary, words that need to be said.

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Fellow students, I would like to thank you all for being there when needed, I really appreciate that, thank you all for moments of laughing and speaking with each other about our studies and life after the serious work was done. Kees, we meet each other since five years on several moments in our life, graduating is part of that. 'Petje af' for who you are and the things you achieve in life, drinking coffee with you is a little party. Inge, it is not 'dankzij'(thanks to), but 'ondanks' (despite of) you that this thesis was written, only a few are able to keep me away from studying, thank you for your overall 'snapvermogen', for meeting you, and not just passing by. Fons, I would like to thank you for doing the dishes with me, each time in such a funny way and in a hurry, when I needed time to work on my thesis.

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Abstract

Background: High levels of aggressive behavior are associated with a low resting heart rate in boys. However, differences in underlying mechanisms, e.g. arousal levels, might exist between boys with disruptive behavior disorders, which might have implications for intervention programs to prevent aggressive behavior to develop further into adulthood. **Methods:** The current study investigated resting heart rate (beats per minute) and skin conductance levels (μS) in boys, 8-12 years old (M_{age} = 9.67, SD = 1.18), with a disruptive behavior disorder (N_{DBD}= 24, $N_{Control}$ = 25). Levels of anxiety and characteristics of an autism spectrum disorder were considered as co-occuring symptoms, to consider possible differences between the two groups and to infer the predictive value of these symptoms regarding arousal levels. Arousal levels in resting state were considered while the participants watched a three minute calming video of fishes. Levels of aggression, anxiety and amount of characteristics of an autism spectrum disorder were measured by questionnaires that were administered by the boys themselves (MASC) and the parents (ASEBA CBCL 6-18 and VISK). One-way analyses of variance were performed to infer possible differences between the control group and the DBD group. Moreover, multiple regression analyses were executed to consider the predictive value of the levels of the mentioned symptoms with regard to arousal levels. **Results:** No differences were found in arousal measures in resting state between the DBD group and the control group. However, expressing higher levels of characteristics of autism, especially not understanding social information (e.g. jokes), stereotypic behavior and anxiety for change, turned out to be partly predictive for higher levels of heart rate in the DBD group. None of the considered factors was predictive for variation in skin conductance levels in this group. **Conclusions:** The current findings suggest that some of the aggression seen in the DBD group could possibly origin from the lack of understanding as well as anxiety or tension with regard to social situations and is associated with somewhat higher levels of arousal instead of lower levels, as previously suggested. The tentative findings in the current study could incite to investigate in more depth the predictors of variation in levels of arousal, which could provide more information about differences between individuals with regard to underlying mechanisms of aggression.

Keywords: Disruptive Behavior Disorder, Aggression, Arousal in resting state, Characteristics autism, Anxiety.

Introduction

The aggressive behavior that is found in boys with disruptive behavior disorders (DBD), e.g. oppositional defiant disorder or conduct disorder, if often seen as preluding more sustained antisocial behavior in adulthood (Thambirajah, 2011). This suggests the importance of applying adequate interventions to prevent a negative development in boys with early-onset aggressive behavior and to support more adaptive behavior (McBurnett, Lahey, Rathouz, & Loeber, 2000). Showing aggressive behaviour during pre-school years, for instance, turned out to be a predictor of aggressive behaviour in adulthood, for aggression is a stable trait (Patterson, 2002). Aggression is an aspect of antisocial behavior and has to do with hurting other persons in a physical way, e.g. hitting, or harming them in a psychological manner; humiliating (Kempes, Matthys, De Vries, Van Engeland, 2005). An aspect that needs to be considered by investigating the etiology of aggression is the level of arousal of the autonomic nervous system, several studies proved that above average levels of aggression are associated with a low heart rate in resting state and deficits in noradrenergic functioning in children and adolescents, as well as possible fearlessness (Raine, 2002). The aggressive behavior as seen in individuals with a disruptive behavior disorder is suggested to be related with deviant peripheral stress reactions, as can be measured by salivary cortisol levels that reflect patterns in the hypothalamic-pituitary-adrenal axis that are suggested to be an underlying mechanism of aggressive behavior as well as coping with stress (McBurnett, Lahey, Rathouz, & Loeber, 2000). However, boys with aggressive behavior cannot plainly be considered as a homogeneous group, differences in underlying mechanisms, as measured by arousal levels, might exist within the population of boys with disruptive behavior disorders (McMurran, & McGuire, 2005), this might have implications for the content or type of future intervention programs that can be applied to prevent aggressive behavior seen in children to develop further into adulthood.

One hypothesis, central to this study, is that arousal levels could differ over subgroups of boys with a disruptive behavior disorder (Matson, & Sturmey, 2011; McBurnett, Lahey, Frick, Risch, Loeber, Hart, Christ, & Hanson, 1991), the current study considers arousal levels in boys who exhibit a disruptive behaviour disorder by taking levels of anxiety and characteristics of an autism spectrum disorder additionally into account. These characteristics are often seen as co-occuring symptoms, additional to the disruptive behavior disorder, and are suggested to account for variation in levels of arousal within the population of aggressive boys. Autism is often associated with aggression (Matson, & Sturmey, 2011) and is a pervasive developmental disorder that results in impairments on a broad spectrum of areas, like communication, social interaction, and behavioral patterns (Quinn, & Malone, 2000). Non-verbal communication is not appropriately considered and language is often considered literally (Wing, Gould, & Gillberg, 2011), though, levels of cognitive functioning varies (Charman, Pickles, Simonoff, Chandler, Loucas, & Baird, 2011). The underlying mechanism of autism spectrum disorders is not yet clear, though, while a growing number of children is diagnosed with an autism spectrum disorder (Penn, 2006). However, a neurobiological aspect that is principally associated with autism is not found, there is a certain amount of overlap in underlying mechanisms with other disorders and behavioral patterns (Abrahams, & Geschwind, 2008). Furthermore, individuals with

autism often have co-occurring symptoms, e.g. aggressive behavior, anxiety and regulation problems. The observed behavior in boys with a disruptive behavior disorder and autism might be comparable, while the underlying mechanisms differ; it is suggested that the aggression in children with an autism spectrum disorder could arise from irritation that is caused by their lack of coping skills on several domains, e.g. social interactions (Zager, 2013), and not from a deviant pattern of arousal (e.g. heart rate), as is suggested in disorders associated with aggression (Gower, & Crick, 2011). With regard to interventions, it can be important to consider this kind of underlying mechanisms, detect the amount of overlap between characteristics of several symptoms that co-exist in children with a disruptive behavior disorder, moreover, differences on this point between boys with aggressive behavior may require different approaches. For example, previously executed studies revealed that children with disruptive behavior disorders, who have a relative low heart rate, benefit less from cognitive behavioral interventions applied to reduce impulsive, oppositional and aggressive behavioral problems (Stadler, Grasmann, Fegert, Holtmann, Poustka, Schmeck, 2008). Coping skills under stressful conditions can be observed by investigating levels of arousal, though, it is important to investigate possible differences in arousal levels in resting condition in the first place, to infer differences in baseline levels. The lack of stable findings on reactivity measurements by considering heart rate (Ming, Julu, Birmacombe, Connor, & Daniels, 2005) gives rise as well to the idea that it is important to consider baseline measurements of arousal as well, to infer the initial levels of arousal as well and be able to state whether differences in arousal are already seen in resting state (Groden, Goodwin, Baron, Groden, Velicer, Lipsitt, Hofmann, & Plummer, 2005).

Moreover, it might be possible that no strictly disjunctive subgroups exist within the population of boys with aggressive behavior when arousal levels are considered, though, a more dimensional approach could be applied, in which boys tend not to show differences within their arousal levels on the lack on one hand or the presence of a certain co-occuring symptom on the other hand, but express simply more or less of a co-occuring symptom which accounts for differences in arousal levels (McMurran, & McGuire, 2005). Besides characteristics of autism, the possible influence of anxiety on the association between aggressive behavior and arousal levels will be considered, for previous executed studies suggest an effect of anxiety on levels of arousal in children with aggression (McBurnett, Lahey, Frick, Risch, Loeber, Hart, Crhist, & Hanson, 1991) and anxiety is a co morbid symptom often observed in boys with disruptive behavior disorders.

It is meaningful to consider differences in the regulation of arousal to make inferences with regard to distinctions that are found within children with disruptive behavior disorders (Van Goozen, Matthys, Cohen-Kettenis, Gispen-de Wied, Wiegant, & Van Engeland, 1998), it could bring forward more information regarding the etiology of these disorders when overlap and differences are considered (Penn, 2006). It is important to examine the similarities in markers of underlying neurobiological processes, for aggression, as well as autism, is a heterogeneous disorder that is associated with co-occurring symptoms (Courchesne, Karns, Davis, Ziccardi, Carper, Tigue, Chisum, Moses, Pierce, Lord, Lincoln, Pizzo, Schreibman, Haas, Akshoomoff, & Courchesne, 2001). It could be discussed whether boys who exhibit aggression with or

without the mentioned co-existing symptoms tend to differ on physiological mechanisms, and whether these variation could be considered by a dimensional approach, stating that boys do not differ on whether a certain characteristics is present or not, but differ on the level in which a certain characteristic is present. Distinguishable or comparable patterns of arousal might emerge, which both will be important to know with regard to obtaining more in depth insight in the underlying mechanisms of aggressive behavior in boys and discuss subsequently the possibility that this is something to consider in order to provide adequate intervention programs to enhance self-regulation and to prevent highly aggressive children from becoming antisocial adults. Moreover, the existence of (certain levels of) influential co-occurring symptoms can indicate shared underlying neurobiological processes that require other interventions to treat dysfunctional behavioral patterns (Levy, Giarelli, Lee, Schieve, Kirby, Cunniff, Nicholas, Reaven, & Rice, 2010).

Autism and aggression

It was previously stated that fifty-three percent of the persons with an autism spectrum disorder expresses physical aggression (Mazurek, Kanne, & Wodka, 2013). Furthermore, it is mentioned that children with autism and aggression share some co-occuring symptoms, e.g. problems in social interactions and sleep problems (Williams, Sears, & Allard, 2004; Anckarsäter, 2006). It is previously suggested that the co-existing symptoms in autism account for the aggression that often arises in persons with autism (Hofvander, Ossowski, Lundström, Anckarsäter, 2009). However, it is not completely clear how aggression and autism are related, whether these are two different types of psychopathology that co-exist or whether they share same underlying neurobiology processes (Farmer, & Aman, 2011).

Arousal

Arousal has to do with being in a state of alertness, or being ready to detect stimuli and process information (Melillo, & Leisman, 2004). Furthermore, stress is an adaptive reaction to changes in ones environment, to regulate once own internal processes and to abrogate the origin of stress (Ursin, & Eriksen, 2004). Physiological arousal arises from the autonomic nervous system, consisting of the excitatory systematic nervous system and the inhibitory parasympathic nervous system, the first is involved during psychological stress and causes the physiological arousal to adjust to the situation (Appelhans, & Luecken, 2006). Though, in a stable situation, the latter system is involved, which accounts for a continuously low level of physiological arousal. The hypothalamic-pituitary-adrenal axis (HPA-axis) is involved as well within the process of adaptation to stress or anticipation towards stress (physical and psychological) (Fink, 2010). The level of arousal can be determined by exploring physiological markers, e.g. heart rate (variability) as a marker of autonomic arousal, whereby increases tend to be influenced by the valence of certain presented stimuli that induced the stress (Reynard, Gevirtz, Berlow, Brown, & Boutelle, 2011). Skin conductance is a good marker of arousal as well and independent of the emotional valence of the stressful stimuli (Lang, & Davis, 2006). Being in a resting state is normally indicated by a regular heart rate and absence of skin conductance. Though, during stress, one will found increased levels of skin conductance and heart rate (Spielbeger, 2004). Previous studies used several indicators of physical arousal, like cortisol, heart rate, skin

conductance and blood pressure. However, disadvantages exist for some markers, like the effect of attention on heart rate (Acharya, 2007). Skin conductance tends to be a stable marker of autonomic arousal in contrast to measures like heart rate and blood pressure (Jacobs, Friedman, Parker, Tofler, Jimenez, Muller, Benson, & Stone, 1994), for ir is not distorted by respiration, like heart rate.

Self-regulation

The importance of investigating patterns of arousal levels in boys with disruptive behavior disorders has to do with the associated effect of deviant arousal patterns on self-regulation (Mowder, Rubinson, Yasik, 2009). Self-regulation is an important capacity to be able to function in daily life and can be exerted in relation to handling emotions (Vohs, & Baumeister, 2011). Moreover, self-regulation is important to process incoming sensory stimuli in an effective way by expressing adequate arousal levels. Hyperarousal is associated with overactive behavior patterns, though, with withdrawal when too much sensory stimuli are experienced and lead to an unpleasant level of arousal. Hypoarousal, on the other hand, is associated with slow reactions and passive behavioral patterns (Vohs, & Baumeister, 2011).

Aggressive behavior and arousal

Children with antisocial behavior have generally lower resting heart rate and basal level of skin conductance were found when they are in a resting state (Kempes, Matthys, De Vries, Van Engeland, 2005). Moreover, lower levels of skin conductance at baseline and lower heart rates in the resting state are associated with criminality years later (Van Goozen, Matthys, Cohen-Kettenis, Gispen-de Wied, Wiegant, & Van Engeland, 1998). Studies with five year old children suggested that resting heart rate did not provide clear differences between groups with high and low levels of behavioral problems at that age (Calkins, Graziano, & Keane, 2007). Though, antisocial behaviour in adolescents is associated with a low resting heart rate (Ortiz, & Raine, 2004; Van Hulle, Corley, Zahn-Waxler, Kagan, & Hewitt, 2000). Previous studies concluded that heart rate in a resting state was convincingly lower in boys with oppositional deviant disorder, however, their heart rate was higher during the stress condition, in which provocation and frustration were induced (Van Goozen, Matthys, Cohen-Kettenis, Gispen-de Wied, Wiegant, & Van Engeland, 1998). Though, lower autonomic arousal is found as well in children with above average levels of aggression during stress conditions (Snoek, Van Goozen, Matthys, Buitelaar, & Van Engeland, 2004). Furthermore, lower levels of electrodermal activity (in anticipation of stress) are associated with aggressive conduct disorder, externalizing behavioural problems in general, low levels of anxiety, and weak emotion regulation (Fowles, 2000; Snoek, Van Goozen, Matthys, Buitelaar, & Van Engeland, 2004). Studies pointed out that heart rate at baseline as well as skin conductance were relatively lower in children with a disruptive behavioral disorder in comparison to a control group (Van Goozen, Matthys, Cohen-Kettenis, Buitelaar, & Van Engeland, 2008). Moreover, differences between the two groups become larger when stress is induced.

Autism and arousal

The difficulties often seen in functioning of children with an autism is suggested to be associated on one hand with the actual deviation in arousal patterns in comparison to typically developing children, but on the other

hand one could also mention the capacity to regulate ones' own arousal and achieve changes in these levels, in order to function in a more adequate manner (Whitman, 2004). Previously executed studies suggest that the heart rate responses in boys with autism are elevated, but the pattern show less change over several conditions (stress versus resting state) (Goodwin, Groden, Velicer, Lipsitt, Baron, Hofmann, & Groden, 2006). The reactivity measurements in children with autism differ over studies, while a more stable finding is reported regarding baseline measurements of heart rate, which are heightened (Schoen, Miller, Brett-Green, & Nielsen, 2009). Moreover, decreased levels of skin conductance were found in individuals with autism. Though, the findings with regard to the association between autism spectrum disorder and arousal patterns are somewhat inconsistent (Mathersul, McDonald, & Rushby, 2013). Autism is associated with both hyper- and hypoarousal in several previously executed studies. Hyperarousal is e.g. suggested to be associated with deficits in social behavior, for participation within social interaction are avoided due to the fact that these situations elicit more than average levels of arousal that cannot be regulated (Carlisle, 2007). The arousal levels tend to be higher in individuals with autism while confronted with unfamiliar situations or stimuli and do not tend to show acclimatization in time. Moreover, it is thought that the characteristic behaviour patterns associated with autism spectrum disorders, for instance stereotypic behavior, are expressed to diminish the experienced arousal. EEG measurements brought forwards that arousal levels actually tend to decrease after expressing these types of behavior, though it is questionable whether these types of behavior are actually expressed in order to reduce arousal (Armstrong, 2010). Other studies suggest that the stereotypic behavior seen in children with autism elicit sensory stimulation in case of hypoarousal (Whitman, 2004). Furthermore, different arousal profiles were found as well with regard to the more stable measurement of skin conductance, both low and high levels of skin conductance in resting state were found previously. The group with higher baseline levels of skin conductance tends to show more characteristics of autism. Hypoarousal, as measured in skin conductance, though, is associated with more attention problems (Schoen, Miller, Brett-Green, & Hepburn, 2008). Anxiety is often considered as co-existing symptoms in individuals with autism as well as aggression, and could possibly account for the suggested association between autism and levels of arousal in children with a disruptive behavior disorder, so it is important to consider the possible influence of anxiety on this association (Bubier, & Drabick, 2009). Fear is one of the emotions persons can experience and is adequate in reaction to stimuli that could be dangerous for one's physical or emotional well-being (Beidel, & Turner, 2013). Fear could be inadequate when it continues to exist and starts to impair someone in his daily functioning, the anxiety is no longer adequate (Beidel, & Turner, 2013). Anxiety disorders exist in 2.4-17.7% of the overall population of children (Essau, & Petermann, 2013), though, roughly seventy-five percent of the children in the Netherlands experience fear for one or more stimuli, mainly a broader spectrum of fears exists. The association between anxiety and over-responsivity is previously discussed, but not yet fully understood (Green, & Ben-Sasson, 2010). Anxiety is associated with muscle tension and hyperarousal, which is observable in heart rate as well as skin conductance levels in resting state (Fonseca, & Peerin, 2011). It is suggested that this hyperarousal results from an inability to cope with and regulate experienced anxiety.

Research question

The above gives rise to the question whether there is an association between the baseline arousal measurements, measured by heart rate and skin conductance, and aggressive behavior in 8- to 12-year old boys. The focus is on variation in arousal in the DBD group, it is hypothesized that particularly characteristics of autism and anxiety are influential factors, and might be predictive for dysregulation within these boys. The predictive value of anxiety (parental reports and self-report) and characteristics of autism is investigated in the current study. Two indicators of arousal (heart rate and skin conductance) are included in the current study, for both are associated with different parts of coping, which is important to consider with regard to self-regulation (Sosnowski, Nurzynska, & Polec, 1991), and skin conductance turned out to be a more stable indicator of arousal patterns (Jacobs, Friedman, Parker, Tofler, Jimenez, Muller, Benson, & Stone, 1994) in comparison to heart rate (Ming, Julu, Birmacombe, Connor, & Daniels, 2005). The following research questions are at issue. First of all, the overall research question is: *What is the association between disruptive behavior disorders and levels of indicators of physiological arousal in resting state in 8- to 12-year old boys, as indicated by heart rate and skin conductance?* Secondly; *What is the predictive value of characteristics of autism and amount of anxiety with regard to the levels of arousal in resting state in the DBD group?,*

Methods

Participants

The sample consists of participants between eight and twelve years old, only boys were included in the sample. The participants were part of a larger sample that was considered in an overarching study with regard to underlying processes of aggression as well as anti-social behavior in boys. The children were recruited by contacting schools (regular as well as schools for special primary education) in the Netherlands, specifically in provinces 'Noord-' and 'Zuid-Holland', as well as organizations that provide mental health care. Parents were invited to take part in the overarching study and to allow their child to participate as well. Both control children and children who obtained a classification of a (developmental) disorder were included in the study.

Procedures

Boys with a disruptive behavior disorder were recruited by clinical referral and approached by schools. The other boys were all recruited by approaching schools. Parents needed to sign a consent form before participating in the study and allowing their child to participate as well. Moreover, informed consent was declared to the parents and signed. An interview (Diagnostic Interview Schedule for Children, DISC) was done with the parent and several questionnaires were administered, e.g. the Child Behavior Checklist. Meanwhile the child participated in a laboratory session, in which both questionnaires and computer tasks were administered as well as physiological measurements were performed (heart rate, skin conductance, cortisol) to infer the levels of arousal in both resting state as well as in a stress condition, during a game.

Measures

Instruments that were applied in the current study, were administered in the context of a broader study, in

which several instruments were applied to collect information from caregivers, teachers and the boys themselves and obtain information with regard to underlying mechanisms of aggression in boys. The participating boys were assigned to the control group or the group of boys with aggressive behavior by the classifications that parents reported, e.g. oppositional deviant disorder or conduct disorder, or by information that results from the DISC interview. To infer the level of aggressive behavior in the several groups as well as the levels of anxiety and the influence of these on the considered associations between aggression and arousal measurements, parents completed the Child Behavior Checklist. The norm scores on the Aggressive Behavior scales as well as the Anxious/Depressed scale were considered only for the current study, moreover, the self-reported level of anxiety, as inferred by the Multidimensional Anxiety Scale for Children, was considered.

Disruptive behavior disorders: The Diagnostic Interview Schedule for Children, parental version, is administered, a structured interview constructed by Schaffer et al. in 2000 (Verheij, 2000) that screens for approximately thirty psychiatric disorders with regard to anxiety, affect, schizophrenia, behavioral disorders, etc. in children (9-17 yr). The DISC-P exhibit 24 modules by means of e.g. the DSM-IV criteria to consider diagnoses of anxiety disorders, affect disorder, behavioral disorders, etc. The module Disruptive Behavior Disorders with regard to the existence of the attention-deficit/hyperactivity disorder, existence of oppositional deviant disorder as well as conduct disorder were considered only for the current study, to determine whether someone is in the control group or in the group with boys with a disruptive behavioral disorder. Reliability and validity of the instrument are respectively good and reasonable. No information is currently available on reliability and validity as reported by the *Commissie Testaangelegenheden Nederland* (COTAN).

Aggressive behavior and anxiety: The Child Behavior Checklist (CBCL/6-18), constructed by Achenbach (Verheij, 2000), is a questionnaire with regard to behavioural problems and abilities of children (6-18 yr) and filled out by parents. The questionnaire contains twenty questions with regard to the activities, social contacts and educational achievements of the child. Moreover, 118 questions are included regarding emotional and behavioural functioning. Parents report whether the suggested behavior was present in their child in the last six months on a three-point Likert scale (0=absent, 1= occurs sometimes, 2=occurs often). Scores on eight syndrome scales can be retrieved from the administered questions: anxious/depressed, depressed, somatic complaints, social problems, thought problems, attention problems, rule-breaking behavior, and aggressive behavior. Out of the first three scales the scale with regard to internalizing problem behavior is constructed, while the latter to together create the scale for externalizing problem behavior. Furthermore, DSM oriented scales are constructed. For the current study, only the scales with regard to anxious/depressed behavior and aggressive behavior were considered. The COTAN has not yet present assessment of this instrument. Though, the CBCL 4-18 is rated with the classification 'sufficient/good' in 1999. The test-retest reliability for these two scales reaches correlations (retesting after two weeks) of .80 or higher. The internal consistency reaches the classification 'good' with a Crohnbach's alpha of. 76. Criterion- as well as concept validity were tested for the CBCL 4-18, which resulted in the classification 'good' for the latter and 'sufficient' for the first type of validity that was considered. Finally, the norms of the CBCL 4-18 were classified as good.

Anxiety: The Multidimensional Anxiety Scale for Children is administered by the boys, this is a self-report questionnaire that is applied to administer in children and youth (8-19 yr.), to consider anxiety levels (Reynolds, & Kamphaus, 2003). Several anxiety expressions are suggested on the questionnaire and the child is asked to rate whether the posed anxiety expression is true for him on a five-point Likert scale from 0 to 4, the latter indicates that the expression is (almost) always true and suggests the highest level of anxiety on the suggested topic. The MASC contains four scales, physical symptoms (subscales tense symptoms and somatic symptoms), avoidance (subscales perfectionism and anxious coping), social anxiety (subscales humiliation fears, performance fear), separation-panic, moreover, a total scale score can be calculated. Furthermore, an anxiety index can be derived from the scores on this instrument ad well as an inconsistency index. The administration of this questionnaire costs approximately an quarter of an hour. The overall instrument has acceptable levels of reliability as well as validity, though, lower values for the internal consisntency of some individual subscales were found, e.g. for the subscales Perfcectionism and Anxious coping, for which levels of Crohnbach's alphan were found below .65. The same is true for the Anxiety Disorder Index, while it must be mentioned that this index considers severla anciety disorders, which makes it a rather heterogeneous scale. With regard to the validity of the instrument, more research is desirable.

Characteristics of autism: Furthermore, the *Vragenlijst voor Inventarisatie van Sociaal gedrag van Kinderen* (VISK), constructed by Luteijn, Minderaa, and Jackson in 1998, is administered by parents with regard to the social behavior of their child (Luteijn, 2003). Originally the VISK is administered in parents of children (4-18 yr.) with a pervasive developmental disorder to make inferences regarding their social problem behavior. The parent report whether the suggested behavior was present in their child in the last six months on a three-point Likert scale (0= not applicable, 1= a bit/sometimes applicable, 2= obviously/often applicable). A total score can be retrieved as an indication of the amount of social problem behavior that is expressed in the child. Moreover, scale scores can be obtained; 1. Not well adapted to social situation, 2. Reduced tendency of social interaction, 3. Orientation problems in time and place, 4. Not able to understand social information, 5. Stereotypic behavior, and 6. Anxiety and resistance towards change. This instrument considers symptoms of the social problem behavior that is characteristic for pervasive developmental disorders. The COTAN considered the norms and criterion validity as insufficient in 2003, though, the reliability and concept validity were sufficient. For the internal consistency of the total score a Crohnbach's alpha of .90 or higher is found. The Pearson's r for the total score is .86, which suggest a high level of interrater reliability. Furthermore, the test-retest reliability (after three to five weeks) for the total score is good, for a Pearson's r is .88.

Markers of arousal: Two markers of arousal levels were measured in resting state to be able to make inferences with regard to the possible differences between the subgroups within the sample of aggressive boys by considering arousal levels in resting state. Measurements for both indicators of arousal, heart rate, measured in beats per minute, as well as skin conductance (average SC (μS)), were obtained while the participants were seated in front of a computer screen on which a three minute movie of fishes was shown, without spoken scenes, and with calming music playing, lights were tempered in order to end up in a

quiescent state. Heart rate measurement is performed by placing three electrodes for electrocardiogram measurements on the chest of the participants, one is placed right beneath the sternum, one beneath the left axilla on the same height as the previous electrode, and an electrode in between the previous attached electrodes on the chest. The TMS (Twente Medical Systems International B.V.) PortiLab2 is the device that was used to measure continuously beats per minute, averages of beats per minute were calculated for time blocks of 30 seconds, six blocks were considered. For the current study only the last block of thirty seconds was considered, for this is perceived as the time period in which actually heart rate is resting state is measured. The average of all six measurements was not considered, for it might be disordered by stress that is experienced in the participants in the first time blocks, for they could be stressed by not knowing what is requested from them. Besides heart rate measurement, skin conductance (microsiemens, μS) baseline levels were considered in the current study. Again the PrtiLab2 device is used to measure skin conductance. Two 1-cm3 Ag/AgCl (silver/silver-chloride) electrodes were placed on the middle phalange of the index finger and the middle finger, the non-dominant hand is involved. Measurements were done by a voltage of 0.5 Volt. In accordance with the heart rate measurements, measurements of skin conductance were considered in six blocks of thirty seconds and means of levels of skin conductance were obtained for each block. Again the last block of thirty seconds is only included in further analyses in the present. Monitoring of the measurements were done by the applying the TMS PortiLab2 software for skin conductance as well, possible artefacts in the obtained data due to e.g. movement of hands were tracked.

Statistical analyses

Statistical analyses were executed to investigate which behavioral characteristics are predictive for variation in arousal measurements in resting state in boys with above average levels of aggression. The considered variables were aggressive behavior (parental report: CBCL Aggressive behavior scale), anxiety (parental report: CBCL Anxious/Depressed scale, self-report: MASC Total score), and characteristics of autism (VISK, total score, subscales). Multiple regression analyses were executed to infer the predictive value of the amount of characteristics of an autism spectrum disorder or levels of anxiety.

Before descriptive and explanatory analyses were executed to investigate possible differences in the association between aggression and arousal in resting state between boys with and without characteristics of autism, some cases were excluded from further analyses. A considerable amount of participants in the original data set were excluded, for no data for arousal measurements were available. Moreover, boys were excluded from analyses for they exhibited no aggression, which might be suitable for being in the control group, but on the contrary exhibit (pervasive) developmental disorders. Moreover, some participants were excluded from analyses, for their parents reported low levels of aggressive behavior on the CBCL, while above average levels of arousal were reported by the teachers of these boys. The resulting sample consists of 51 boys between eight en twelve years old (M=9.73, SD= 1.20, $Min = 8$, $Max = 12$). Twenty-four boys are in the DBD group, they express developmental disruptive behavior disorder (N=25; 49%), while twenty-six children are in the control group (N=26; 51%). Nine boys were classified with an autism spectrum disorder (N=9;

17.6%), while forty-two children were not classified with an autism spectrum disorder (*N*=41; 82.4%). Heart rate in resting state is considered by looking at mean BPM (beats per minute) measurements for the last block of thirty seconds (*M*=75.82, *SD*= 9.55). Two outliers were found for the mean measurements in the last block, these boys had deviant high measurements, though, their measurements did not deviate more than two standard deviations from the mean, will not have considerable influence on the other measurements, and were consequently not excluded from subsequent analyses. The galvanic skin response in resting state is considered by looking at mean electro dermal response for the last block of thirty seconds. This variable (*M*=6.86, *SD*= 4.77) has a distribution that deviates from normality as well, which have implications for the value of the interpretations that result from analyses that were done with this variable included. Furthermore, the statistics for the total scores on the MASC questionnaire, filled in by the child, were considered (*M*=42.84, *SD*=19.34). The variable of the total score on the VISK questionnaire (*M*=24.25, *SD*= 22.41), filled in by parents, has a distribution that deviates from normality. One outlier is found, though, the score of this participant deviates less than two standard deviations from the mean and will not be excluded. The distribution of the variable that exhibits the total score on the Anxious/Depressed scale (*M*=4.86, *SD*=5.28) of the CBCL 6-18, as filled out by parents, has a distribution that deviates from normality, for the distribution is skewed. However, no extreme outliers were found. The last variable that is considered is the Aggressive behavior scale (*M*=8.63, *SD*=8.65) of the CBCL 6-18 has a distribution that deviates from normality, though, no extreme outliers were found. By excluding the considered outliers, descriptive statistics of the final sample of 49 boys can presented with mean age within the final sample is 9.67 years old (*SD*=1.18). Twenty-four boys are in the DBD group, they express developmental disruptive behavior disorder (*N*=24; 49%), while twenty-five children are in the control group (*N*=25; 51%). Eight boys were classified with an autism spectrum disorder (*N*=8; 16.3%), while forty-one children were not classified with an autism spectrum disorder (*N*=41; 83.7%).

Results

Descriptive statistics

The total score on the Anxious/Depressed scale of the CBCL (*M*= 4.98, *SD*=5.34) had a distribution that deviated from normality, for the distribution was skewed. Moreover, the total score on the Aggressive behavior scale had a mean of 8.84 (*M*=8.84, *SD*=8.75) and a distribution that deviated from normality as well. The variable BPM Block 6 (*M*=75.16, *SD* = 9.15) had a normal distribution. The variable GSR Block 6.89 (*M*=6.89, *SD* =4.83) had a distribution that deviates from normality, which could have had implications for the value of the interpretations that result from analyses done with this variable included. The variable of the total score on the VISK (*M*=24.90, *SD*= 22.61) had a distribution that deviated from normality as well. Though, the variable total score on the MASC (*M*=43.27, *SD*=19.45) is normally distributed.

Aggressive behavior

The means with regard to the levels of aggressive behavior were calculated for the group of boys with a disruptive behavior disorder (*M*=68.58, *SD*=10.35) as well as the control group (*M*=51.16, *SD*=2.39). To be able to infer whether the DBD group expresses significantly higher levels of aggressive behavior (*Fig.1)* an

analyses of variance was performed, though, the error variance was not equal across groups, so a non-parametric test (Kruskal-Wallis Test) was executed. Which suggested the existence of a significantly higher level of aggressive behavior in the DBD group ($p<.001$).
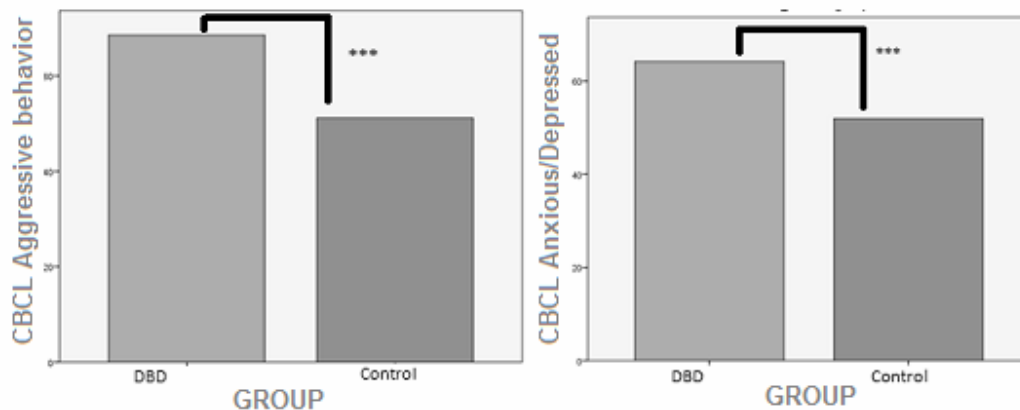

*Fig. 1. Bar charts levels of aggression (a) and anxiety (b) for the DBD and control group ($p< .001=$ ***)*

Anxiety

The means with regard to the levels of anxious behavior (CBC, Anxious/Depressed scale) were calculated for the group of boys with a disruptive behavior disorder ($M=64.21$, SD=11.01) as well as the control group ($M=51.92$, SD=4.38). To be able to infer whether the DBD group expresses significantly higher levels of anxious behavior (*Fig. 1*) an analyses of variance was performed, though, the error variance was not equal across groups, so a non-parametric test (Kruskal-Wallis Test) was executed. Which suggested the existence of a significantly higher level of anxious behavior in the DBD group ($p<.001$). One-way analyses of variance were executed as well to infer possible differences between the control group and the DBD group with regard to the mean scores on the subscales of the MASC (self-report, *Fig. 2*). Though, for none of the considered subscales significant differences were found between the two groups. Exhibiting above average levels of aggressive behavior seems not to account for differences in levels of self-reported anxiety in comparison with boys without above average levels of anxiety.
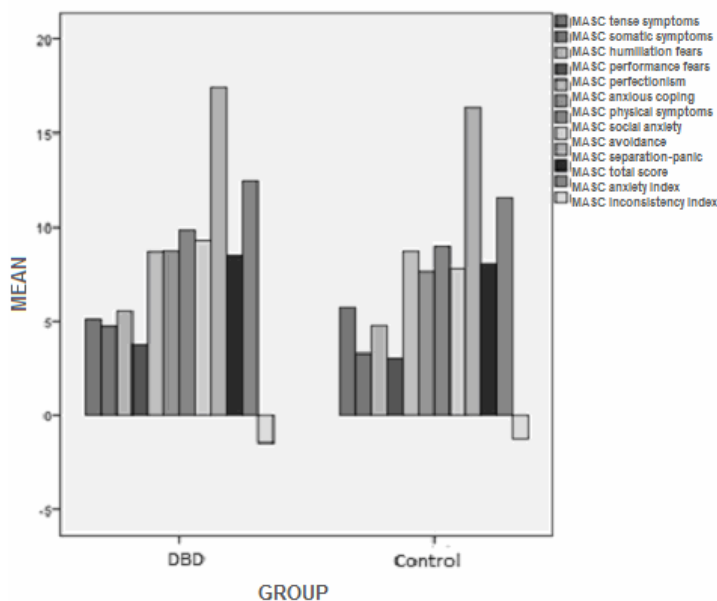

Fig. 2 Subscales MASC DBD vs. control group

Characteristics of autism spectrum disorder

The means for the DBD group and the control group were compared on the subscales of the VISK. The differences in mean scores between the DBD and control group (*Fig. 3)* on the several scales were tested by a non-parametric (Kruskal-Wallis Test), for the assumptions for executing an analysis of variance were not met. It turned out that the DBD group had a significantly (p<.001) higher mean (*M*=12.13, *SD*=5.42) in comparison with the control group (*M*=2.72, *SD*=6.37) on the subscale with regard to not showing adaptive behavior. Moreover, the DBD group had a significantly (p<.001) higher mean (*M*=7.67, *SD*=6.08) in comparison with the control group (*M*=2.00, *SD*=3.66) on the subscale with regard to withdrawal behavior. Furthermore, the DBD group had a significantly (p<.001) higher mean (*M*=6.33, *SD*=3.68) in comparison with the control group (*M*=1.44 *SD*=2.04) on the subscale with regard to problems with orientation. Besides, the DBD group had a significantly (*p*<.001) higher mean (*M*=6.92, *SD*=3.54) in comparison with the control group (*M*=2.04 *SD*=1.67) on the subscale with reagrd to problems with understanding. In addition, the DBD group had a significantly (p<.001) higher mean (*M*=5.79, *SD*=4.39) in comparison with the control group (*M*=.72, *SD*=1.40) on the sub scale with regard to stereotypic behavior. Moreover, the DBD group has a significantly (*p*<.001) higher mean (*M*=2.50, *SD*=1.96) in comparison with the control group (*M*=.20, *SD*=.65) on the subscale with regard to adaptation to change. Finally, the DBD group has a significantly (*p*<.001) higher mean (*M*=41.33, *SD*=20.80) in comparison with the control group (*M*=9.12, *SD*=8.83) on the total scale of the VISK.
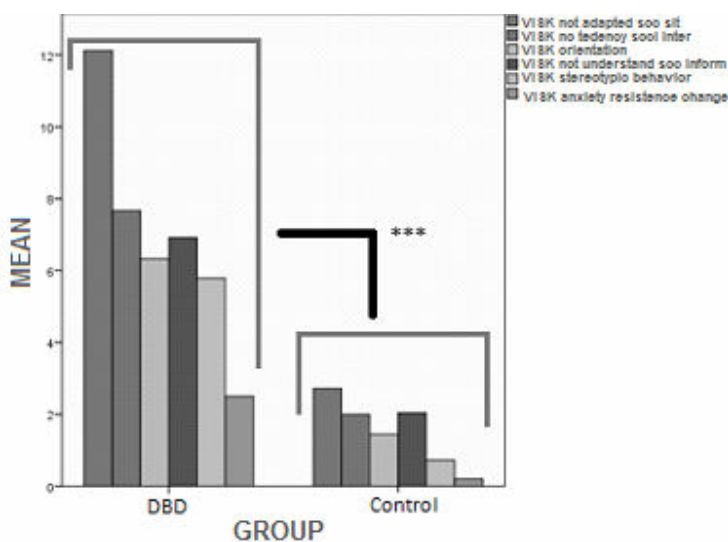

*Fig. 3 Subscales VISK DBD vs. control group (p< .001= ***)*

Markers of arousal

Differences were inferred between the control group and the group of boys with higher levels of aggressive behavior with regard to the considered markers of physiological arousal, heart rate and skin conductance in resting state. So, differences in heart rate and skin conductance were tested between both groups.

Heart rate (beats per minute): First of all, the difference between the two group regarding heart rate (*Fig. 4)*

in resting state was considered. The descriptive statistics were considered before executing an analysis of variance (M=75.16, SD=9.15, Min=57.30, Max=98.34), the variable beats per minute was normally distributed (skewness=.196 (std. Error=.340), and Kurtosis=.253 (std. Error=.668). Descriptive statistics were considered for the DBD group (M=76.19, SD=10.14) and the control group (M=74.17, SD=8.17). Equal error variances were assumed, for a non-significant Levene's Test was found ($F(1,47)$=.593, p=.445). A non-significant F-value was found for the effect of group on heart rate measurement ($F(1,47)$ =.592, p=.445), which suggested that group does not account for differences in heart rate in resting state.

Skin conductance: Moreover, the descriptive statistics of skin conductance measurement (*Fig.* 5) in resting state were considered as well, before executing an analysis of variance to infer the effect of group on skin conductance measurement (M =6.89, SD =4.83, Min =.62, Max =21.12), the variable for the sixth block of skin conductance measurements was normally distributed (skewness=1.424 (std. Error=.340), and Kurtosis=1.816 (std. Error =.668). Descriptive statistics were considered for the DBD group (M =6.67, SD=4.90) and the control group (M =7.11, SD=4.85). Equal error variances were assumed, for a non-significant Levene's Test was found ($F(1,47)$=.299, p=.587). A non-significant F-value was found for the effect of group on skin conductance measurement in resting state ($F(1,47)$ =.097, p=.756), which suggested that group does not account for differences in skin conductance in resting state.
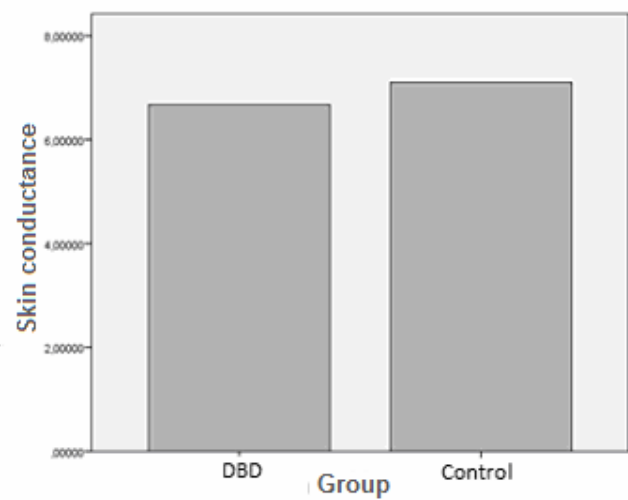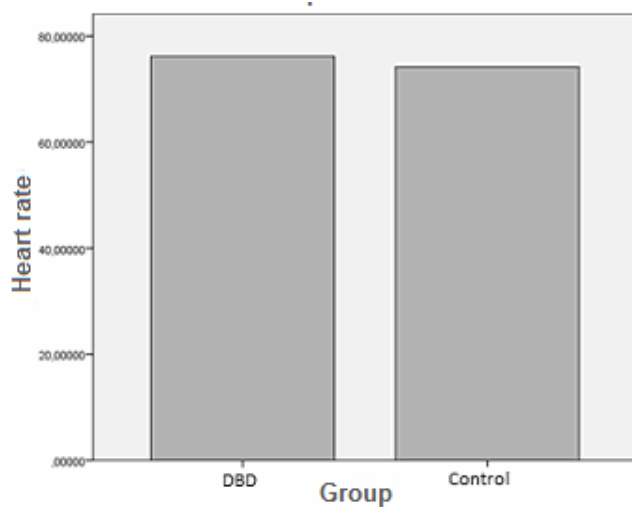

Fig. 4 Heart rate (BPM) for DBD and control group Fig. 5 Skin conductance (μS) for DBD and control group

Regression analyses – *Dimensional approach*

The influence of aggressive behavior and anxiety (reported by the parents and the boys themselves), as well as characteristics of an autism spectrum disorder on the arousal measurements in resting state was assessed. Multiple regression analyses were performed for the DBD group only, so it could be inferred which variables account for variation in the arousal measurements within the group with higher levels of aggression. A regression analysis was executed by the backward method, variables were removed when the p-value for F was larger than .100. Considered predictor variables were: norm score on the scale Anxious/Depressed and Aggressive behavior, the total score on the MASC and the VISK. First of all, descriptive statistics were

considered for the independent variables as measured in the DBD; norm scores on the scale Aggressive Behavior of the CBCL (M =68.58, SD =10.35), norm scores on the Anxious/Depressed scale of the CBCL (M=64.21, SD =11.01), the total score on the MASC (M =45.38, SD =17.85), and the total score on the VISK (M =41.33, SD=20.80).

Correlation between independent variables

Moreover, Pearson correlation between the independent variables were calculated for the DBD group. Significant correlations were found between the CBCL norm scores on the scale Aggressive behavior and anxious behavior as reported by the parents (CBCL scale score Anxious/Depressed) (r=.45, p=.028), as well as the and the level of characteristics of autism as measured by the total scores on the VISK (r=.52, p=.009). Moreover, a significant correlation was found between the anxious behavior as reported by the parents (CBCL scale score Anxious/Depressed) and level of characteristics of autism as measured by the total scores on the VISK (r=.69, p=<.001) as well as the anxiety level as reported by the child by the total score on the MASC (r=.42, p=.041). Furthermore, significant correlations were found between heart rate measurement and characteristics of autism as measured by the total scores on the VISK (r=.43, p=.036) as well as the anxiety level as reported by the child by the total score on the MASC (r=.41, p=.047). No significant correlations were found for measurements of skin conductance.

Predictive value of independent variables on Heart rate in DBD group

First of all, heart rate in resting state was considered. There was a significant model, which only includes the total score on the VISK *(Fig. 6)*. The independent variable total score on the VISK did significantly predict the dependent variable $F(1,22)=4.978$, p=.036. The significant model had a R-value of .450, which suggested a moderate level of prediction of the levels of arousal as measured by beats per minute in resting state by the current model with the total score of the VISK as independent variable. The value for explained variance was R^2=.185, which suggested that the proportion of variance in the arousal measurement is explained by the independent variables is 18,5%. The independent variable total score on the VISK did significantly contribute to the prediction, p>.036. It turned out that expressing higher levels of characteristics of an autism spectrum disorder are predictable for a higher amount of beats per minute while being in a resting state in boys with above average levels of aggressive behavior. *(Fig. 6)*.
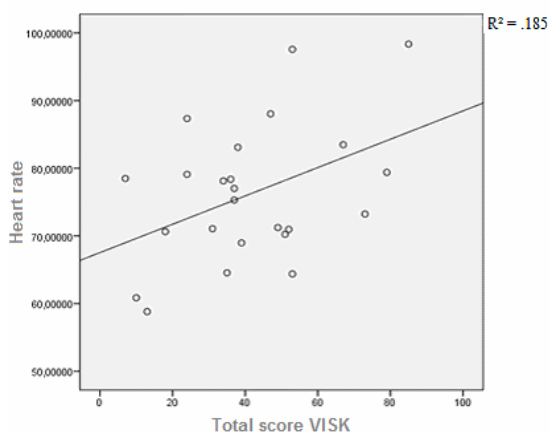

Fig. 6 Scatterplot association total score VISK and heart rate (BPM) in DBD group

Predictive value of independent variables on skin conductance in DBD group

A multiple regression analysis was executed to predict skin conductance in resting state from the level aggression, characteristics of an autism spectrum disorder and anxiety as reported by the parents, as well as levels of anxiety as reported by the boys themselves. There was no significant model. It turned out that the considered independent variables, levels of aggressive behavior, anxiety and amount for characteristics of an autism spectrum disorder, did not predict levels of skin conductance in boys with disruptive behavior disorders in resting state.

Characteristics of autism spectrum disorder

For the total score on the VISK turned out to contribute to the prediction of heart rate levels, one can have a closer look at the subscales of the VISK and their correlation with heart rate, to infer which specific characteristics were associated with heightened levels of heart rate in resting state *(Table 2)*. Significant associations with heart rate in the DBD group were found between heart rate and the characteristics regarding not understanding social information ($r=.473$, $p=.020$), stereotypic behavior ($r=.433$, $p=.035$), and anxiety/resistance to change ($r=.404$, $p=.050$) as well as the total score on this instrument ($r=.430$, $p=.036$), which suggest low correlations, for which higher levels of these mentioned characteristics are associated with more beats per minute in resting state.

Table 2. Correlations between heart rate (beats per minute) and subscales of the VISK

Group			Not adapted	No tedency social interactions	Orientation	Not understand social information	Stereotypic behavior	Anxiety/ resistence change	Total
DBD	BPM_ Block 6	r	,322	,268	,324	,473[*]	,433*	,404[*]	,430*

P< .05, **p<.001

In addition, for the dimensional approach suggested the influential role of the amount of characteristics of autism on the arousal measurements, it was subsequently investigated whether subgroups could exist within the DBD group, based on whether boys have an classification with an autism spectrum disorder in addition to the disruptive behavior disorder. Multivariate analyses of variance were executed. The group someone is in did not show a significant effect on both measurements of heart rate ($F(2, 46) = 1.37$; $p < .265$; partial $\eta^2 =$ .06) and skin conductance ($F (2, 46) = .15$; $p < .858$; partial $\eta^2 = .01$) of the considered resting state. It has to be mentioned that the groups were small, which could have had some influence on the reliability of the findings regarding differences between groups in heart rate and skin conductance. However, the exploratory analysis provided some differences between the groups on behavioral level, which are worth considering, though not part of the actual objective of the current study. Both norm scores on the scale Aggressive behavior (CBCL) and norm scores on the scale Anxious/Depressed (CBCL) were significantly higher in boys that show above average levels of aggressive behavior in comparison to the control group. However, only the group of boys with a co morbid classification of autism reported more characteristics of anxiety themselves, as indicated by the total scores on the MASC, the group of boys with aggression without co morbid autism reported comparable levels of anxiety as the control group. `

Discussion

Summary

The current study considers the arousal patterns of boys (8-12 yr.) with a disruptive behavior disorder (DBD). These boys exhibit significantly higher levels of aggressive behavior in comparison with the control group. Furthermore, the DBD group exhibits significantly higher levels of anxiety, as reported by their parents, though, boys in the DBD group did not report higher levels of anxiety themselves in comparison to the control group. Moreover, boys in the DBD group exhibit more non-adaptive behavior, withdrawal behavior, orientation problems, more problem behavior with regard to not understanding social information, and show more stereotypic behavior, which could already imply the overall higher levels of aggressive behavior in these boys. Besides, the levels of anxiety, as reported by parents in the DBD group, turned out to be positively associated with levels of aggressive behavior. Moreover, both parental reported levels of aggressive behavior and anxiety were positively associated with amounts of characteristics of an autism spectrum disorder in the DBD group.

While differences were found between the DBD group and the control group on the existence of co-occurring symptoms, no significant differences were found between the two groups with regard to the arousal patterns in resting state, as indicated by heart rate and skin conductance. Thus, the group someone is in, based on the clinical diagnosis of DBD, does not account for differences in the considered physiological measurements of arousal in resting state, although differences with the control group were seen on behavioral level.

However, while differences *between* groups with and without disruptive behavior disorder were not found by considering arousal levels, differences *within* the DBD group were found on the other hand. It turned out that higher levels of anxiety and a larger amount of characteristics of autism were associated with a higher heart rate within the DBD group. Though, no associations were found between behavioural measures and levels of skin conductance in the DBD group. Furthermore, characteristics of autism spectrum disorders turned out to predict observed variance in heart rate in resting state for approximately nineteen percent. The specific characteristics of an autism spectrum disorder of which higher levels are associated with a higher resting heart rate in the DBD group are; not understanding social information, stereotypic behavior, as well as anxiety/resistance to change. However, no behavioural measures were found to be predictive with regard to skin conductance.

Relation with previously executed studies

Previous studies (Raine, 2002) suggest that above average levels of aggression are associated with a low heart rate in resting state as well as skin conductance levels (Fowles, 2000), though, in contradiction to what was previously found, no differences were found between the control group and the DBD group in the current study with regard to the arousal measures in resting state. It has to mentioned that the considered groups were small, which could have distorted the associations that actually exist in the population.

Moreover, in previously executed studies, an effect was found of the existence of a classification with an autism spectrum disorder on arousal measurements in resting state (Schoen, Miller, Brett-Green, & Nielsen, 2009), baseline heart rate measurements were suggested to be higher in children classified with this pervasive

developmental disorder. In the current study classifications of autism in addition to the disruptive behavior disorder were not considered extensively, for the group of children with both above average levels of aggressive behavior and an classification with autism was very small, which could have led to biased results. Though, in the current study a significant predictive value of characteristics of autism is found with regard to heart rate measurements in resting state, which is in line with what was previously found. However, previous findings were somewhat ambiguous with regard to the association between autism and levels of arousal, both hypo- and hyperarousal were discussed previously (Mathersul, McDonald, & Rushby, 2013). The current study did bring forward that a larger amount of characteristics of an autism spectrum disorder are associated with higher levels of heart rate at rest.

Furthermore, in accordance with previous findings, higher levels of arousal were especially found as predicted partly by higher levels of behavior associated with not being able to understand social information, stereotypic behavior, and anxiety/resistance to change. Previous studies considering hyperarousal in children with an autism spectrum disorder suggest an association with deficits in the ability to show adaptive behavior in social interactions, which are consequently avoided for instance (Carlisle, 2007). Besides, the association between higher levels of arousal while being in unfamilair situations was suggested previously (Carlisle, 2007), which is comparable to the finding in the current study that being less able to adapt to change is predictive for higher levels of heart rate. Though, by considering previous studies it could be discussed whether the lack of this ability is predictive for the higher level of arousal or the other way around, as was suggested previously (Carlisle, 2007); the unfamiliar situations and social interaction were avoided for they elicit higher levels of arousal in the person, which is experienced as uncomfortable. It was suggested that these situations elicit more than average levels of arousal that cannot be regulated by the individual. However, the currently found association between the characteristics of autism and heart rate does not suggest that the behavioral patterns function as the origin of the heightened arousal levels, so, one cannot do proper statements regarding the direction in which the biological mechanisms are expressed.

Moreover, it was found in the current study that expressing stereotypic behavior is predictive for higher levels of arousal, this is in accordance with previous findings, however, again in could be discussed whether this type of behavior is expressed to diminish the levels of arousal that is experienced as uncomfortable (Armstrong, 2010) or is only associated with the higher levels of arousal for instance as a part of the underlying neurobiological mechanism of both the behavioral and physiological part.

Finally, anxiety seems to be associated with exhibiting a disruptive behaviour disorder and a small positive association was found between anxiety, self-report measurement, and heart rate in resting state, though, anxiety levels seem not to be predictive for variation in arousal levels within the DBD group. Other influential variables will probably have cause the overlap that is found between these two measurements. This underlying mechanism needs to be considered in more depth consequently, for previous studies mentioned as well that anxiety is associated with (hyper)arousal, found in both heart rate and skin conductance (Fonseca, & Peerin,

2011), which is sometimes suggested to be due to an inability to cope with and regulate the experienced anxiety (Green, & Ben-Sasson, 2010).

Implications

The above presented findings suggest that it could be important to be aware of co-occuring symptoms in case of above average levels of aggressive behavior. The considered sample would have been too small to consider subgroups in the DBD group, which could have been interesting with regard to exploring possible differences in underlying mechanisms in boys who do express comparable problems on the behavioral level. By detecting differences in underlying mechanisms, differing arousal patterns in this case, with regard to aggressive behavior that is shown, one could discuss the existence of varying sources from which the aggressive is elicited which might require different interventions. Though, based on the findings in the current study, a strong suggestion is done to be aware of the influential co-occuring symptoms that predict part of the variance found in the arousal measurements. Expressing more characteristics of autism is associated with an higher heart rate in boys with disruptive behavior disorders, which implies that it can be important to consider this type of co-occuring problem behavior as well, instead of only considering the aggressive behavior itself by applying an intervention. Especially not understanding social information and adaptation towards change are associated with more beats per minute, the same is true for stereotypic behavior patterns. Consequently, it might be suggested that the aggression seen in boys with a disruptive behavior disorder origins from not understanding social information and anxiety or tension with regard to social situations. Therefore these types of behavior might be important to consider, for it might be true that aggression seen in boys with a disruptive behavior disorder and higher levels of these characteristics could have another neurobiological background in comparison to boys who exhibit less high levels of these behavioral characteristics. It could be true that the boys who *do* exhibit higher levels of these behaviour characteristics tend *not* to experience under arousal, as is found in previous studies regarding aggressive behaviour (Kempes, Matthys, De Vries, Van Engeland, 2005), but in contrary with somewhat higher levels of arousal instead. This suggestion requires a more in depth investigation in the future with larger sample sizes, though, is worth considering, for even with the considered sample size the following findings resulted and could imply the need for another intervention approach.

Relevance

The found predictive value of the amount of characteristics of an autism spectrum disorder regarding levels of arousal (heart rate) in boys with a disruptive behaviour disorder has some important implications, one could think of considering characteristics of autism as well that could be found in boys with disruptive behavior disorders and are associated with higher levels of heart rate in resting state, regardless whether the actual diagnosis of an autism spectrum disorder is adequate, for it is suggested that another neurobiological background could be at issue. Although anxiety tends not to be well enough predictive for a heightened heart rate, one can think of the inability to cope with changes and the inability to understand social information and cope with change, which could elicit both higher levels of anxiety and could result in the above average levels of aggression. Though, this need to be investigated in more depth in future studies. Moreover, it is important as

well to be aware of co morbid existing disorders or symptoms, for they might share underlying neurobiological processes in boys with a disruptive behavior disorder. The omission of not understanding the underlying mechanisms of aggression could mean being deprived from adequate (additional) treatment/intervention, but also adequate general facilities, like an appropriate education (Gillberg, & Billstedt, 2000). By sticking on well delineated diagnoses, though, one neglect the fact that functioning profiles could not always be completely described by diagnostic labels, for which it might be the case that one expresses the behavior to meet all the criteria of a certain diagnosis, but does need treatment based on the combination of co morbid symptoms (Gillberg, & Billstedt, 2000). The current study considers consequently not simply co-existing classifications of an autism spectrum disorder or anxiety disorders, but characteristics of autism and anxiety, for it turned out expressing a certain *amount* of characteristics of an associated disorder, although not expressing the full blown disorder itself, is predictive for deviant arousal patterns. Moreover, if it is known which symptoms share some characteristics in their neurobiology, one could investigate whether it is needed that co morbid symptoms are considered and treated as well or are expected to become more prevalent on a later age, as is the case by aggression in combination with autism spectrum disorders, which could require prevention activities.

Limitations

Limitations of the current study can be discussed. First of all, the number of participants was small, which might imply some limitations for the interpretation of the presented findings. One need to be aware of the effect of a small sample size on the statistical power (Drisko, & Grady, 2012), power could have been decreased which lower the reliability of the interpretations of the findings. Besides, a small sample size implies a larger standard error and subsequently less firm statements about the effect of the considered predictor variables. Furthermore, over-estimations of associations between considered variables could have been occurred, for false-positive findings could emerge from analyses executed with a small sample size. On the other hand, type II errors could have occurred as well, for the possibility that false negatives emerge increases in case of a small sample size. Moreover, due to the small sample size, significant differences in the population might be overseen, for these differences between participants and groups can be less well detected in a small sample.

Other limitations can be mentioned as well; one can think of the distributions of the considered variables, only few extreme cases were excluded for the éxistence of an already small sample size, though, interpretations need to be made with caution in case of distributions that deviates from normality. Futhermore, one could consider the lack of considering the stress condition, it would have been interesting to consider the arousal patterns in both resting state as well as a stress condition, to infer differences under stress as well as look for variability in the arousal measures. Besides, one needs to consider the fact that especially heart rate turned out to be predicted partly by the amount of characteristics of an autism spectrum disorder, not skin conductance. As is discussed in previously executed studies, heart rate is a less well stable measurement of arousal in comparison to skin conductance (Jacobs, Friedman, Parker, Tofler, Jimenez, Muller, Benson, & Stone, 1994), which is not distorted by respiration. It could have been more reliable when it turned out that arousal patterns as measured by skin conductance in resting state were partly predicted by amount of characteristics of an autism spectrum disorder,

for this is a more stable indicator of arousal. Though, the two considered indicators of arousal, skin conductance and heart rate, have to do with different coping aspects, which could have led to the fact that not both turned out to be predicted by the mentioned characteristics of autism. Fowles (2000), suggested a three-arousal model to obtain more insight in psychopathological behaviour. The three systems within this model are the activation system, the behavioural inhibition system and the non-specific arousal system, which obtains input from the previous two systems. The first system is involved by behaviour in reaction to positive stimuli and could be measured by heart rate. The second system is involved by inhibiting behaviour in response to negative stimuli and could be measured by electro dermal activity, like skin conductance. Finally, found associations between independent variables could be (partly) due to the fact that the major part of these variables are based on scores on questionnaires administered by the parents and regarding levels of problem behavior observed in the boys. There could be overlap in topics of items, which accounts for part of the found association.

Strengths

A strength of the current study is the consideration several possible influential variables at once with regard to different types of arousal measurements by performing rather basic statistical analyses to get a rough idea of possible associations between and predictability of several variables while discussing heart rate. The outcomes of this study would not provide one with stable outcomes that could function as a guideline to establish adequate interventions that suit the individual that expresses a certain amount of the influential characteristics, though, it might function to incite other studies on this topic that will be able to investigate the relation between characteristics of autism and arousal measures in resting state, and desirable during stress, in more depth. Another strength of the current study is the fact that two different types of arousal measurement were considered, both heart rate and skin conductance, to get a more depth insight in the arousal patterns and make inferences with regard to the stability of findings. Skin conductance for instance tend to be a more stable measure (Sosnowski, Nurzynska, & Polec, 1991), while several disadvantages are proved to exist in relation to some markers of arousal, like the effect of attention and respiration on heart rate (Acharya, 2007). Moreover, these types of measurements are associated with reactions to different kinds of stimuli and different types of coping (Reynard, Gevirtz, Berlow, Brown, & Boutelle, 2011), which might have important implications for which type of coping will be affected by symptoms that co-exist besides e.g. the aggressive behavior, though this issue is not extensively discussed in the current study.

Future directions

Future studies could focus on other indicators of physiological arousal than heart rate and skin conductance, especially arousal measurement under stress, indicated by cortisol levels (McBurnett, Lahey, Rathouz, & Loeber, 2000), would be interesting to consider, in order to consider the differences in arousal patterns in more depth. Furthermore, more general ideas for future studies can be suggested. The current study focused on boys only, for externalized behavior, like aggressive behavior, is more often seen in boys than girls, though, it would be interesting to consider differences in arousal patterns in girls, for previous studies suggest a lack of association between aggressive behavior in the adolescence and levels of cortisol in girls for instance, while a

negative association was found in boys (Poustka, Maras, Hohm, Felliner, Holtmann, Banaschewski, Lewicka, Schmindt, Esser, & Laucht, 2010). In addition to this, it turned out previously that especially boys are more severe influenced by exhibiting autism in addition to the characteristics of aggressive behavior on arousal measurement (Kaartinen, Puura, Helminen, Salmelin, Pelkonen, & Juurjärvi, 2012). This findings could be considered again in the future by considering subgroups, as was done in a tentative way in the current study, based on the existence of a classification of an autism spectrum disorder, though with larger sample sizes. So, future studies could focus on subgroups that might exist in the population of boys with autism, that were not detected in the current study, which might be due to the small sample. The considered subgroups were made based on the existence of a co-occurring autism spectrum disorder above average levels of anxiety. With larger groups, differences might emerge between groups, which could have implications for intervention methods that are applied for treatment of the considered problem behavior (McMurran, & McGuire, 2005). When it turns out that aggressive behavior tend not be associated with hypoarousal per se, as was suggested in previous studies, though higher levels of arousal might exist in boys with co-occuring autism, different underlying mechanisms on the aggressive behavior can be discussed. This could suggest that hyper arousal is (partly) responsible for the observed aggressive behavior in these boys, induced by the anxiety that possibly elicited from not understanding social situations and from the stress that is aroused by changes that could be difficult to deal with that emerge in daily life. This would require possibly another type of intervention in comparison to someone who expresses aggressive behavior to be able to experience higher levels of arousal, for originally a below average levels of arousal is exhibited.

Furthermore, one could think, with regard to future studies, to focus on several types of aggression while considering the patterns of arousal and co-existing symptoms, for these several types of aggression were associated with differing arousal levels in previously executed studies, though, other arousal measurements were often considered in these studies. This would be important to investigate, for apart from the differences in arousal patterns seen in boys with and without co-occuring problems, one can think of differences between the several types of aggression itself as well while considering arousal. Proactive and reactive aggression could be considered for instance. One could think, with regard to this, of the fearlessness theory, which suggests that low levels of arousal indicate a low degree of fear, which consequently results in aggressive behavior due to a deficiency in the development of conscience. This idea indicates that low resting levels of arousal as well as lower levels of arousal during stress will be found in children with proactive aggression, for they seem to be fearless, although studies have not yet confirmed this idea. Moreover, an association was found between higher levels of skin conductance during stress and reactive aggression (Connor, 2012).

Besides, it could be interesting to consider how the boys themselves feel during the resting state. In the current study, the movie of the fishes was shown one time earlier in the protocol of the overarching study, so it is not suspected that participants were anxious for what might be coming in the movie or think they have to remember or count what they have seen. However, it could be interesting to consider whether the participants experienced actually a calming state while being expected to be in resting state. In addition to this, it could be important to

compare arousal patterns in resting state with the arousal measurements in the stress condition, so one could infer whether the rest condition measured actually the arousal pattern in resting state.

Moreover, anxiety levels in general are worth being considered regarding this topic as well in future studies with larger sample sizes, for previous studies suggested that anxiety can change the direction of the association between aggressive behavior and levels of arousal (McBurnett, Lahey, Frick, Risch, Loeber, Hart, Crhist, & Hanson, 19991), in which exhibiting above average levels of anxiety besides above average levels of aggression in associated with the higher levels of arousal, while aggression without heightened level of anxiety is associated with below average levels of arousal. Furthermore, to wander a bit from the main subject with regard to arousal levels, it would be interesting to consider the ability of boys with disruptive behavior disorder to report on own behavior in more depth in the future, for the current study considered both anxiety as reported by the boys themselves (MASC) as well as reported by parents (CBCL Anxious/Depressed scale). It is an noticeable finding that boys in the DBD group without a classification of an autism spectrum disorder seems to have a lack of insight or tend to underreport their own level of anxiety, for their parents report significant higher levels of anxiety, while boys with a disruptive behavior disorder as well as a classification of an autism spectrum disorder report higher levels of anxious behavior themselves as well.

Finally, the fact that expressing characteristics of autism is associated with more adequate reporting of anxiousness and the lack of adequate reporting of anxiety levels in boys with aggressive behavior only, makes it worth to investigate in future studies whether the arousal patterns actually differ by considering subgroup with larger sample sizes. Differences could suggest comparable types of aggression on the behavioral level, while different mechanisms underlie the expressed aggression. Anxiety might be exhibited as well as actually experienced in the group of children with disruptive behavior disorders with comorbid autism and might not be experienced in children with aggressive behavior only, while it could be observed by others and is seen in arousal levels.

Conclusion

The current study stressed the importance of taking co-existing symptoms into account while considering arousal levels in boys with disruptive behavior disorders and subsequently discussing possible differences in underlying mechanisms of aggressive behavior. Especially not understanding social information, stereotypic behavior and anxiety for change are predictive for higher levels of heart rate in these boys and are worth considering in more depth, for it might me true that some of the aggression seen in boys with disruptive behaviour disorder could possibly origin from the lack of understanding as well as anxiety regarding social situations and is associated with somewhat higher instead of lower levels of arousal, as previously suggested with regard to aggression. However, more research needs to be done to investigate this issue in more depth.

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