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ORIGINAL ARTICLE

# Self-perception of self-regulatory skills in children with attention-deficit/hyperactivity disorder aged 8–10 years

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**Abstract** Several studies have reported a characteristic "positive illusory bias" in the self-evaluation of children with ADHD. However, results are controversial. The aim of the present study was to investigate whether children with ADHD aged 8 to 10 years can rate their self-regulatory skills accurately when assessed with an age appropriate instrument. Twenty-seven children with ADHD and 27 matched normal control children completed the Self-rating Scale of Self-regulatory Function (SelfReg), a new rating scale that has been specifically designed for this age group. As expected, children with ADHD rated themselves significantly more dysfunctional than control children. In most domains, self-ratings of children with ADHD did not diverge from parent and teacher ratings to a greater extent than self-ratings of control children, although overall results indicated a moderate tendency toward a positive bias. When a cluster analysis based on discrepancies between children's and adults' evaluations was carried out, three groups with different self-rating patterns emerged: A "positive bias" group containing exclusively children with ADHD, a "negative bias" group containing both children with ADHD and control children, and the largest group of accurate self-raters which also included children from both diagnostic groups. It is concluded that overly positive self-judgments are not a ubiquitous finding in ADHD, but may be confined to a specific subgroup of children whose specific characteristics remain to be determined.

**Keywords** Attention deficit · Hyperactivity disorder · ADHD · Self-perception · Self-regulation · Positive illusory bias · Self-report · Metacognition

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## Introduction

Children with ADHD have consistently been found to demonstrate a large variety of difficulties in everyday life, such as academic underachievement (LeFever et al. 2002; Loe and Feldman 2007), social deficits (McQuade and Hoza 2008; Bagwell et al. 2001; Hodgens et al. 2000) and behavioral problems (e.g. Barkley 1997; Steinhausen et al. 2003). Some researchers suggest that despite these chronic functional problems in different areas, many children with ADHD tend to under-report the presence of these problems (Hoza et al. 2002, 2004; Evangelista et al. 2008). Conversely, some studies indicate that children with ADHD perceive their difficulties quite accurately (e.g. Barber et al. 2005; Bell et al. 2010; Klimkeit et al. 2006; Ialongo et al. 1994). Thus, the nature of self-perceptions and self-concept in children with ADHD remains a topic of controversy.

Accurate self-perceptions of competence have been described as essential aspects of mental health (Colvin et al. 1995). A limited degree of positive illusion or bias in self-perceptions may be both normative (Harter 1999; Alicke and Govorun 2005) and adaptive (Mazur et al.

1999; Taylor et al. 2000). Preschool children generally tend to overestimate their performance (Bjorklund 1997), but normal adults still continue to focus on positive achievement rather than on previous failure (Mezulis et al. 2004). However, findings from several studies suggest that pronounced positive biases are associated with problems in emotional and behavioral adaptation such as aggression and violence (Baumeister et al. 2000; Colvin et al. 1995; Costello and Dunnaway 2003; DuBois et al. 1998; Hughes et al. 1997) as well as low achievement (Hoza et al. 2004). A reduced awareness of self-regulatory skills in particular has been linked to learning difficulties (Borkowski and Thorpe 1994). Furthermore, there is suggestive evidence that awareness of one's own deficits may serve a motivating function in behavioral treatment (Hoza and Pelham 1995), whereas inaccurate estimations of self-competence may interfere with treatment progress. Thus, a better understanding of the self-perception of children with ADHD may have implications for future treatment issues.

Studies of self-perceptions in children with ADHD have yielded mixed results. Some studies indicate that self-ratings of children with ADHD are overly positive (Vaughn 2007; Ljusberg and Brodin 2007; Dyson 2003; Gresham et al. 2000; Stone and May 2002; Heath and Glen 2005; Hoza et al. 2002, 2004, 2010; Owens and Hoza 2003; Diener and Milich 1997; Mikami et al. 2010; see Owens et al. 2007 for a review) due to self-protection as a reaction to repetitive negative feedback (Diener and Milich 1997; Hoza et al. 2002) or because of neuropsychological dysfunction and cognitive immaturity (see Poissant 2005). In contrast, other studies found that children with ADHD are able to perceive their difficulties quite accurately (Barber et al. 2005; Treuting and Hinshaw 2001; Klimkeit et al. 2006; see Owens et al. 2007).

Hoza et al. (2002, 2007) proposed that these contradictory findings may be partly due to a methodological limitation. In these studies, results are often based on the analysis of discrepancy scores, calculated by subtracting a criterion (e.g. parent report) from the child's report of self-competence, with large differences indicating overestimations by the child (see Gresham et al. 1998; Hoza et al. 2002, 2004; Owens and Hoza 2003; Diener and Milich 1997). However, ADHD children's self-perceptions are not significantly more positive than those of comparison children but are simply more discrepant from their poorer actual performance. Furthermore, larger discrepancies may simply be related to increased symptom severity (Owens and Hoza 2003; Hoza et al. 2002; De Los Reyes and Kazdin 2004).

Several theoretical explanations have been put forward to explain the tendency of ADHD patients to overestimate their competence (for a review see Owens et al. 2007). To date, the self-protective hypothesis has garnered more empirical support than any other explanation for the "positive illusory bias (PIB)" in children with ADHD. Nonetheless, because inconsistencies and methodological limitations remain, additional investigation and extension to other domains of competence is warranted (Owens et al. 2007). Another line of recent research has linked deficits in accuracy of self-perceptions in ADHD to impairments in metacognitive abilities (Poissant 2005; Cornoldi et al. 1999). Metacognition refers to the self-knowledge about cognitive processes, self-assessment of ongoing processes (monitoring), and self-regulation that is based on such assessments (Nelson and Narens 1990). In a study by Poissant (2005), children with ADHD differed significantly from control children in their metacognitive knowledge. The author posited that differences in metacognitive knowledge between children with ADHD and controls are a question of delayed development, rather than one of the disorder itself. Social psychology research (Kruger and Dunning 1999, 2002) has proposed that deficits in judging relative performance come from poor performers' tendency to overestimate their abilities, which in turn, is due to their poorer metacognitive skills. Finally, several studies have shown that children with ADHD are less aware of errors. Typically, in neuropsychological tasks, they do not slow down response speed after commission errors, in contrast to normal control children (Schachar et al. 2004; O'Connell et al. 2009). This finding has been linked to abnormal fronto-striatal network function, especially to dysfunction of the anterior cingulate cortex (Liotti et al. 2005; Albrecht et al. 2008).

The majority of studies claiming a positive bias in the self-estimation of ADHD children have been based on scales assessing general self-concept in academic, social, physical or other domains (e.g. Piers-Harris Children's Self-Concept Scale, Piers and Herzberg 2002). Specific self-report scales for children with ADHD based on DSM-IV-criteria, which ask for ADHD-related problems and typical situations, have been shown to correlate with parents' ratings (e.g. Görtz et al. 2002) and, thus, provide evidence that children and adolescents with ADHD are at least partly aware of their problems. However, these scales are likely to be less appropriate when it comes to the investigation of biased self-perception, because they are specific to ADHD and may produce floor effects in non-affected children. Most ADHD self-report scales are designed for older children and adolescents, i.e. from the age of 11 years on, probably due to the fact that questionnaires relating to abstract verbal concept are too difficult to be understood by younger children. This latter point is also true for the majority of scales relating to self-regulatory function.

Deficient self-regulation has been considered a core feature of ADHD (Barkley 1997, 2006), but is also present

in many other psychopathologies such as learning disorders, conduct disorders, autism, and neurological conditions. According to current definitions, self-regulatory skills enclose a cognitive as well as an emotional/motivational dimension (see Blair and Diamond 2008, see the monograph by Baumeister and Vohs 2004). The concept shows considerable overlap with the neuropsychological construct of executive functions, especially with models that comprise "hot" (i.e. emotional/motivational) as well as "cold" (i.e. cognitive) executive functions (Hongwanishkul et al. 2005; Kerr and Zelazo 2004). A number of different self-report inventories of self-regulatory skills have been developed for older children and adolescents, some focusing more on metacognitive skills (e.g. Dennison et al. 1996; Meltzer et al. 2004), and others more on executive functions (e.g. Guy et al. 2005).

To fill in the gap for younger school children, we developed a new self-report scale of self-regulatory skills, the Self-rating of Self-Regulatory Function (SelfReg) (Rizzo et al. Rizzo et al. 2006, 2010). The development of the scale was based on the assumption that children younger than 10 years old are able to make accurate judgments on self-regulatory functions, as long as items are presented in an age-appropriate form. Although metacognitive skills in the strict sense seem to emerge at the age of 8–10 (Veenman et al. 2006; Lockl and Schneider 2006), young schoolchildren with academic or behavioral problems leading to negative feedback may have a clear notion of being different and less apt than their peers (Bell et al. 2010; Chapmann 1998; Bear et al. 2002; Zeleke 2004; Treuting and Hinshaw 2001; Ialongo et al. 1994; Klimkeit et al. 2006). On the SelfReg, instead of relating to abstract verbal statements, children compare their own behavior to that of others in concrete daily life scenarios (for a detailed description, see methods section). A previous study showed that clinically referred children with various types of academic, behavioral, and developmental difficulties rated themselves accurately as more impaired on the SelfReg compared to age matched controls (Rizzo et al. 2010).

The aim of the present study was to investigate whether children with ADHD as young as 8–10 years are able to rate their self-regulatory skills accurately when assessed with an age-appropriate instrument. First, and in contrast to studies that found no difference between absolute self-ratings in children with and without ADHD (see Owens et al. 2007), we expected children with ADHD to rate themselves accurately as more impaired than control children on the SelfReg. In a second step, we investigated whether self-estimation of children with ADHD diverges more from parents and teacher's judgments than self-estimation of controls. Here, we hypothesized in accordance with the PIB hypothesis that discrepancies between children's self-ratings and teacher's/parents' ratings would be more pronounced in children with ADHD than in control children. Finally, in an exploratory analysis, we investigated whether characteristic over-estimation is confined to specific subgroups. As pointed out by recent research findings, there is considerable heterogeneity of neuropsychological impairment in ADHD (e.g. Sonuga-Barke 2005; Willcutt et al. 2005) with the majority of ADHD children showing no or only minor deficits. Likewise, PIB might either be a general phenomenon in ADHD or, rather, constrained to a small subgroup of children.

## Method

### Participants

Participants consisted of twenty-seven children with ADHD and twenty-seven normal control children (CTL) aged 8–10 years matched for age, gender, and IQ (Table 1). Both groups included 21 boys and six girls.

Children with ADHD were recruited via the Department of Child and Adolescent Psychiatry, University of Zurich. CTL were recruited via public schools in the surrounding regions of Zurich. Intelligence (IQ) was measured individually by a short form of the German version of the revised Wechsler Intelligence Scale for children (HAWIK III), which includes the subtests Block Design, Picture Arrangement, Arithmetic, and Vocabulary (Schallberger 2005).

ADHD diagnosis was based on HYPESCHEME, a computerized operational criteria checklist and diagnostic algorithm for DSM-IV and ICD-10 from the international genetic study IMAGE (Curran et al. 2000; see Christiansen et al. 2008), which includes a diagnostic interview (Parental Account and Symptom Ratings PACS, Taylor et al. 1986) and the Conners Teacher Rating Scale Revised CTRS-R (Conners 1997). Based on HYPESCHEME, 14 children were classified as ADHD combined subtype and 13 as inattentive subtype. Children referred to the clinic for severe behavioral problems (Oppositional Defiant Disorder/Conduct Disorder) were not included in the study. Twenty-three children had received a formal diagnosis of ADHD by an independent clinician prior to entering the study. At the time of assessment, thirteen of the 27 children with ADHD were taking stimulant medication.

Control children who scored above the clinical cutoff on the SNAP (Swanson et al. 1998) or CTRS-R were excluded from the study. Written consent was obtained from the parents of all children. The study was approved by the Ethical Committee of the Department of Psychiatry, University of Zurich.

**Table 1** Descriptive data of children with ADHD and controls (CTL)

| | ADHD ($N = 27$) Mean (SD) | CTL ($N = 27$) Mean (SD) | $P$ |
|---|---|---|---|
| Age | 9.9 (0.8) | 9.8 (0.6) | ns |
| Boys/girls | 21/6 | 21/6 | ns |
| Estimated IQ | 103.3 (15.7) | 108.8 (18.8) | ns |
| Parents' ratings | | | |
| Brief parents' (*T*-scores) | | | |
| Behavioral regulation | 62.1 (12.8) | 46.3 (8.1) | *** |
| Metacognition | 64.1 (10.5) | 48.6 (10.3) | *** |
| CBCL (*T*-scores) | | | |
| Internalizing problems | 58.8 (11.5) | 49.6 (9.4) | ** |
| Externalizing problems | 63.6 (9.8) | 50.0 (8.7) | *** |
| Aggressiveness | 63.1 (8.6) | 54.0 (4.1) | *** |
| Anxious depressed | 59.4 (10.6) | 53.5 (5.9) | * |
| SNAP (raw scores) | | | |
| Attention | 16.7 (4.6) | 6.3 (4.5) | *** |
| Hyperactivity | 5.9 (3.3) | 1.4 (2.0) | *** |
| Impulsivity | 5.5 (3.2) | 1.8 (1.7) | *** |
| ODD | 9.44 (3.5) | 4.7 (3.3) | *** |
| SDQ (raw scores) | | | |
| Conduct problems | 3.5 (2.0) | 1.2 (1.1) | *** |
| Emotional problems | 3.8 (2.7) | 1.6 (1.7) | ** |
| Peer problems | 2.9 (2.2.) | 1.2 (1.5) | ** |
| Supplementary questions (raw scores) | | | |
| Sluggish tempo | 9.7 (3.2) | 7.4 (2.3) | ** |
| Motivation | 9.6 (2.8) | 6.2 (2.1) | *** |
| Teacher ratings | | | |
| CTRS-R (*T*-scores) | | | |
| Conners DSM-IV hyperactive-impulsive | 63.2 (11.9) | 48.6 (7.0) | *** |
| Conners DSM-IV inattentive | 64.1 (9.2) | 49.4 (6.2) | *** |
| Brief teacher (*T*-scores) | | | |
| Behavioral regulation | 66.3 (13.6) | 51.2 (10.0) | *** |
| Metacognition | 68.1 (11.7) | 53.8 (10.2) | *** |
| Supplementary questions (raw scores) | | | |
| Sluggish tempo | 9.6 (3.0) | 7.5 (2.8) | * |
| Motivation | 9.1 (2.9) | 5.7 (2.0) | *** |

*T*-tests, *SD* standard deviation, *ns* not significant

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

## Instruments

### *Children*

Children reported self-perceptions on the SelfReg (Rizzo et al. 2006, 2010). The SelfReg consists of 28 items belonging to 7 subscales with four items each: 1. Distractibility, 2. Sustained Attention, 3. Emotional Control, 4. Motor Activity, 5. Motivation, 6. Inhibition, and 7. Speed of Processing. Each item begins with the description of a typical situation, followed by two ensuing opposing types of behavior shown by children: one example of good regulatory skills and one of poor self-regulation. The child is then asked whether he or she is likely to show the same behavior as in one of the presented alternatives. In half of the items, the child is asked to compare his or her own behavior to the negative, in the other half to the positive alternative. The child answers on a five-point Likert scale ranging from "very often" to "never". Each item is illustrated by pictures. Two versions have been created, one for boys and one for girls, with gender-specific pictures and names. About half of the scenarios are situated at home and the other half at school. Examples for each subscale are listed in the "Appendix" (for an example of a single item see Fig. 1). Items and subscales were derived empirically from an original set of 112 items and validated on a sample of normal school children aged 8–10 years (Rizzo et al. 2010).

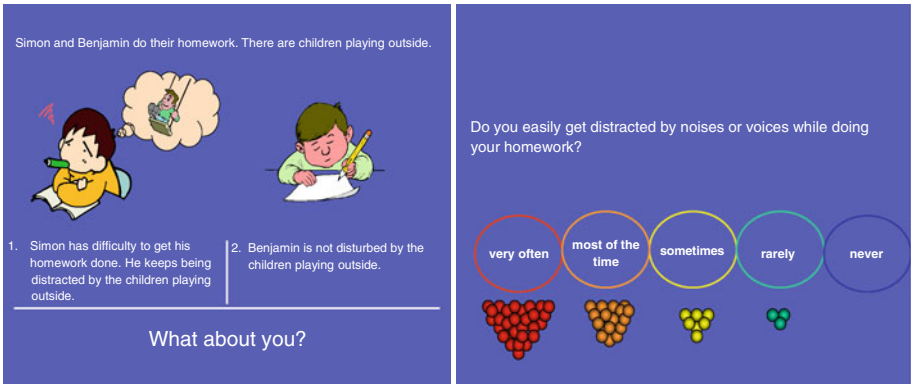


**Fig. 1** SelfReg item example

*Parents*

The parents completed the Behavior Rating Inventory of Executive Function BRIEF (Gioia et al. 2000), the Child Behavior Checklist (CBCL, Achenbach 1991), a German short version (18 items plus 8 ODD items) of the Swanson, Nolan and Pelham Questionnaire (SNAP, Swanson et al. 1998), the Strength and Difficulty Questionnaire (SDQ, Goodman et al. 1998), as well as a short checklist with supplementary questions on the child's regulation of motivation and speed of processing. Responses to this checklist were rated on a five-point Likert scale ranging from "very often" to "never". This checklist had been created by the authors in order to collect parental ratings that matched the equivalent subscales of the SelfReg (see "Appendix").

*Teacher*

In addition to the Conners Teacher Rating Scale Revised (CTRS-R, Conners 1997), teachers filled in the teacher version of the BRIEF (Gioia et al. 2000). They also completed a checklist with supplementary questions on the child's motivation and speed of processing/sluggish tempo (see "Appendix").

Procedure

The SelfReg and the IQ-tests were administered to the children at the Department of Child and Adolescent Psychiatry, or in a separate room at the child's school. The administration of the SelfReg took approximately 15–20 min. To ensure comprehension, research assistants administered measures individually and read aloud all items of the SelfReg to child participants. Parents generally completed written measures on their own, either at the clinic or at home.

Data analysis

In a first step, items with negative content of the SelfReg were re-coded so that high subscale scores indicate dysfunctional self-regulatory skills. Because distributional assumptions of equality of covariance and error variance for MANOVA were not met, even after application of the standard transformation procedures (see Kirk 1995), SelfReg subscale scores of children with ADHD and controls were compared separately by *t*-tests. A Bonferroni correction was performed and the significance level was set to alpha = .007. Effect sizes (Cohen's *d*) were calculated for all subscales and the total score of the SelfReg.

The accuracy of self-perceptions was examined by comparing the self-perceptions of children with ADHD and CTL children relative to parents' and teacher's perceptions. To this aim, separately for each domain, discrepancy scores were calculated by subtracting aggregated scores from parents' and teacher's ratings from the children's subscale scores. All scores were previously z-transformed. Aggregated scores from both parents and teacher ratings were chosen because SelfReg items depict situations at home as well as in class. For the aggregation of parents and teacher judgements, subscale scores were first z-transformed and then added to each other. As the SelfReg does not match directly any existing rating scale for parents or teacher, subscale scores had to be selected from different instruments and subtracted from z-transformed SelfReg subscales as follows: 1. SNAP (parents) inattention score and CTRS-R DSM-IV inattention score were aggregated and subtracted from a combined SelfReg Distractibility and SelfReg Sustained Attention score. It was necessary to combine these two SelfReg subscales into one, because the items on sustained attention and distractibility belong to the same subscale in the parent and teacher scales. 2. The aggregated BRIEF emotional control subscale (parents' and teacher's version) score was subtracted from the SelfReg Emotional control score. 3. The aggregated SNAP

(parents) hyperactivity subscale score plus the CTRS-R Hyperactivity subscale score were subtracted from the SelfReg Motor Activity score. 4. The aggregated supplementary parent's and teacher's questions score on motivation were subtracted from the SelfReg Motivation score. 5. The aggregated BRIEF inhibition subscales (parent's and teacher's version) scores were subtracted from the SelfReg Inhibition score. 6. The aggregated supplementary parent's and teacher's questions scores on speed of processing/sluggish tempo were subtracted from the SelfReg Speed of processing score. Discrepancy scores were compared by Mann–Whitney *U* tests (because of unequal variances), and effect sizes according to Cohen's *d* were calculated. Overall discrepancies (Diff total score) were calculated for both groups and compared by Mann–Whitney *U* test. Additionally, an exploratory cluster analysis based on six discrepancy scores was carried out for the whole sample ($N = 54$) with the aim of detecting subgroups of children who under- or over-estimated their skills (Ward Method, 2–4 cluster preselected). Differences between cluster members with regard to discrepancy scores and clinical scores were compared by nonparametric methods (Kruskal–Wallis H, Mann–Whitney *U*). All statistical computations were performed by use of the Statistical Package for the Social Sciences (SPSS 14).

## Results

### Analyses of group differences on SELFREG and discrepancies

As shown in Table 2, children with ADHD rated themselves as more impaired than control children on 5 out of 7 subscales with effect sizes ranging from .68 to 84. After Bonferroni correction, significant group differences remained for the subscales measuring Distractibility, Emotional Control, Motor Activity and Inhibition.

Results of discrepancy analyses are shown in Table 3. Except for the discrepancy between SelfReg subscales Distractibility/Sustained Attention and aggregated inattention scores ($P = .048$), no significant group differences emerged. Discrepancies for Inhibition and Motor Activity were significant by trend only with moderate effect sizes. After correction for multiple testing group difference between discrepancy scores was not significant anymore. Overall discrepancies (Diff total score) did not discriminate between groups. However, effect size (Cohen's *d*) of discrepancies total score reached 0.51 which is considered an effect of moderate size. These findings indicate that in relation to parent's or teacher's ratings, self-ratings on the SelfReg by children with ADHD on different subscales are mostly as accurate as those by CTL children, although overall results indicate a tendency toward a positive bias.

### Cluster analysis

A three cluster-solution provided the most convincing result. Mean discrepancy scores and SelfReg subscale means of cluster members are displayed in Table 4. Cluster 1 comprises 16 children, eight children with ADHD and eight CTL. Cluster1 children rated themselves as more severely impaired on self-regulatory functions compared to parents' and teacher's estimation. This cluster may be labeled "negative bias" or "under-estimators". Cluster 2 comprises 30 children, 11 with ADHD and 19 CTL children. This largest group represents children with accurate self-perception compared to parent's and teacher's judgment so that this cluster contains the "accurate estimators". Cluster 3 consists of eight children with ADHD and no CTL. These children had systematically overestimated self-regulatory skills compared to parent's and teacher's ratings. Thus, this cluster may be called "positive bias" or "over-estimators". Children from Cluster 1, 2, and 3 significantly differed with regard to discrepancies between self- and parents/teacher judgments on all scales except for Motivation and Speed of Processing as may be seen from Table 4. Members of Cluster 1, 2, and 3 also showed significant differences on four out of seven SelfReg subscales (Table 4). "Under-estimators" differed from "over-estimators" on all subscales, except for Speed of Processing. When children from the "positive bias" Cluster 3 were directly compared to all remaining children from Cluster 1 and 2 ("negative bias" plus "accurate", $N = 46$), group differences of SelfReg total score ($P = .012$) and subscales Distractibility ($P = .001$) and Sustained Attention ($P = .036$) became significant, indicating that children from Cluster 3 had effectively chosen more overtly positive self-ratings compared to all other children (Fig. 2).

To detect specific characteristic of children within the ADHD group presenting a positive bias in their self-evaluation, children from Cluster 3 were compared with diagnosed ADHD children from Cluster 1 and Cluster 2. In a first, the two subgroups were considered separately (Cluster 1: $N = 8$, Cluster 2: $N = 11$), and in a second step the two subgroups were combined ($N = 19$). Findings are shown in Table 5. When comparing the three clusters, group differences were found on parents SDQ ratings of Emotional Problems and teacher ratings of the CTRS-R DSM-IV Inattentive and Hyperactive-impulsive subscales. Only the latter two proved to be significant on direct subgroup comparison. When Cluster 3 children were compared to the remaining combined ADHD children subgroup, a significant effect for age and a trend for IQ emerged. Children from the "positive bias" Cluster 1 were

**Table 2** SelfReg subscale scores (raw scores) of children with ADHD and controls (CTL)

| Subscale | ADHD ($N = 27$) Mean (SD) | CTL ($N = 27$) Mean (SD) | $P$ | Effect size ($d$) |
|---|---|---|---|---|
| Distractibility | 12.8 (4.6) | 9.7 (2.4) | .004* | .84 |
| Sustained attention | 11.3 (4.8) | 8.8 (2.0) | .019 | .68 |
| Emotional control | 11.5 (4.1) | 8.6 (2.9) | .004* | .82 |
| Motor activity | 11.9 (4.6) | 9.1 (2.3) | .006* | .77 |
| Inhibition | 10.9 (5.1) | 7.7 (2.7) | .006* | .78 |
| Motivation | 10.8 (5.0) | 9.8 (4.1) | .432 | .22 |
| Speed of processing | 11.4 (3.7) | 10.8 (3.4) | .494 | .17 |
| SelfReg total score | 81.0 (27.0) | 61.9 (12.2) | .002 | .91 |

*SD* standard deviation

* Significant after Bonferroni correction

**Table 3** Mean discrepancies ($z$-values) between SelfReg subscales and aggregated scores from parent's and teacher's ratings in children with ADHD and control children (CTL)

| | ADHD ($N = 27$) Mean (SD) | CTL ($N = 27$) Mean (SD) | $P$ | ES ($d$) |
|---|---|---|---|---|
| Differences between SelfReg ratings minus aggregated parents' and teacher's ratings (z-scores) | | | | |
| DIFF distractibility/sustained attention[a] | −.352 (1.62) | .352 (.76) | .040 | .55 |
| DIFF emotional control[b] | −.104 (1.46) | .104 (.96) | .910 | .16 |
| DIFF motor activity[c] | −.311 (1.61) | .311 (.68) | .154 | .50 |
| DIFF motivation[d] | −.054 (.44) | .054 (.39) | .406 | .26 |
| DIFF inhibition[e] | −.314 (1.53) | .314 (.88) | .088 | .50 |
| DIFF speed of processing[f] | −.034 (.62) | .034 (.45) | .653 | .12 |
| DIFF total score | −1.101 (5.37) | 1.101(2.83) | .126 | .51 |

SelfReg subscales minus aggregated ratings from: [a]SNAP (parents) inattention subscale plus CTRS-R DSM-IV inattentive subscale, [b]BRIEF emotional control subscales (parent's and teacher's version), [c]SNAP (parents) hyperactivity subscale plus CTRS-R hyperactivity subscale, [d]supplementary parents' and teacher's questions on motivation ("Appendix"), [e]BRIEF inhibition subscales (parent's and teacher's version), [f]supplementary parent's and teacher's questions on speed of processing/sluggish tempo ("Appendix"); *ES* effect size, Cohen's $d$

rated as more impaired by parents on the Metacognition Index of the BRIEF and by teachers on the CTRS-R DSM-IV inattentive and hyperactive-impulsive subscales.

## Discussion

In this study, the accuracy of self-perceptions of self-regulatory skills in children with ADHD aged 8–10 years was compared to age-matched control children. Children rated their skills on a new rating scale, the SelfReg, and their scores were subsequently related to parents' and teachers' ratings on different clinical scales. Consistent with the initial hypothesis, children with ADHD rated themselves as more impaired than control children on a majority of subscales. This is in accordance with several studies reporting that young school children with various types of behavioral or developmental difficulties are quite well aware of their problems (Bell et al. 2010; Chapmann 1998; Bear et al. 2002; Zeleke 2004; Treuting and Hinshaw 2001; Ialongo et al. 1994; Klimkeit et al. 2006). Consequently, we did not find clear evidence that children with ADHD consistently overestimate their skills compared to age-matched peers, as claimed by the illusory positive bias theory. Although there might be a general tendency toward a positive bias, as indicated by the moderate effect size for discrepancies total score, this effect seems to be smaller here compared to the literature (i.e. ES = 1.48 for discrepancy scores on behavioral ratings, Hoza et al. 2002).

Several explanations may account for this finding. On the SelfReg, children are not asked to rate the quality of performance or the severity of deficits directly but, rather, have to compare their own behavior to that of others. The description of other children's behavior in concrete and familiar situations provides a frame of reference which, for some children, makes it easier to refer to daily life experiences and to evaluate their own behavior in a more realistic way. It has been argued that the PIB effect is not present when children with ADHD have to evaluate performances of others, showing that PIB is not simply due to cognitive impairment or inadequate skills in evaluating performance (Evangelista et al. 2008). However, in

**Table 4** Mean discrepancies scores (*z*-values) and mean Selfreg subscale scores in three clusters of children

| | Cluster 1 "negative bias" ($N = 16$) Mean (SD) | Cluster 2 "accurate estimation" ($N = 30$) Mean (SD) | Cluster 3 "positive bias" ($N = 8$) Mean (SD) | *P** | *P*** |
|---|---|---|---|---|---|
| Differences between SelfReg ratings minus aggregated parents' and teacher's ratings | | | | | |
| DIFF distractibility/sustained attention[a] | 1.382 (.67) | −.172 (.54) | −2.117 (1.02) | .000 | C1, C2 > C3 |
| DIFF emotional control[b] | 1.134 (.55) | −.185 (.91) | −1.572 (1.24) | .000 | C1, C2 > C3 |
| DIFF motor activity[c] | 1.089 (.69) | −.113 (.68) | −1.756 (1.70) | .000 | C1, C2 > C3 |
| DIFF motivation[d] | .042 (.40) | −.030 (.40) | .028 (.54) | .791 | |
| DIFF inhibition[e] | 1.305 (.75) | −.216 (.78) | −1.797 (.91) | .000 | C1, C2 > C3 |
| DIFF speed of processing[f] | .068 (.61) | −.106 (.51) | .262 (.44) | .149 | |
| SelfReg (mean raw scores, SD) | | | | | |
| Distractibility | 14.0 (3.4) | 11.0 (3.6) | 7.1 (2.7) | .000 | C1, C2 > C3 |
| Sustained attention | 12.9 (4.2) | 9.3 (2.9) | 7.4 (3.6) | .003 | C1 > C3 |
| Emotional control | 13.2 (3.5) | 8.9 (3.2) | 8.1 (3.2) | .001 | C1 > C3 |
| Motor activity | 13.5 (4.2) | 9.8 (3.0) | 7.9 (3.6) | .010 | C1 > C3 |
| Inhibition | 13.2 (5.1) | 8.0 (3.1) | 6.6 (1.4) | .002 | C1 > C3 |
| Motivation | 12.2 (4.8) | 10.0 (4.5) | 7.6 (3.5) | .100 | C1 > C3 |
| Speed of processing | 12.6 (3.6) | 10.8 (3.3) | 9.5 (3.5) | .088 | |
| SelfReg total score | 91.1 (24.8) | 65.5 (16.5) | 54.2 (11.4) | .000 | C1 > C3 |

*C1* cluster1, *C2* cluster2, *C3* cluster3

* Three groups comparison, Kruskal–Wallis; ** Two groups comparison, Mann–Whitney *U*

SelfReg subscales minus aggregated ratings from: [a]SNAP (parents) inattention subscale plus CTRS-R DSM-IV inattentive subscale; [b]BRIEF emotional control subscales (parents' and teacher's version) [c]SNAP (parents) hyperactivity subscale plus CTRS-R Hyperactivity subscale; [d]supplementary parents' and teacher's questions on motivation ("Appendix"), [e]BRIEF inhibition subscales (parents' and teacher's version); [f]supplementary parents' and teacher's questions on sluggish tempo ("Appendix")

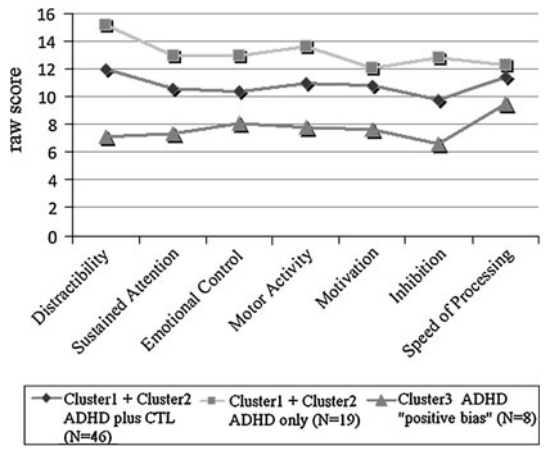


**Fig. 2** SelfReg subscales mean scores of children with ADHD presenting a positive bias ($N = 8$) compared to children from Cluster 1 and Cluster 2 (ADHD plus CTL and ADHD only)

relatively young children and in children with metacognitive difficulties (see Poissant 2005), items representing small scenes may permit an easier access to realistic self-representations than abstract verbal items. In addition, SelfReg subscales that discriminated best between children with and without ADHD were closely related to ADHD main symptoms. Although the SelfReg is conceived as a measure of self-regulatory function and not as a specific ADHD scale, there might be a considerable overlap. This has also been found for other scales on self-regulation/executive function, such as the BRIEF, which quite reliably discriminates children with ADHD from non-affected controls (Sullivan and Riccio 2007; Toplak et al. 2009).

In a second step, we investigated whether the self-ratings of children with ADHD diverge more strongly from the judgments of parents and teachers than the self-ratings of control children. Even though children with ADHD may be aware of some difficulties, they could nevertheless underestimate the severity of their problems. Contrary to expectations, this was not the case. When corrected for multiple testing, discrepancies between children's and adults' ratings were not significantly larger in the ADHD group compared to controls. However, effect sizes were medium for three discrepancy scores, i.e. the aggregated score of the Distractibility/Sustained Attention subscales, the Inhibition subscale, and the Motor Activity subscale, and for the discrepancies total score, indicating a tendency toward a positive bias after all.

Therefore, in a third step, we investigated whether it is possible to detect subgroups within the total sample that systematically under- or overestimated skills, compared to adults' ratings.

**Table 5** Characteristics of cluster members (total sample $N = 54$ and ADHD $N = 27$) and symptom severity (mean, SD) of children with ADHD ($N = 27$) from Cluster 1, Cluster 2, and Cluster 3

| Characteristic/scale | Cluster 1 "negative bias" | Cluster 2 "accurate estimation" | Cluster 3 "positive bias" | $P^a$ | $P^b$ | $P^c$ |
|---|---|---|---|---|---|---|
| All ($N = 54$) | $N = 16$ | $N = 30$ | $N = 8$ | | | |
| Age (mean, SD) | 9.9 (.66) | 10.0 (.75) | 9.4 (.91) | ns | | |
| Boys/girls (*N*) | 12/4 | 25/5 | 5/3 | ns | | |
| Estimated IQ (mean, SD) | 107.9 (18.8) | 108.1 (17.5) | 94.7 (10.0) | ns | | |
| ADHD ($N = 27$) | $N = 8$ | $N = 11$ | $N = 8$ | | | |
| Combined/inattentive (*N*) | 3/5 | 6/5 | 5/3 | | | |
| Age mean (SD) | 10.0 (.79) | 10.3 (.80 | 9.4 (.91) | ns | | C3 < C12* |
| Boys/girls (*N*) | 6/2 | 10/1 | 5/3 | | | |
| Estimated IQ (mean, SD) | 105.4 (13.7) | 106.6 (18.3) | 94.7 (10.0) | ns | | C3 < C12+ |
| BRIEF parent | | | | | | |
| Behavioral regulation | 60.8 (10.9) | 57.4 (13.7) | 69.9 (10.6) | ns | | C3 > C12* |
| Metacognition | 61.7 (11.4) | 63.5 (10.3) | 67.2 (10.7) | ns | | ns |
| SDQ | | | | | | |
| Peer problems | 2.2 (1.8) | 2.8 (2.2) | 3.6 (2.6) | ns | | ns |
| Emotional problems | 5.1 (2.6) | 2.4 (2.5) | 4.5 (2.7) | * | ns | ns |
| Conduct problems | 3.7 (1.3) | 3.3 (2.4) | 3.6 (2.2) | ns | | ns |
| SNAP | | | | | | |
| Inattention | 15.0 (1.8) | 16.4 (6.3) | 18.8 (3.4) | ns | | ns |
| Hyperactivity | 5.4 (2.5) | 6.1 (2.5) | 6.2 (5.1) | ns | | ns |
| Impulsivity | 6.1 (3.6) | 4.7 (2.3) | 6.2 (4.0) | ns | | ns |
| ODD | 10.2 (2.5) | 9.0 (3.7) | 9.2 (4.5) | ns | | ns |
| CBCL | | | | | | |
| Aggressiveness | 61.8 (6.6) | 61.6 (9.1) | 66.5 (9.6) | ns | | ns |
| Anxious/depressed | 60.6 (10.9) | 56.1 (10.7) | 62.6 (10.2) | + | ns | ns |
| CTRS-R | | | | | | |
| DSM-IV inattentive | 57.1 (7.3) | 64.9 (4.5) | 70.2 (11.6) | * | C1 < C3* | C3 > C12* |
| DSM-IV hyperactive-impulsive | 57.7 (10.6) | 59.9 (7.8) | 73.5 (12.5) | * | C1 < C3*, C2 < C3* | C3 > C12* |
| BRIEF teacher | | | | | | |
| Behavioral regulation | 62.6 (7.3) | 64.9 (9.6) | 72.0 (20.9) | ns | | ns |
| Metacognition | 66.0 (9.4) | 69.9 (6.2) | 67.7 (18.8) | ns | | ns |

*C1* cluster 1, *C2* cluster 2, *C3* cluster 3, *C12* cluster 1 plus cluster 2 ($N = 19$), *CTL* controls, *ns* non significant

* $P < .05$; + $.05 < P < .06$

[a] Three cluster comparison (Kruskal–Wallis)

[b] Cluster 3 compared to Cluster 2 and Cluster 3 separately (Mann–Whitney *U*)

[c] C3 compared to C12 (Mann–Whitney *U*)

A cluster analysis based on discrepancy scores of the complete sample distinguished three different clusters of self-raters in relation to the evaluation of parents and teachers: accurate estimators (no bias), under-estimators (negative bias), and over-estimators (positive bias). The subgroup of children overestimating their self-regulatory skills relative to the other two cluster groups (accurate estimators and under-estimators) was composed exclusively of children with ADHD. Thus, one may conclude that the characteristic positive bias observed in ADHD was also found in the present sample. However, it was limited to a subgroup of children. When ratings of this "positive bias" subgroup on the SelfReg were directly compared to all other children's ratings, they generally scored lower, and, in consequence, rated themselves more positively than other children. Thus, the classification of this group into a cluster of "over-estimators" was not simply due to a methodological artifact, but represented a real difference with regard to the self-evaluation of self-regulatory skills of these children. Interestingly, the group of under-

estimators, that is children who have a lower opinion of their own skills and a more negative view of their deficits compared to adults' ratings, was composed half of children with ADHD and half of control children. Thus, it is not only possible to detect a group of children with ADHD that present positively biased self-evaluations but also a subgroup of children with ADHD whose self-estimation is systematically biased into a negative direction. As this tendency can also be observed to the same extent in normal children, it may be considered within the limits of normal variability and obviously has received no special interest in the literature so far, at least not with regard to self-ratings in the behavioral domain. Children with ADHD from the "negative bias group" scored significantly higher on the SelfReg than other groups, so that cluster-membership was not merely an artifact due to low symptom severity as rated by adults.

Finally, ADHD children from the cluster groups were compared with regard to demographic characteristics and clinical symptoms. Children belonging to the "positive bias" group were slightly younger and tended to have lower IQ scores than the other children with ADHD. This is in accordance with "immaturity" and "metacognitive deficit" explanations of PIB (e.g. Poissant 2005), but in contrast to recent studies claiming that PIB persists in ADHD over the years (Hoza et al. 2010). Children from the "positive bias group" were also rated as more impaired by parents on the Behavioral Index of the BRIEF and by teachers on the CTRS-R DSM-IV Inattentive and Hyperactive-impulsive Indices. We did not detect group differences with regard to CBCL aggressiveness or anxious/depressed subscales, i.e. on symptom dimensions that might represent possible confounds (Kaiser et al. 2008; see Owens et al. 2007), possibly because severe ODD had been excluded.

## Limitations

A limitation compared to other studies on PIB lies with the fact that we could not rely on matched self-report and informant forms in order to establish discrepancy scores between children's and adults' ratings. The necessary aggregation of two SelfReg subscales into one that matches equivalent adults' report inattention subscales may represent a further methodological weakness. In addition, in the absence of viable alternatives, we had to create supplementary items on motivation and speed of processing for parents and teachers, which have not been evaluated yet for psychometric properties. Finally, given the small subsample sizes, generalization of the present findings may be questioned. Thus, the exploratory nature of this part of the analysis has to be emphasized.

## Conclusion

Children with ADHD as young as 8–10 years old provide accurate judgements on their self-regulatory skills when tested with an age appropriate instrument. Although we could not find a distinct positive bias in the self-perception of skills and deficits in ADHD, subsequent analysis of subgroups provided evidence for characteristic overestimation as well as for unexpected underestimation of skills in different subgroups of children. These findings suggest that a positive bias in self-perception is not universal to ADHD, but may be restricted to a distinct subgroup of children whose special characteristics and developmental risks remain to be fully described.

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## Appendix

SelfReg: item examples for different subscales

*Distractibility*

Simon and Benjamin do their homework. There are children playing outside.

1. Simon has difficulty to get his homework done. He keeps being distracted by the children playing outside.
2. Benjamin is not disturbed by the children playing outside.

What about you? Do you easily get distracted by noises or voices while doing your homework?

*Sustained attention*

The children are in class.

1. Alessandro chats very often with his neighbor instead of paying attention.
2. Andreas is able to pay attention for a long time. He rarely chats with his neighbour.

What about you? Are you able to pay attention for a long time without chatting with the person sitting next to you?

*Emotional control*

Pascal, Joel, and Tim play "Connect 4" at Pascal's home. Pascal is the first to have placed all four figures in the goal.

1. Joel gets angry and throws all figures all over the play ground.
2. Tim thinks "it's a pity I lost", but keeps calm.

What about you? Do you keep calm if you lose a game?

*Motor activity*

Yves and Marc go shopping with their parents.

1. Yves is running away all the time and touches all kinds of things in the shop.
2. Marc stays with his parents and does not touch things when he is not allowed to.

What about you? Do you stay with your parents when you go shopping?

*Motivation*

The children have to solve a difficult problem and have difficulty to find the solution.

1. Roman tries to solve the problem for another while.
2. Dario loses his patience after a short while and does not continue. If something doesn't work right away, Dario gives up.

What about you? Do you try to solve a problem for a while, even if it's difficult?

*Inhibition*

The teacher asks a question related to today's topic "My family".

1. Daniel raises his hand and answers only when the teacher asks him to.
2. Ivan shouts out the answer in class, without raising his hand.

What about you? Do you shout out an answer in class without raising your hand?

*Speed of processing*

The teacher says: "Once you have finished this two math problems you can go for a break!"

1. Alex is playing outside for some time. He was as quick as his friends.
2. Fabian is still solving math problems while his friends are playing outside for some time.

What about you? Do you still have to finish your task while other children can go for a break?

*Supplementary questions*

*Motivation*

1. Must be called upon to do homework even though he/she fully realizes its importance.
2. Does not finish boring tasks without reward.
3. Needs encouragement and positive feedback to make an effort.

*Speed of processing/sluggish tempo*

1. Needs more time than other children when trying to work without careless mistakes.
2. Needs more time than other children to finish tasks.
3. Needs much time to learn new things.

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