



# Teacher Feedback, Student ADHD Behavior, and the Teacher–Student Relationship: Are These Related?

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## Abstract

This cross-sectional study aimed to compare positive and corrective teacher feedback toward children with attention-deficit/hyperactivity disorder (ADHD) and typically developing children, and to examine whether the quality of the teacher–student relationship moderated associations between child behavior and teacher feedback. We observed and coded classroom ADHD behaviors of 55 children with ADHD and 34 typically developing children (TDC; 6–12 years), as well as the levels of positive and corrective teacher feedback they received. Teachers rated closeness and conflict using the Student–Teacher Relationship Scale in the ADHD group. Multilevel analyses revealed that teachers provided significantly more corrective feedback to children in the ADHD compared to the TDC group. Children in the ADHD group received more corrective than positive feedback, but this pattern was reversed for the TDC group. Multiple regression analyses in the ADHD group indicated that lower levels of positive feedback were related to higher levels of motor hyperactivity. Higher levels of corrective feedback were associated with higher levels of verbal hyperactivity. Closeness moderated this association: Corrective feedback was related to levels of verbal hyperactivity only if teachers experienced less closeness in the relationship with the child. None of the other moderation effects were significant. Teachers provided more corrective feedback to children with ADHD than to typically developing children, and teacher feedback toward children with ADHD was associated with levels of hyperactivity. A close teacher–student relationship may serve as protective factor for the receipt of corrective feedback in this group, but experimental studies are needed to confirm this hypothesis.

**Keywords** ADHD · Classroom observations · Teacher feedback · Teacher–student relationship

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## Introduction

Almost every classroom includes students with subthreshold or clinical levels of symptoms of attention-deficit/hyperactivity disorder (ADHD), together representing about 20% of all school-aged children (Kirova et al., 2019; Polanczyk et al., 2014). These children suffer from problems with inattention, hyperactivity, and/or impulsivity (American Psychiatric Association, 2013) that are related to academic, behavioral, and/or social problems in the classroom (Kirova et al., 2019; Zendarski et al., 2020).

Teachers experience externalizing behavioral problems, such as ADHD, as the most difficult to handle type of behavioral problems in the classroom (Greene et al., 2002). These children are at risk of being exposed to a greater number of corrections by teachers than classmates without externalizing behavioral problems (McClowry et al., 2013; Sprouls et al., 2015). However, corrections by teachers may in turn increase behavioral problems (Clunies-Ross et al., 2008), while higher levels of positive feedback by teachers may promote appropriate classroom behavior of children (Hattie & Timperley, 2007). Given this bidirectional relationship between teacher feedback and behavioral problems (Nelson & Roberts, 2000; Reinke et al., 2016; Sutherland & Oswald, 2005), it is important to gain insight into how teachers behave toward children with ADHD and to gain insight into factors that may influence this coercive cycle.

To manage children's behavior in the classroom, teachers provide children with positive feedback (i.e., providing approval or praise for desired behavior, such as compliments) and corrective feedback (i.e., disapproving undesired behavior, such as reprimands) (Sprouls et al., 2015). There is no empirically based cut-off for ratios of positive to corrective feedback for teachers to achieve appropriate classroom behavior (e.g., engagement); the literature ranges from 3:1 (Shores et al., 1993) to 5:1 (Flora, 2000) for positive versus corrective feedback for typically developing children. For children with emotional and/or behavioral problems, an even higher rate of approximately nine praises to one reprimand is recommended (Caldarella et al., 2019). However, teachers tend to provide nearly three times more corrective than positive feedback to their students, independent of the levels of externalizing behavior displayed by the student (McClowry et al., 2013; Sprouls et al., 2015). These studies focused on teacher feedback toward children at risk of emotional and behavioral difficulties but not specifically subthreshold or full threshold ADHD. Currently, observational studies on teacher feedback are scarce. Including observations of teacher feedback is of importance, because self-report and observational measures yield different information.

Factors such as stress and low feelings of self-efficacy are likely to influence self-reported outcomes (De Los Reyes & Kazdin, 2005). Experienced difficulties in parenting are, for example, related to higher levels of reported negative parenting by parents than observed (Moens et al., 2018). Observations of behavior may thus provide more objective information. Also for children showing subthreshold or full threshold levels of ADHD behavior, there are studies examining self-reported teacher feedback, but observational studies are lacking. These self-report studies indicated that teachers report to use more positive than corrective feedback, regardless of whether a child has ADHD or not (Gaastra et al., 2020; Martinussen et al., 2011). Moreover, the first aim of this study was to compare positive and corrective teacher feedback toward children with ADHD and typically developing children using masked classroom observations.

Next to the fact that teachers may provide children with ADHD with more corrective and less positive feedback, teachers may respond differently to different types of behaviors, such as inattention or hyperactivity. Studies in typically developing children indicate that corrective feedback is usually provided in response to non-desired behavior (e.g., hyperactive and inattentive behavior), while positive feedback is usually provided in response to good academic performance, rather than toward desired behavior (e.g., sitting quietly in the chair, attentive behavior during a task) (Beaman & Wheldall, 2000; Clunies-Ross et al., 2008; Wisniewski et al., 2020). Evidence from behavioral teacher training studies shows that rewarding desired behavior and correcting non-desired behavior are effective strategies for teachers in remediating ADHD symptoms (DuPaul et al., 2012), but the relation between teacher feedback and inattentive and hyperactive behavior has not been examined in samples of children with ADHD so far. Insight into the relationships between the types of behavioral problems and the teachers' use of positive and corrective feedback can yield important initial information on how teachers deal with inattentive and hyperactive behavior of children with ADHD. The second aim of this study is therefore to examine associations between children's levels of inattentive and hyperactive behavior and positive and corrective teacher feedback.

Finally, high-quality teacher–student relationships may mitigate associations between behavioral problems of children with ADHD and levels of corrective feedback by teachers (Chang & Davis, 2009). This relationship can be characterized in terms of positive and negative affective attitudes, i.e., closeness and conflict, respectively. Closeness describes whether the teacher perceives the relationship with the child as warm, affective, and trustful. Conflict, on the other hand, concerns whether the relationship is characterized by negativity, discordance and distrust (Pianta, 2001; Verschueren & Koomen, 2012). In general, teacher–student relationships

of children with ADHD are characterized by higher levels of conflict and lower emotional closeness compared to typically developing children (Ewe, 2019; Rogers et al., 2015; Zee et al., 2013). However, also children with behavioral problems can have high-quality teacher–student relationships (Sabol & Pianta, 2012). Such high-quality relationships with low levels of conflict and high levels of closeness may serve as a buffer against the progressive exacerbation of children’s behavioral problems (Sabol & Pianta, 2012; Silver et al., 2005). Teachers that experience high-quality relationships might succeed better in maintaining adequate responses (little corrective feedback, a lot of positive feedback) when faced with high levels of ADHD behavior than teachers that experience conflictual and less warm relationships. This seems particularly relevant for motor and verbal hyperactivity of children with ADHD as this may disrupt the flow of lessons and may thus trigger more negative (i.e., corrective) teacher behaviors. A teacher–student relationship characterized by low levels of conflict and/or high levels of closeness may thus mitigate associations between hyperactivity of the child and teacher feedback, and may buffer against the receipt of corrective feedback (Driscoll & Pianta, 2010; Myers & Pianta, 2008).

The current study will investigate the relationship between positive and corrective teacher feedback and children’s classroom inattentive and hyperactive behaviors and look at whether these associations are related to the quality of the teacher–student relationship. We examined levels of positive and corrective feedback provided by teachers utilizing objective measures of structured classroom observations of ADHD behaviors inattention (off-task behavior) and hyperactivity (motor and verbal), and teacher feedback (positive and corrective feedback). We expected the ratio between corrective and positive feedback to be larger (i.e., more corrective feedback) for children in the ADHD group than for typically developing children (McClowry et al., 2013; Sprouls et al., 2015) (hypothesis 1). Further, we examined to what extent positive and corrective feedback is related to levels of inattentive and hyperactive behavior of children in the ADHD group. We expected higher levels of corrective feedback and less positive feedback to be related to higher levels of off-task, motor, and verbal hyperactive behavior (Beaman & Wheldall, 2000; Clunies-Ross et al., 2008; Wisniewski et al., 2020) (hypothesis 2). Finally, we examined whether conflict and closeness in the teacher–student relationship moderate associations between corrective and positive feedback by teachers and inattentive and hyperactive behavior of children. We hypothesized that associations between corrective feedback provided by the teacher and hyperactive behavior of the child would be lower in the context of a teacher–student relationship with higher levels of closeness and/or lower levels of conflict (Baker, 2006; Chang & Davis, 2009; Myers & Pianta,

2008) (hypothesis 3). Because children meeting full criteria for ADHD (i.e., full threshold) and children experiencing impairing levels of symptoms without meeting full criteria for the diagnosis (i.e., subthreshold) experience largely similar problems related to behavioral, social and academic functioning (Kirova et al., 2019; Zendarski et al., 2020), this study focused on children with full threshold as well as subthreshold ADHD (i.e., ADHD group) compared to typically developing children (i.e., TDC group).

## Methods

### Participants

Participants were 55 children with (full threshold or subthreshold) ADHD, referred to as ADHD group, and 34 typically developing children, referred to as TDC group. Both groups attended regular primary education in the Netherlands, and 85% of the children in the TDC group were classmates of children assigned to the ADHD group (15% of the TDC group was recruited through other teachers of the same school, see below). In total, children from 56 teachers of 40 schools participated. All children were in the age range 6–12 years. Most teachers were female (95%), and they had an average of 15.07 (SD = 11.57) years of teaching experience.

Children from the ADHD group were recruited as part of the baseline assessment of an intervention study in which we looked at efficacy of different teacher training components, reported elsewhere: Staff et al. (2021). These children were included if they: (a) obtained a score > 90th percentile on the teacher-rated Inattention and/or Hyperactivity/Impulsivity scale of the Dutch version of the Disruptive Behavior Disorders Rating Scale (DBDRS) (Oosterlaan et al., 2008); (b) showed at least three symptoms on the Inattention and/or Hyperactivity/Impulsivity scale of the semi-structured DSM-IV-TR Teacher Telephone Interview (TTI) conducted by a trained clinician (AS) (Tannock et al., 2002); and (c) obtained a score > 5 (indicating impairment, range 0–10) on at least one domain of an adapted version of the teacher-rated Impairment Rating Scale (IRS) (Fabiano et al., 2006). Teachers rated school impairment on the IRS assessing five areas of functioning: peer, teacher, classroom, academic, and self-esteem. In order to avoid overlap between the ADHD and TDC groups (see below), we added an additional inclusion criterion for this study and excluded children within the ADHD group who scored < 80th percentile on the Hyperactivity scale of the teacher-rated Strengths and Difficulties Questionnaire (SDQ) (Diepenmaat et al., 2014; Goodman, 1997).

Children in the TDC group were classmates of the children assigned to the ADHD group and recruited through the teachers specifically for this study. Teachers could nominate a classmate of the same age. If no classmates were available in a class, other teachers of the same school were asked to select a typically developing child of the same age. Children in the TDC group were required not to attend special education classes and to obtain a score < 80th percentile on the Hyperactivity scale of the teacher-rated SDQ. Correlations between teacher ratings on the ADHD scale of the SDQ and teacher ratings on the Inattention and Hyperactivity/Impulsivity scales of the DBDRS are high ( $r = .83$ ,  $r = .79$ , respectively) (Oosterlaan et al., 2008).

Children in both groups were excluded if they: (a) had an estimated full-scale IQ lower than 70 as assessed with a short form of the Wechsler Intelligence Scale for Children-third edition (WISC-III) including the subtests Block Design and Vocabulary (Sattler, 2008), (b) were taking psychotropic medication during the last month, or (c) had a diagnosis of autism spectrum disorder or conduct disorder according to the DSM-IV-TR or DSM-5 as reported by parents on a demographic questionnaire.

## Procedure

Ethical approval was based on the larger intervention study. The local medical ethical committee waived the need for medical ethical approval (University Medical Center Groningen, 2016/198). The study was conducted in accordance with the applicable Dutch legislations and the Declaration of Helsinki. Teachers for the larger intervention study (Staff et al., 2021) were recruited through school principals, educational consult associations, and an outpatient mental health clinic. After inclusion of the child(ren) displaying ADHD symptoms, teachers were asked to select a typically developing child of the same age. Teachers, parents, and children older than 11 years provided their written consent for study participation. Teacher and parent questionnaires were administered via a secured website, during the same week classroom observations took place. Data collection occurred during one school day, between April 2017 and April 2019. Teachers introduced observers as interns who visited different classes for their study, to observe how children are working during a lesson. Observations were conducted when children attended morning lessons in their own classroom led by their teacher. For four children (2 ADHD, 2 TDC), observations were in the afternoon due to practical reasons. Teachers and children in both the ADHD and TDC group were simultaneously observed in the classroom using two video cameras. Observers positioned cameras in a corner at front of the classroom to prevent target children being aware they were object of observation. Parents agreed with this procedure. Parents of other children in the classroom were informed

about the observation and provided with an opt-out option. If parents opted-out, the camera was positioned in a way that the particular child was not video-taped. Teachers consented that videotaped classroom observations took place, with the aim to observe child behavior and teacher–student interactions. Afterward, they were debriefed about which teacher behaviors were observed. Observers also administered the WISC-III short form for both the children in the ADHD and TDC group in a quiet room at the school.

## Measures

### Classroom Observations of Child ADHD Behaviors and Teacher Feedback

Inattentive and hyperactive behavior of children and corrective and positive feedback of teachers were assessed with the Ghent University Classroom Coding Inventory (GUCCI) (Imeraj et al., 2013, 2016). The GUCCI is an observation instrument developed to assess ADHD behavior in the classroom. We used the Dutch adapted version (Staff et al., 2020), consisting of five scales: Inattention (i.e., no visual attention to task), Motor Hyperactivity (i.e., motor movements), Verbal Hyperactivity (i.e., talking or other vocalizations), Oppositional Behavior (e.g., arguing, anger), and Teacher Attention (i.e., individual attention from the teacher to the child). The Oppositional Behavior scale was not included in the current study as rates of oppositional behavior were very low in the ADHD group (only 13 children showed oppositional behavior), and did not occur in the TDC group (Staff et al., 2020). The remaining three child behavioral scales consist of two mutually exclusive categories, coding behavior as absent or present (e.g., the Motor Hyperactivity scale distinguished between no motor hyperactivity and motor hyperactivity) (see Table 1). The Teacher Attention scale consisted of four mutually exclusive categories: *no teacher attention*, *positive feedback*, *corrective feedback*, and *instructions/structure*. The categories positive and corrective feedback were used for the current study. Definitions of the categories are presented in Table 1. All scales were coded using continuous sampling, indicating that all behaviors were coded throughout the coding period.

For Inattention, the percentage of time *off-task* was calculated by dividing the total time off-task by the total time in which the child was expected to be involved in class activities (sum of the time of *on-* and *off-task*). For Motor and Verbal Hyperactivity percentage of total time, the behavior occurred was calculated, both consisting of two levels: *no motor hyperactivity* versus *motor hyperactivity*, and *no verbal hyperactivity* versus *verbal hyperactivity*. Regarding the Teacher Attention scale, we calculated the frequency of occurrence for positive and corrective feedback. When corrective feedback was provided by the teacher, the tone of

**Table 1** Operational definitions of observed behaviors

Scale	Levels of behavior (coding category)	Description	Metric
<i>Child behaviors</i>			
Inattention	On-task	The child is involved in activities that are expected by the teacher (e.g., paying visual attention to task or to the teacher), and is following teacher's instructions and requests	
	Off-task	The child is involved in activities that are not expected by the teacher for at least two seconds (e.g., not working on assignments, daydreaming)	% of time
Motor hyperactivity	No motor hyperactivity	The child remains seated. Small, but not disturbing, movements of arms, hands, feet, or legs are observed	
	Motor hyperactivity	The child is not sitting (still) on the chair (e.g., overturns or swings the chair, standing up without permission, walks through the classroom). The child shows small or large movements that are annoying or disturbing peers (e.g., tapping with a pen, pricking neighbor with a finger)	% of time
Verbal hyperactivity	No verbal hyperactivity	The child is quiet, or the child talks in reaction to the teacher's request	
	Verbal hyperactivity	The child is talking or making vocal sounds (e.g., whispering to self, humming)	% of time
<i>Teacher behaviors</i>			
Teacher attention	Positive feedback	The teacher appoints desired behavior (i.e., behavior or performance), or provides non-verbal positive feedback (e.g., thumps up, to behavior or performance)	Frequency
	Corrective feedback	The teacher appoints undesired behavior (i.e., behavior or academic performance), or provides non-verbal corrective feedback (e.g., shaking 'no' with the head, to behavior or performance)	Frequency
		Corrective feedback could be provided in an explicit or harsh tone	

this feedback (harsh or explicit) was also coded (outcome was the frequency of harsh statements).

Teachers and children in both groups were observed simultaneously for approximately 90 min (i.e., video recordings were collected from start of the day to morning break, from end of morning break to lunch break, or from end of lunch break to end of the day), using two video cameras. The first 60 min of the recording that contained actual lessons was selected for coding (e.g., the observation started when children were arriving at the beginning of the day, coding started when the teacher started the first lesson) ( $M = 1:02$  h,  $SD = 0:06$  h). The Observer XT Software (Noldus Information Technology, version 13) was used for importing video material, coding behavior and calculating outcomes. As described in detail in Staff et al. (2020), fourteen graduate psychology students (i.e., observers) were individually and intensively trained by the first author (AS) to code the specific behaviors and to work with The Observer XT software. During this training, of at least two sessions of two hours each, they were introduced to the scale(s) and the levels of behavior belonging to that scale, and to the coding system; thereafter, the observers practiced coding of the observations and discussed their coding with the first author. Per observer, extra training sessions were held until inter-observer agreement with the trainer reached  $\geq .80$ . Observers coded a maximum of two scales in order to increase

accuracy and inter-observer reliability. For the total group of 91 children and their teachers, four observers coded Inattention, five other observers coded Motor Hyperactivity and Teacher Attention, and another five observers coded Verbal Hyperactivity. Observers were blind to the group status (ADHD or TDC) of the child. A random sample of the observations (21%) was coded twice to calculate inter-observer agreement. Intra-class coefficients (ICC) were calculated as measure of inter-observer agreement, which appeared to be excellent for all scales (range .78–.99). The GUCCI is able to discriminate between children with and without ADHD, especially for levels of off-task behavior. For a detailed description of the psychometric properties, please see (Staff et al., 2020).

### Teacher–Student Relationship

Because we aimed to study the role of the quality of the teacher–student relationship for children in the ADHD group, we assessed the quality of the teacher–student relationship only in this group. The Closeness and Conflict subscales of the shortened Dutch version of the Student–Teacher Relationship Scale (STRS) were used (Koomen et al., 2012; Pianta, 2001). Each subscale consists of five items rated on a 5-point Likert scale (1 = *definitely does not apply*, 5 = *definitely applies*). Closeness reflects the degree of openness,



warmth, and security in the relationship and is viewed as a positive aspect of the relation. Conflict reflects a relationship that is characterized by negative interactions that are unpredictable and unpleasant, and discordance. Mean item scores on the two dimensions served as the outcome measures. Reliability of the shortened Dutch version of the STRS is good (Bosman et al., 2018; Zee et al., 2013). Validity was investigated in a Dutch sample for the long version of the STRS; construct validity was confirmed (Koomen et al., 2012). Internal consistency was sufficient in this sample ( $\alpha = .73$  for Conflict,  $\alpha = .79$  for Closeness).

## Statistical Analysis

Statistical analyses were performed using Stata, version 16. Outliers ( $> 3$  SD) were winsorized (Tabachnick et al., 2007). There were no missing data on any of the main outcome variables. Group differences in demographic characteristics, IQ, and teacher-rated ADHD symptoms were assessed using independent samples *t*-tests and Chi-square tests. All further analyses were based on observed teacher and child behavior. To test our hypothesis that teacher behavior toward children with ADHD as measured with the GUCCI differs from teacher behavior toward typically developing children (hypothesis 1), we compared the groups on positive and corrective feedback. Separate multivariate analyses were conducted for child and teacher behavior scales of the observational coding system (see Table 1). As children in both groups were classmates, we used multivariate mixed model analyses to account for the interrelatedness of the measurements. Two hierarchical levels were distinguished: Children (level 1), nested in classrooms (level 2). Random intercept at classroom level was only included if significantly improving model fit as determined by Likelihood Ratio Tests. We inserted group as between-subject factor (ADHD = 0, TDC = 1) and levels of the behaviors assessed by a particular scale of the coding system as outcomes (within-subject factor). Because metrics of scores differed between scales (percentage or frequency of occurrence), all outcomes were transformed to *z*-scores. The regression coefficient for group therefore represents the difference between groups as expressed in SD units and is equal to Cohen's *d* measure of effect. To explore whether the tone of corrective feedback differed between groups, we calculated the number of corrective feedback statements that was provided in a harsh tone and compared groups by using mixed model analysis.

We investigated associations between teacher feedback and child behavior using multiple regression analysis in the ADHD group (hypothesis 2). Two multiple regression analyses were performed, with positive and corrective feedback serving as dependent variables and the three child behaviors (i.e., inattention, motor hyperactivity, verbal hyperactivity)

as independent variables in both analyses, by using the enter method. Next, using multiple regression models, we examined whether closeness and conflict in the teacher–student relationship moderated these associations (hypothesis 3). For this purpose, main effects of conflict or closeness and the interaction effect of one of the child behaviors with either conflict or closeness were added to the models (Hayes, 2017). A total of twelve interactions were tested in separate models. All variables were centered. Alpha was set at .05/2 to correct for multiple testing (two moderation analyses per outcome). Effect sizes were expressed as Cohen's *d*, with .20, .50 and .80 referring to the thresholds to define small, medium and large effects, respectively.

## Power

Power analyses were conducted using *G\*power*. To test for group differences between the ADHD and TDC group in received feedback (hypothesis 1), we used a multivariate ANOVA with two outcomes (positive and corrective feedback) and group as between-subject factor (ADHD, TDC). We expected a medium sized effect ( $f = .25$ ) (i.e., small for positive feedback, large for negative feedback) based on the study by Sprouls et al. (2015), and a small correlation between positive and corrective feedback ( $r = .06$ ) according to the study by McClowry et al. (2013). Power analysis revealed that we needed a total of 70 children to have sufficient power to detect group differences ( $\alpha = .05$ ,  $\text{power} = .80$ ). To account for nesting, we aimed to include 10% more children (Twisk, 2021), thus 77 children in total. For the additional analyses within the ADHD group (hypothesis 2 and 3), 59 children were needed to detect interaction (i.e., moderation) effects in a multiple regression model with three predictors (child behavior, teacher–student relationship dimension, and their interaction) ( $\alpha = .05$ ,  $\text{power} = .80$ ). Because quantitative studies examining the interaction between child behavior and the quality of the teacher–student relationship on teacher feedback are lacking, we decided to use a conservative estimated effect (i.e., small to medium effect;  $f = .20$ ).

## Results

Table 2 displays characteristics of the sample. Group comparisons revealed no differences in age and IQ between the ADHD and TDC group. As expected, based on the higher rate of ADHD in boys, there were more boys in the ADHD group compared to the TDC group. Therefore, all analyses were re-run using groups matched on sex as well as age (see Supplementary Material S1). According to parental reports, 14 of 55 children (25%) in the ADHD group had a clinical diagnosis of ADHD, and none of the children had a clinical

**Table 2** Sample characteristics

	ADHD ( <i>n</i> = 55)	TDC ( <i>n</i> = 34)	Group comparisons
Age (years)	8.55 (1.32)	8.76 (1.54)	<i>t</i> (87) = −.67, <i>p</i> = .502, <i>d</i> = .15
Sex, <i>n</i> (%) boys	44 (80.0)	17 (50.0)	$\chi^2(1) = 8.77, p = .003, V = .31$
IQ	100.02 (11.83)	105.20 (15.21)	<i>t</i> (83) = −.17, <i>p</i> = .085, <i>d</i> = .39
<i>DBDRS</i>			
Inattention	17.46 (4.32)		
Hyperactivity/impulsivity	15.52 (6.54)		
<i>TTI (number of symptoms)</i>			
Inattention	4.62 (1.68)		
Hyperactivity/impulsivity	4.02 (2.13)		
ODD	.91 (1.27)		
<i>IRS<sup>a</sup></i>			
Number of domains	3.16 (.97)		
SDQ hyperactivity	8.51 (1.33)	.59 (.82)	<i>t</i> (87.00) = 34.72, <i>p</i> < .001, <i>d</i> = 6.81

*M* and *SD* are depicted unless otherwise stated

*ADHD* Attention-deficit/hyperactivity disorder, *DBDRS* Disruptive behavior disorders rating scale, *IRS* Impairment rating scale, *SDQ* Strengths and difficulties questionnaire, *TTI* Teacher telephone interview

<sup>a</sup>Four children started directly after the summer holiday, but were screened before the summer holiday. As teachers were not able to rate impairment in the first week of school, for these children impairment was based on the fact that the teacher was seeking help to cope with the child’s behavior, which was substantiated by *TTI* scores

diagnosis of ODD. As expected, children in the ADHD group showed higher teacher ratings of ADHD symptoms as compared to typically developing children, assessed with the *SDQ* (see Table 2).

**Group Comparisons (Hypothesis 1)**

Results of the group comparisons on observed child and teacher behavior are presented in Table 3. For child behavior, model fit improved by including a random intercept for classroom. For teacher behavior, classroom did not improve model fit and was therefore omitted from the models.

Children in the ADHD group showed higher scores than children in the TDC group on all observed child behavior scales (large multivariate effect), with medium (Motor

Hyperactivity) to large (Inattention) univariate effect sizes. Teacher behavior toward children in the ADHD and TDC group differed, with a medium- to large-sized multivariate effect. Univariate analysis revealed that teachers provided significantly more corrective feedback (very large effect) and more positive feedback (small effect) to children in the ADHD compared to TDC group, although this latter difference just escaped conventional levels of significance (*p* = .052). Children in the ADHD group received more corrective than positive feedback (ratio positive to corrective feedback 1.0:1.3), whereas children in the TDC group received up to five times more positive than corrective feedback (ratio positive to corrective feedback 1.0:0.2).

We additionally explored whether corrective feedback was provided in an explicit or harsh tone. Of the 296 times

**Table 3** Group differences on behavioral outcomes as measured with classroom observations

	Metric	ADHD ( <i>n</i> = 55)	TDC ( <i>n</i> = 34)	Multivariate effect <sup>a</sup>	Univariate effect <sup>a</sup>
Child behavior <sup>b</sup>					
Inattention	%	27.99 (14.14)	13.99 (10.91)	<i>B</i> = −.75, <i>SE</i> = .12, <i>p</i> < .001	<i>B</i> = −.102, <i>SE</i> = .18, <i>p</i> < .001
Motor hyperactivity	%	35.57 (18.92)	25.20 (20.45)		<i>B</i> = −.58, <i>SE</i> = .18, <i>p</i> = .001
Verbal hyperactivity	%	9.03 (6.86)	5.11 (5.30)		<i>B</i> = −.66, <i>SE</i> = .18, <i>p</i> = .001
Teacher behavior					
				<i>B</i> = −.74, <i>SE</i> = .15, <i>p</i> < .001	
Positive feedback	<i>K</i>	3.82 (3.65)	2.35 (3.94)		<i>B</i> = −.39, <i>SE</i> = .20, <i>p</i> = .052
Corrective feedback	<i>K</i>	5.05 (4.45)	.50 (1.08)		<i>B</i> = −1.09, <i>SE</i> = .20, <i>p</i> < .001

Reported figures indicate *M* (*SD*). *K* = count

<sup>a</sup>*B* is equal to effect size (Cohen’s *d*)

<sup>b</sup>Levels child and classroom were included in the model

corrective feedback was provided (i.e., aggregated over the two groups); 21 remarks were harsh (7%), with 95% of these harsh remarks being directed to (ten children in) the ADHD group and 5% (one child) in the TDC group. Mixed model analysis, with a random intercept for classroom, revealed that the frequency of harsh corrective feedback differed significantly between groups:  $B = -.40, SE = .04, p < .001, d = .62$ . Given the rare occurrence of harsh corrective feedback scores, we did not include this in further analyses.

Analyses were re-run on groups matched on sex and age ( $n = 27$  per group, with  $n = 18$  boys and  $n = 11$  girls per group) (see Supplementary Material S1, Table A). All significant findings were replicated with highly similar effect sizes.

**Associations Between Teacher Feedback and Child Behaviors for the ADHD Group (Hypothesis 2)**

The associations between teacher feedback and child behavior as well as both teacher–student relationship dimensions are shown in Supplementary Material S2 (Table B). Results of the multiple regression analyses in the ADHD group are presented in Table 4. Analyses revealed that lower levels of positive feedback were related to higher levels of motor hyperactivity. Higher levels of corrective feedback were related to higher levels of verbal hyperactivity. Level of inattentive behavior was not significantly related to positive nor

corrective feedback after adjusting for both of the hyperactive behaviors.

**Moderation Effects of the Teacher–Student Relationship on Associations Between Teacher Feedback and Child Behavior for the ADHD Group (Hypothesis 3)**

Teachers’ reports of the quality of the teacher–student relationship in the ADHD group revealed significantly higher levels of conflict ( $M = 2.76, SD = .90; t(1351) = 1.91, p < .001$ ) and lower levels of closeness ( $M = 3.67, SD = .77; t(1348) = 2.34, p = .019$ ) compared to data of a Dutch normative sample of similar age ( $N = 1300$ ; Bosman et al., 2018).

We investigated whether conflict and closeness moderated the observed associations between teacher positive and corrective feedback and child ADHD behaviors. Of the twelve investigated interactions, only for the association between teacher corrective feedback and child verbal hyperactivity a significant moderator effect for closeness was present, see Table 5. Main effects of conflict and closeness on teacher feedback were not significant. Post hoc simple slopes analyses based on median split analysis of the moderation effect (see Fig. 1; median = 3.80) revealed that only for children with low levels of closeness higher levels of corrective feedback were associated with verbal hyperactivity ( $B = .49, SE = .11, p < .001$ ). For children with higher

**Table 4** Results of multiple regression analyses predicting teacher behavior (positive and corrective feedback) with child behavior (inattention, motor and verbal hyperactivity) in the ADHD group, measured by the classroom observations

Model	R <sup>2</sup> total model	B	SE B	β (r <sup>2</sup> )	p
Outcome: teacher positive feedback	.11				.107
Constant		5.35	1.27		<.001
Child inattention		.03	.04	.10 (.01)	.521
Child motor hyperactivity		-.07	.03	-.35 (.12)	.015
Child verbal hyperactivity		.02	.08	.03 (.00)	.831
Outcome: teacher corrective feedback	.28				<.001
Constant		2.96	1.40		.039
Child inattention		.04	.04	.13 (.02)	.348
Child motor hyperactivity		-.05	.03	-.21 (.05)	.092
Child verbal hyperactivity		.30	.09	.47 (.22)	<.001

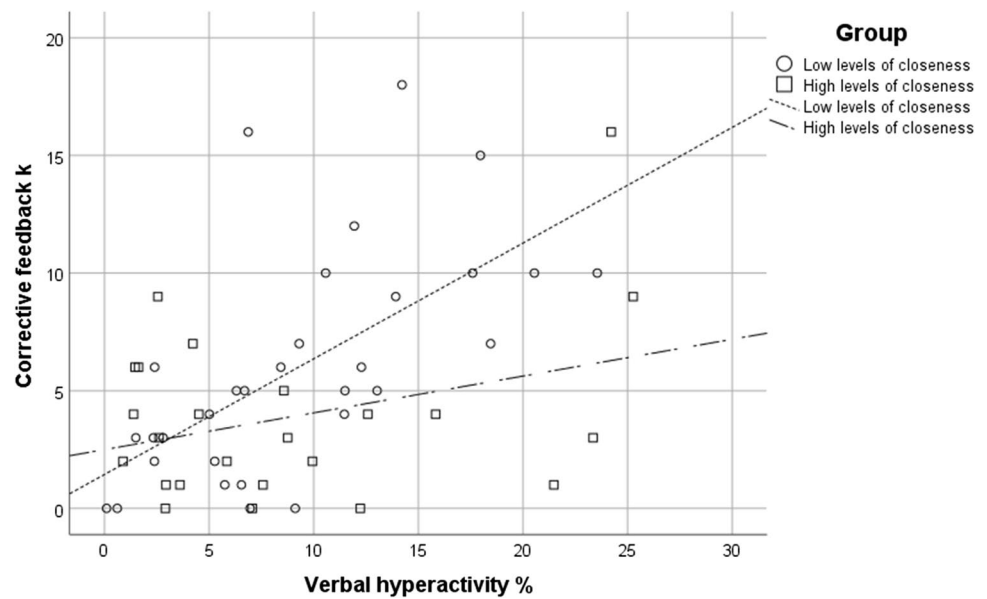
**Table 5** Results of the significant moderation analyses examining conflict and closeness as moderators between child behavior and teacher feedback in the ADHD group

Model	R <sup>2</sup> total model	B	SE B	β (r <sup>2</sup> )	p
Outcome: teacher corrective feedback	.38				<.001
Constant		4.95	.50		<.001
Child inattention		.02	.04	.08 (.01)	.560
Child motor hyperactivity		-.04	.03	-.17 (.03)	.183
Child verbal hyperactivity		.35	.09	.54 (.29)	<.001
Closeness		-1.25	.69	-.22 (.05)	.075
Child verbal hyperactivity * closeness		-.300	.12	-.28 (.08)	.019*

\*Significant after correction for multiple testing



**Fig. 1** Scatterplot of the association between corrective feedback and verbal hyperactivity for children in the ADHD group characterized by low and high levels of closeness in the teacher–student relationship. Note.  $k$  = count



levels of closeness, corrective feedback was not significantly related to levels of verbal hyperactivity ( $B = .16$ ,  $SE = .09$ ,  $p = .112$ ). Full results of the moderation analysis are provided in Supplementary Material S3 (Table C).

## Discussion

The current study utilized masked classroom observations to investigate positive and corrective teacher feedback toward children with ADHD and typically developing children, the extent to which different types feedback were related to inattentive and hyperactive behaviors, and investigated whether the quality of the teacher–student relationship moderated these associations. Children in the ADHD group received more corrective feedback than children in the TDC group. Findings suggested that levels of positive feedback in the ADHD group were also higher than the TDC group, but these findings were less conclusive. While typically developing children received more positive than corrective feedback, this pattern was reversed for children with ADHD. In the ADHD group, lower levels of positive feedback were associated with higher levels of motor hyperactivity, while higher levels of corrective feedback were associated with more verbal hyperactivity. Closeness in the teacher–student relationship moderated the association between teacher’s use of corrective feedback and verbal hyperactivity: Only for children whom teachers reported to experience low levels of closeness, higher levels of corrective feedback were related to levels of verbal hyperactivity. None of the other moderation analyses were significant.

## Teacher Behavior Toward Children with ADHD and Typically Developing Children

Our findings showed clear differences in teacher feedback toward children with ADHD compared to typically developing children, which is in contrast with earlier findings based on teacher’s self-report (Gaastra et al., 2020). For typically developing children, teachers in this study met the optimal ratio of at least three positive responses to one corrective response (Rathel et al., 2014; Shores et al., 1993), while for children with ADHD a different pattern emerged. These children received 30% more corrective than positive feedback, with up to five times more corrective feedback than their peers.

While high levels of corrective feedback are in general seen as negative for children, the implications of corrective feedback for children’s development are actually less clear. There are studies showing that higher levels of corrective feedback result in negative outcomes in terms of motivation and behavioral functioning (e.g., compliance, frustration tolerance) for both children and teachers (Driscoll & Pianta, 2010; Hamre & Pianta, 2001). Further, the use of corrective feedback in response to behavior of children with ADHD may not be effective in reducing inattention and verbal hyperactivity (Clunies-Ross et al., 2008; Leflot et al., 2010). However, there is also ample evidence that corrective feedback to non-desired behavior can be important, as it communicates teacher expectations and, when done well, can serve to prevent accidental reinforcement of this behavior (e.g., peer responses or adult negative attention in response to talking out loud) (Hattie & Timperley, 2007). Appropriately delivered corrective feedback is described as a teacher response that contains a

brief description of the alternative desired behavior and is delivered with a neutral tone of voice (Owens et al., 2018; Reinke et al., 2013). A study by Owens et al. (2018), for example, showed that appropriately delivered corrective feedback is more effective on reducing rule violations of children with ADHD than non-appropriate corrective feedback. In our study, the tone of voice of corrective feedback was mostly neutral, which may suggest that this could have contributed to reducing verbal hyperactivity. However, as we have not coded the content of the feedback, future studies differentiating between the quality of corrective feedback are needed to gain insight in whether the current findings can be interpreted as positive or negative. Also coding the quality of positive feedback (i.e., vague versus specific, indirect versus direct) might be considered as potential future direction. Furthermore, future research should study causal and longitudinal relations between child and teacher behavior to gain insight whether the teacher's use of corrective as well as positive feedback influence the coercive cycle between child and teacher (Nelson & Roberts, 2000; Reinke et al., 2016; Sutherland & Oswald, 2005).

In our study, the two types of teacher feedback were related to different types of child behaviors in the ADHD group. Teacher behavior was related to levels of motor and verbal hyperactivity of children with ADHD, but to a lesser extent to levels of inattentive behavior. The significant relation between corrective feedback and verbal hyperactivity was in line with previous studies (Beaman & Wheldall, 2000; Clunies-Ross et al., 2008), and may tentatively suggest that teachers use corrective strategies (i.e., either intentionally or unintentionally) to control hyperactive behavior. Lower levels of positive feedback were associated with higher levels of motor hyperactivity. As verbal hyperactivity such as talking out loud or not waiting a turn in the classroom disrupts ongoing lessons, it is possible that this is likely to evoke more corrective teacher responses than motor hyperactivity such as swinging in the chair (Myers & Pianta, 2008). On the other hand, corrective feedback by the teacher may reinforce (i.e., receiving teacher's attention) verbal hyperactive behavior (Driscoll & Pianta, 2010; Myers & Pianta, 2008; Patterson, 1982). Furthermore, although levels of inattentive behavior were much higher in the ADHD group than in the TDC group, teachers' feedback was not related to the level of inattention in the ADHD group. Although the absence of significant effects must be interpreted with caution, this may indicate that teachers did not notice and/or were less responsive to inattentive behavior, which raises the question whether teachers provide sufficient support to these children in the classroom. Studies examining causal relationships may provide further insights into transactional relationships between teacher feedback and child behaviors in order to interpret obtained associations.

## The Moderating Role of the Teacher–Student Relationship

Our hypothesis that the quality of the teacher–student relationship might influence the association between levels of teacher feedback and behavioral problems was only partly affirmed (Chang & Davis, 2009; Myers & Pianta, 2008). Levels of closeness in the teacher–student relationship influenced the relation between corrective feedback and verbal hyperactivity. For children whom teachers reported to have warm and affectionate relationships, corrective feedback was not related to levels of verbal hyperactivity, while these associations were found for children of whom the teacher experienced low levels of warmth and affection. Negative attitudes about ADHD, such as viewing the child itself as problematic (e.g., defiant) rather than realizing that he/she does not have control over certain behavior and/or situations, can result in negative (i.e., more corrective) teacher behavior and negative mental representations of the child (Chang & Davis, 2009; Glen et al., 2004). Although the mechanism and direction of the association remain unclear, one may suggest that teachers are better able to respond in adaptive ways to hyperactive behavior if mental representations of the child are more positive, such as in a close teacher–student relationship. None of the other moderation analyses was significant. However, it may also be that small effects have remained undetected because of our relatively small sample size. Gaining more insight into the reciprocity of teacher–student interactions as well as the (possible causal) role of the quality of the teacher–student relationship in improving classroom ADHD behavior is of interest for future research and should be studied in larger samples.

## Strengths and Limitations

Because teachers struggle when dealing with ADHD behavior in the classroom, this study aimed to gain insight in relations between teacher feedback and ADHD behaviors of children in order to be able to support both children in their behavior and teachers in their management of behavioral problems of children in the classroom. The use of classroom observations for studying child and teacher behavior is underrepresented in the literature and a strength of the current study. Further, as a substantial amount of children in classrooms show ADHD behaviors, our heterogeneous sample of children with subthreshold and full threshold ADHD is representative for regular primary education. In interpreting our findings, it is important to also acknowledge the limitations of our study. First, as this was a cross-sectional study, we were not able to conclude on the causality of child and teacher behavior, limiting the possibilities to gain insight in the development of (coercive) interaction patterns. Second, although teachers were not told beforehand what

specific teacher behavior was observed, they were aware of the camera and observer in the classroom. This may have increased their use of positive feedback and decreased their use of corrective feedback; also tone of voice could be affected. Current findings may therefore overestimate levels of positive feedback and underestimate levels of (harsh) corrective feedback provided by teachers. Nevertheless, teachers still provided more corrective than positive feedback to children with ADHD, emphasizing the importance of increasing positive feedback and decreasing corrective feedback in this group. For children in the TDC group, levels of positive feedback were higher compared to other studies (e.g., Zakszeski et al., 2020). This may be related to teachers selecting a typically developing child, which may have led teachers to select a child they specifically liked. Third, the observational measures were based on a single observation in the classroom. Although single observations were also used in previous studies of teacher–student interactions (e.g., Allen et al., 2013; Reinke et al., 2016), these may not be representative for typical child and/or teacher behavior, as well as interactions. Fourth, although our findings provide useful information for children with ADHD within the school setting, levels of comorbid problems were relatively low which may limit the generalizability of the findings to more severely impaired children with ADHD and comorbid problems (Gillberg et al., 2004).

## Conclusions and Clinical Implications

In conclusion, this study showed that teachers provided more corrective feedback and somewhat more positive feedback to children with ADHD compared to typically developing children. However, while children in the TDC group received up to five times more positive feedback than corrective feedback, this ratio was much lower for children with ADHD. Feedback provided by teachers was related to levels of hyperactive behavior of the child and to a lesser extent to inattentive behavior. Teachers perceived their relationship with children with ADHD as less close and more conflictual, but overall, this was not likely to be related to their behavior toward these children. Only for closeness, it was found that a warm and affectionate relationship with the child may be related to the amount of corrective feedback provided by the teacher when the child shows high levels of verbal hyperactivity.

As teachers seem not aware of their use of corrective feedback and are likely to overestimate their use of positive feedback (Gaastra et al., 2020; Martinussen et al., 2011), these findings stress the importance of teacher training programs for ADHD that focus on the reduction in non-adequate corrective responses to undesirable behavior while increasing positive and adequate corrective responses (DuPaul et al.,

2012). This may be particularly relevant for hyperactive behavior. Teachers may benefit from increasing awareness regarding their decreased use of positive feedback toward children that show higher levels of motor hyperactivity as well as from teaching them other behavioral strategies than corrective feedback to reduce verbal hyperactivity. Furthermore, teachers may benefit from training on how to support attentive behavior of children by providing feedback. This may potentially contribute to higher levels of engagement and, as a result, academic achievement of children (Lei et al., 2018). Finally, increasing closeness in the teacher–student relationship may contribute to improving teacher feedback (Chang & Davis, 2009), and prevent the development of coercive interaction patterns.

Taken together, the findings of the current study provide input for supporting teachers in dealing with classroom ADHD behaviors. Future experimental (causal) studies are recommended to confirm findings and proposed hypotheses.

## Supplementary Material

S1. Group differences on behavioral outcomes as measured with classroom observations in a subsample of groups matched on age and sex.

S2. Correlation matrix of child behavior and teacher feedback in the ADHD group.

S3. Additional results of moderation analyses examining whether conflict and closeness interact with non-significant associations between child behavior and teacher feedback in the ADHD group.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s12310-022-09550-1>.

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**Data Availability** The data that support the findings of this study are available from the corresponding author (AS) upon reasonable request.

## Declarations

**Conflict of interest** The authors have no relevant financial or non-financial interest to disclose.

**Ethics Approval** This study was performed in line with the Dutch legislations and the principles of the Declaration of Helsinki. The Ethics Committee of the University Medical Centre Groningen has confirmed that no ethical approval is required (2016/196).

**Consent to Participate** Informed consent was obtained from all teachers, parents, and children older than 11 years in the study.

**Consent for Publication** Not applicable.

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