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Risky business! Behavioral bias and motivational salience of rule-violations in children with conduct disorder

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ABSTRACT

Conduct disorder is characterized by both habitual aggression as well as non-aggressive rule-breaking behavior. While a large body of research has focused on aggressive behavior to date, the subtype of non-aggressive rule-breaking behavior is poorly understood. The current study represents a first attempt to directly assess decision biases toward rule-breaking behavior, their motivational salience, and the association with interpersonal factors in conduct disorder. Participants (n = 20 children with conduct disorder and n = 20 healthy controls) played a video game with the goal to deliver a hot pizza by bicycle to a marked location on a two-dimensional city map. In each trial, participants decided whether to use the regular route (streets) or opt for a potential shortcut that was either permitted (bicycle lane) or prohibited (park). The efficiency of the shortcut was parametrically varied to assess individual decision functions. Consistent with our hypotheses, group differences emerged only when taking a shortcut represented a rule violation (park condition), with the conduct disorder group committing significantly more rule violations than controls. Furthermore, conduct disorder children showed a substantial frequency of rule violations even in the absence of shortcut related gains, indicating a pronounced insensitivity towards sanctions. Importantly, this tendency was associated with self-reported impulsivity and rule violations in real life.

1. Introduction

Learning to adhere to rules and social norms is a challenge each child wrestles during the course of their development. This crucial part of the socialization process is heavily affected in psychiatric conditions such as conduct disorder, which is characterized by habitual violent and non-violent rule-violating behaviors that exceed the behaviors of normally developing children in both frequency and severity (American Psychiatric Association, 2013). Such severe and chronic conduct problems not only impair social and academic functioning (Kimonis and Frick, 2011), they can also manifest in severe adult outcomes, e.g., substance abuse, antisocial personality disorder, and criminal behavior (Burt et al., 2011; Colman et al., 2009; Fergusson et al., 2007; Odgers et al., 2008; Satterfield et al., 2007).

The symptom presentation in conduct disorder is highly heterogeneous which is why previous research has made attempts to identify meaningful subtypes in order to better understand the underlying etiology.

For instance, there is compelling evidence linking certain affective characteristics (e.g., lack of empathy and callous-unemotional traits) and individual dispositions (e.g., impulsivity), which have been subsumed under the concept of psychopathy, to more severe rule-breaking behavior in children with conduct disorder (Frick et al., 2014; Frick and White, 2008; McCuish et al., 2014). A particularly influential taxonomy differentiates conduct disorder primarily by the age of onset, i.e., early and late onset subtypes (Moffitt, 1993). This taxonomy has since been called into question due to both methodological issues and evidence suggesting that the age of onset distinction confounds the early development of overt deviant behavior, e.g., aggression, and the later development of covert deviant behavior, such as theft (for a review, see Tremblay, 2010). Importantly, recent work has therefore established a taxonomy based on the type of rule-breaking behavior, differentiating between two major categories, namely the aggressive subtype (e.g., getting into physical fights, bullying) and the non-aggressive subtype (e.g., theft, truancy, vandalism; Burt, 2012b; Tackett et al., 2005). A line of research suggests that these two behavioral subtypes have distinct developmental trajectories and likely very different underlying

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etiologies. Aggressive behavior is generally more common during early childhood years and tends to steadily decrease throughout a child's development, while rule-breaking behavior tends to be rare during childhood and peaks in adolescence (Tremblay, 2010). The aggressive and rule-breaking dimensions of clinically relevant conduct problems have also been confirmed using varying methodological approaches (Burt, 2012a; Burt et al., 2011; Hinshaw et al., 1995; Tackett et al., 2005; Tackett et al., 2003). The aggressive subtype in particular has been shown to exhibit a higher stability, higher genetic heritability, as well as a stronger link to impaired executive function and verbal IQ (Burt, 2012a, 2012b; Rohlf et al., 2018; Tremblay, 2010). Non-aggressive or rule-breaking behavior, on the other hand, has been shown not only to have a particularly strong association with impulsivity and stronger ties to delinquent peer affiliation (Burt, 2012b) but also to be particularly predictive of adult antisocial outcomes (Burt et al., 2011; Burt and Hopwood, 2010). Importantly, the severity of rule-breaking behaviors varies to a similar extent as within the aggressive subtype, with illegal and severe behaviors being more rare and clinically relevant than most other forms of rule violation (Burt et al., 2016).

While a large body of research has focused on the etiology of aggressive behavior in particular, surprisingly few studies have been dedicated to non-aggressive rule-breaking behaviors in individuals with conduct problems. When an individual is faced with the decision to break or follow a rule, what are the determinants of the behavioral outcome? In the present paper, we propose a first empirical approach to studying decision-making in the context of non-aggressive rule breaking. Arguably the majority of rule-violating behavior in real-world settings, such as shortcutting, bypassing or ignoring orders, are subsumed under the label of "routine violations" (Reason, 1995, 2000; Runciman and Walton, 2007). While this type of rule violation typically comes with limited but clear benefits, it also has low potential costs for the individual.

Children with conduct problems may be more prone to rule violations for several reasons. For one, conduct disorder has been associated with difficulties in the valuation of the different behavioral consequences in reinforcement based learning and the associated neural structures (White et al., 2013; White et al., 2016). Previous research has also demonstrated that conduct disorder is associated with an altered processing of reward (Ernst et al., 2003; Fairchild et al., 2009; Finger et al., 2011; Schutter et al., 2011) and a reduced sensitivity to aversive stimuli (Gao et al., 2010; Syngelaki et al., 2013; van Goozen, et al.,2004; White et al., 2013). Accounts that highlight impulsivity as a major component of rule breaking in conduct disorder suggest that this group may be particularly vulnerable to the presence of immediate, short-term rewards, which could translate into a stronger incentive for routine violations compared to their normally developing peers (Burt, 2012b). Despite this obvious link between conduct disorder and behavioral proneness to routine violations, no study to date has addressed these questions.

The present study approaches these questions in a sample of children with conduct disorder. For this purpose, we recruited a group of referred children with conduct problems and assessed their preference for rule-based and rule-violating behavior in a naturalistic task based on a real-world scenario representing "routine violations" (Pfister et al., 2018). The participants played a video game with the goal of delivering a hot pizza by bike to a marked location on a two-dimensional city map (Fig. 1). In each trial, the map featured streets around a block of houses. In addition to normal streets, either a bicycle lane or a park ran through each block of houses. Participants were informed that passing through the park was prohibited, whereas the bicycle lanes could be used at leisure. Importantly, the park or lane could be used as a shortcut to the target location, and the amount of time gained or lost by opting for the park or lane rather than the streets was varied parametrically. This allowed for the assessment of decision functions for each participant which indicate the amount of gains required to commit a rule violation. Based on previous research, we hypothesized that children with conduct disorder would exhibit a sustained behavioral proneness to "routine violations" when compared to healthy controls. This proneness should result in more frequent rule violations in the "Park" condition, while both groups should show a similar preference for the shortcut as a function of increasing gains in the "Lane" condition. Furthermore, we were interested in whether children with conduct disorder would show stable tendencies of rule-violating behavior even in the absence of gains, which would be indicative of a perturbed rule representation. This would be reflected in an enhanced frequency of rule violations in the condition in which taking an alternative path yielded neither gains nor losses, and this frequency should exceed the frequency of rule-violation choices in the control group. Finally, we were interested in whether the affinity for rule-violating behavior was associated with real life rule-breaking behaviors, as assessed by a caregiver report, as well as with individual characteristics previously associated with antisocial behavior, such as self-reported aggression and psychopathy.

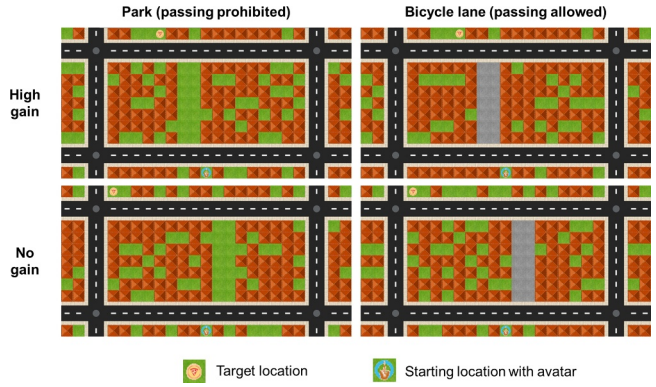

Fig. 1. City maps showing a block of houses, surrounding streets and the park or bicycle lane on the block. The position of the target location as well as the shortcut type (park or lane) were varied systematically to allow for different gains by using the park or lane as shortcuts.

2. Method

2.1. Questionnaires and control measures

2.1.1. Cognitive performance test (Kogntiver Fähigkeitstest; KFT)

We used the Figure Analogies subtest of the KFT (Heller and Perleth, 2000) to assess non-verbal reasoning skills in order to estimate mental ability. The subtest was comprised of 25 items, with sets for each student grade level (4–12) containing increasingly more difficult items (class-level adaptive testing).

2.1.2. Self-report measures

The German versions of the following questionnaires were used: Youth Psychopathic traits Inventory (YPI; Andershed et al., 2002); Buss-Perry Aggression Questionnaire (BPAQ; Buss and Perry, 1992; Herzberg, 2003); Youth Self-Report Child Behavior Checklist 11–18R (YSR; Achenbach, 1991; Döpfner et al., 2014).

2.1.3. Caregiver rating for conduct problems

The caregiver rating scales for conduct problems from the Diagnostic System for Youth and Children Psychiatric Disorders (DISYPS; Döpfner et al., 2008) was employed to measure the severity of conduct problems and was completed by parents or childcare workers who were primarily involved with the supervision of the child in institutional settings. The subscale is tailored to the diagnostic criteria DSM-IV and ICD-10 criteria for conduct disorder and contains a total of 25 items. The items are rated on a Likert scale ranging from 0 to 3, indicating how well each item applies to the child. A mean score of 0.5–1.0 indicates moderate to clinically significant symptom severity,

and scores > 1.0 indicate very severe symptoms (Döpfner et al., 2008). To differentiate between the aggressive and rule-breaking subtypes, two scales were constructed which included behaviors referring to one of the two subtypes (Burt, 2012b; Loeber and Schmaling, 1985; Tackett et al., 2005).

2.2. Participants

Participants with probable conduct disorder were recruited via cooperating institutions for youths with behavioral difficulties and the university's outpatient clinic of the Department for Clinical Psychology and Psychotherapy. Inclusion criteria were: (1) 10–18 years of age, (2) moderate to severe conduct problems as indicated by the parent/guardian rating (DISYPS mean for conduct symptoms > 0.5). Exclusion criteria were: (1) autism-spectrum disorder, (2) mental retardation, (3) insufficient knowledge of the German language. Children referred to the institutions due to conduct problems were contacted by the institution's psychological service. Interested candidates were screened for conduct disorder symptom severity prior to the testing. Out of the 32 interested participants, 27 were eligible to participate with regard to conduct disorder symptom severity criterion. Seven participants were excluded due to outlier performance or performance indicative of inattention or misunderstanding of the task, resulting in a final sample of 20 participants in the conduct disorder group (see Table 1 for demographic and diagnostic details).

The control participants were recruited through advertisements in a local newspaper and from the department's participant pool. Interested participants were selected to match the age range and educational background of the participants in the conduct disorder group. Thus, we included participants who were 10–18 years of age with sufficient knowledge of German, no current psychopathology, and who did not show elevated symptoms of conduct disorder as indicated by the caregiver reports (DISYPS mean for conduct symptoms < 0.5). A total of five participants were excluded due to outlier performance or performance indicative of inattention or misunderstanding of the task, resulting in a final dataset of $n = 20$ controls. All participants as well as their parents/legal guardians gave written informed consent and all participants received reimbursement for participation. The study protocol was approved by the university's ethics review board and was carried out in accordance with the Declaration of Helsinki.

2.3. Procedure

There were two sessions for each individual assessment (90–120 min each). In the first session, the participants first completed two blocks of the experimental paradigm before the administration of the KFT and several self-reported questionnaires. The second assessment consisted of the remaining two blocks of the experimental paradigm as well as self-report measures and an additional experimental task.

2.4. Experimental task

The experimental assessment was conducted on 15.6″ HP Pavillion notebooks. The task consisted of trials depicting a city map through which the participant, represented as an avatar, was able to move by using up/down and left/right arrow keys. The participants were instructed to play a game in which they worked for a pizza delivery company. The goal was to deliver a pizza by bike to a target location as quickly as possible. The participant's starting position was always fixed at the horizontal center at the lower edge of the map, whereas the target location was always on the upper edge of the map. The horizontal position was varied systematically as described below.

There were three types of passable terrain: streets, bicycle lanes, and a public park. Each trial featured either a bicycle lane or a park, which served as potential shortcuts (see Supplementary Figs. 1–3 for animated examples). However, while taking the bike lane was permitted, riding through the park was explicitly prohibited. Different combinations of

Table 1
Demographic and diagnostic sample description.

		CD ($N = 20$)	CTL ($N = 20$)	Statistics
Demographics	Age	13.70 (2.05)	14.10 (2.15)	$t(38) = 0.60$; n.s.; $d = 0.19$
	Females	1	3	$X^2_{(1)} = 1.11$; n.s.; $d = 0.34$
KFT	Total score	19.05 (5.73)	19.10 (4.90)	$t(38) = 0.03$; n.s.; $d = 0.01$
YPI	Grandiose/manipulative	22.20 (10.24)	19.45 (9.05)	$t(38) = 0.90$; n.s.; $d = 0.28$
	Callous/unemotional	20.70 (8.09)	15.60 (6.16)	$t(38) = 2.24$*; $d = 0.71$
	Impulsive/irresponsible	24.60 (7.12)	20.70 (5.65)	$t(38) = 1.92$; n.s.; $d = 0.61$
	Total score	67.50 (18.85)	55.75 (16.96)	$t(38) = 2.07$*; $d = 0.65$
BPAQ	Physical aggression	28.35 (9.13)	19.75 (6.56)	$t_{Welch}(34.50) = 3.42$**; $d = 1.08$
	Verbal aggression	17.75 (4.25)	14.00 (3.74)	$t(38) = 2.96$**; $d = 0.94$
	Anger	17.90 (5.50)	13.40 (4.72)	$t(38) = 2.78$**; $d = 0.88$
	Hostility	26.40 (7.67)	20.50 (4.95)	$t_{Welch}(32.47) = 2.89$**; $d = 0.91$
	Total score	90.40 (23.49)	67.65 (15.22)	$t_{Welch}(32.56) = 3.64$***; $d = 1.15$
CBCL DSM-oriented scales (self-report)	Affective problems	5.35 (3.01)	3.45 (2.70)	$t(38) = 2.10$*; $d = 0.66$
	Anxiety problems	4.05 (3.28)	3.70 (2.74)	$t(38) = 0.36$; n.s.; $d = 0.11$
	Somatic problems	2.90 (2.55)	1.75 (2.27)	$t(38) = 1.51$; n.s.; $d = 0.48$
	Total internalizing score	13.75 (7.73)	9.25 (6.28)	$t(38) = 2.02$*; $d = 0.64$
	ADHD problems	6.35 (3.23)	5.05 (2.72)	$t(38) = 1.38$; n.s.; $d = 0.44$
	Oppositional problems	4.55 (1.80)	2.20 (1.58)	$t(38) = 4.41$***; $d = 1.39$
	Conduct problems	9.30 (5.61)	3.70 (2.50)	$t_{Welch}(26.23) = 4.08$***; $d = 1.29$
	Rule-breaking behaviors	9.05 (5.49)	5.10 (3.13)	$t(38) = 2.80$**; $d = 0.89$
	Aggressive behaviors	12.45 (5.55)	5.65 (3.39)	$t(38) = 4.68$**; $d = 1.48$
	Total externalizing score	21.50 (10.25)	10.75 (5.73)	$t(38) = 4.09$***; $d = 1.29$
	Total score	91.90 (34.31)	57.50 (27.86)	$t(38) = 3.48$***; $d = 1.10$
DISYPS (caregiver report)	Oppositional aggressive	1.56 (0.41)	0.34 (0.24)	$t(38) = 11.63$***; $d = 3.67$
	Dissocial aggressive	0.48 (0.29)	.11 (0.10)	$t_{Welch}(23.41) = 5.47$***; $d = 1.73$
	Rule-breaking subtype	0.63 (0.32)	0.14 (0.14)	$t_{Welch}(26.33) = 6.27$***; $d = 1.98$
	Aggressive subtype	0.54 (0.35)	0.11 (0.12)	$t_{Welch}(23.09) = 5.13$***; $d = 1.62$

Note. The data represented in the table refers to means and standard deviations for each measure (in parentheses). CD = conduct disorder; CTL = healthy controls. KFT = Kognitiver Fähigkeitstest; YPI = Youth psychopathic traits inventory; CBCL = Child behavior checklist; DSM = Diagnostic and Statistical Manual; DISYPS = Diagnostic system for psychiatric disorders (Diagnostik-System für psychische Störungen); BPAQ = Buss-Perry Aggression Questionnaire; *** = significant at $p < 0.001$; ** = significant at $p < 0.01$; * = significant at $p < 0.05$; n.s. = non-significant. In case of unequal variances between groups we reported the Welch-Test with corrected degrees of freedom.

target and shortcut positions resulted in different gains as shown in Supplementary Table 1, with gains ranging from −10 to +16. There were 108 trials in each block, with half of the trials featuring bicycle lanes and half of the trials featuring parks. The frequencies of different combinations for target positions and shortcut positions were predetermined in order to ensure an equal number of trials with potential gains and losses (irrespective of gain or loss magnitude) and an overall sum of possible gains equal to zero (Supplementary Table 2).

Each trial had a 10% chance of featuring a policeman on the bicycle lane or in the park (determined randomly at the beginning of the trial). Passing the policeman while riding in the bicycle lane did not have any effect. In the park condition, however, the policeman reacted to upward movements made by the participants, which triggered a 10 s warning message after which the trial was canceled (see Supplementary Fig. 4).

The entire task was comprised of 432 trials, which were divided into two sessions with two blocks each, in which trials were presented in randomized order. Each session was preceded by detailed instructions and three training trials. To avoid fatigue, participants were prompted to take a break after completing the first half of each block (i.e., 54 trials).

3. Results

3.1. Sample characteristics

The sample characteristics are summarized in Table 1. The conduct disorder group and the control group did not differ with regard to any of the demographic measures or IQ estimate as indicated by the KFT. The conduct disorder group exhibited significantly higher observer ratings for conduct behavior problems as well as higher self-reported internalizing and externalizing symptoms, self-reported aggression, and psychopathy scores.

3.2. Experimental task

Fig. 2 shows the relative frequencies of shortcut choices separately for both groups and all conditions (for detailed descriptive statistics, see Supplementary Table 3). As a first step, we entered the data into an analysis of variance (ANOVA) with the within-subjects factors Shortcut type (park vs. lane) and Gain (−10, −6, −2, 0, 2, 4, 6, 8, 10, 16) as well as the between-subjects factor Group (conduct disorder vs. controls). This analysis yielded significant main effects for the factors Shortcut type, $F(1, 38) = 77.11$, $p < 0.001$, $\eta_p^2 = 0.67$, Gain, $F(9, 342) = 190.38$, $p < 0.001$, $\eta_p^2 = 0.83$, and Group, $F(1, 38) = 9.32$, $p = 0.004$, $\eta_p^2 = 0.91$. Furthermore, significant two-way interactions emerged for Shortcut type × Group, $F(1, 38) = 5.64$, $p = 0.023$, $\eta_p^2 = 0.13$, Shortcut type × Gain, $F(9, 342) = 22.41$, $p < 0.001$, $\eta_p^2 = 0.37$, as well as Group × Gain, $F(9, 342) = 4.84$, $p < 0.001$, $\eta_p^2 = 0.11$. These main effects and interactions were further qualified by a significant three-way interaction Shortcut type × Gain × Group, $F(9, 342) = 2.10$, $p = 0.029$, $\eta_p^2 = 0.05$. To further investigate the three-way interaction, we conducted separate 2 (Group) × 10 (Gain) ANOVAs for the different shortcut types. For the lane condition, only a significant main effect of Gain emerged, $F(9, 342) = 285.15$, $p < 0.001$, $\eta_p^2 = 0.88$, while neither Group nor the Gain × Group interaction reached significance, $ps > 0.199$. Thus, both groups showed a tendency to prefer the shortcut as a function of increasing gains. For the park condition, by contrast (i.e., when taking the shortcut represented a rule violation), the analysis yielded significant main effects of Gain, $F(9, 342) = 45.16$, $p < 0.001$, $\eta_p^2 = 0.54$, and Group, $F(1, 38) = 9.31$, $p = 0.004$, $\eta_p^2 = 0.20$, which were further qualified by a Gain × Group interaction, $F(9, 342) = 4.81$, $p < 0.001$, $\eta_p^2 = 0.11$. Taken together, this indicates that while both groups show an enhanced tendency to take the shortcut with increasing gains, the participants of the control group required significantly higher incentives (i.e., gains) when the shortcut represented a rule violation.

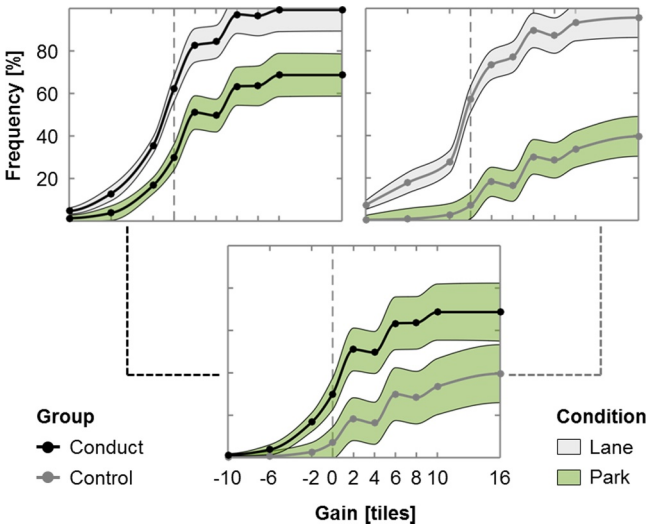

Fig. 2. Relative frequencies of park and lane choices as a function for the conduct disorder group (upper left panel) and the control group (upper right panel), as well as a direct comparison of the park conditions between both groups (lower panel). Shaded areas represent standard errors of paired differences (SE_{PD}; upper panels) or standard errors of between-group differences around the average frequencies (SE_D; lower panel; cf. Pfister and Janczyk, 2013).

To investigate whether children with conduct disorder indeed exhibited a disturbed representation of rules, we conducted additional analyses of the choice frequencies in the zero gain condition, i.e., when the shortcut and the regular path were equally long. We entered the frequencies to take these "shortcuts" in a 2 (Group) × 2 (Condition) ANOVA, which yielded a significant effect of Shortcut type, $F(1, 38) = 90.85$, $p < 0.001$, $\eta_p^2 = 0.70$, and Group, $F(1, 38) = 4.78$, $p = 0.035$, $\eta_p^2 = 0.11$, as well as a significant interaction, $F(1, 38) = 4.32$, $p = 0.044$, $\eta_p^2 = 0.10$. Post-hoc t-tests revealed that the groups differed significantly in the Park condition, $t(38) = 3.10$, $p < 0.001$, $d_Z = 0.98$, but not in the Lane condition, $t(38) = 0.64$, $p = 0.528$, $d_Z = 0.20$.[1] Finally, we computed additional one sample t-tests in order to investigate whether the tendency for rule violations in the zero gain condition differed from chance level (0.5) and from 0 in each group. This analysis yielded significant differences for both groups (Controls: $M = 0.07$, $SD = 0.160$; $t(19) = 12.10$, $p < 0.001$, $d_Z = 2.70$; Conduct Disorder: $M = 0.30$, $SD = 0.29$; $t(19) = 3.03$, $p < 0.007$ $d_Z = 0.67$) when comparing the violation frequency to chance. When further testing the mean frequency against zero, we only observed a small and non-significant effect for the control group $t(19) = 1.96$, $p = 0.065$, $d_z = 0.37$, but a large effect for children with conduct disorder, $t(19) = 4.57$, $p < 0.001$, $d_z = 1.34$ (note that these latter test results of both groups are biased by the fact that any random deviation from the test value of 0 is positive in this case).

[1] The sphericity assumption of repeated-measures ANOVA was violated for all analyses involving the factor gain as indicated by Mauchly's test of sphericity. Correcting the p-value according to the method of Greenhouse-Geisser did not affect the results for the analysis of the lane condition ($\varepsilon = 0.362$; Gain: $p < 0.001$, Gain × Group: $p = 0.253$) or park condition ($\varepsilon = 0.189$; Gain: $p < 0.001$, Gain × Group: $p = 0.015$). In the omnibus analysis, only the three-way interaction failed to reach significance ($\varepsilon = 0.240$, $p = 0.126$). To validate whether separate analyses of the two shortcut conditions were still justified, we re-analyzed the data using linear mixed-effects modelling (running the lme4-package 1.1–13 in R). This analysis replicated our initial results by suggesting the three-way interaction to be reliable, $X^2(1) = 29.43$, $p < 0.001$.

Table 2
Correlation between the affinity toward rule breaking and clinical scales.

		D_{0gain}	
Measures		Conduct disorder (N = 20)	Controls (N = 20)
DISYPS	Rule-breaking behaviors	−0.51*	0.02
	Aggressive behaviors	−0.10	0.17
CBCL	Rule-breaking behaviors	−0.13	−0.18
	Aggressive behaviors	−0.15	−0.35
YPI	Grandiose/manipulative	−0.39	−0.05
	Callous/unemotional	0.26	−0.21
	Impulsive/irresponsible	−0.52*	−0.31
	Total score	−0.30	−0.21

Note. The data represented in the table refers to bivariate correlations between the indicated measures for the conduct disorder and the control group. D_{0gain} = difference score for the frequency to take the shortcut when the gains equaled zero between the park and lane shortcut type ($D_{0gain} = F_{lane} - F_{park}$), with positive values indicating a preference for the rule-based shortcut type; CBCL = Child behavior checklist, self-report; DISYPS = Diagnostic system for psychiatric disorders (Diagnostik-System für psychische Störungen), caregiver report; YPI = Youth psychopathic traits inventory; *** = significant at $p < 0.001$; ** = significant at $p < 0.01$; * = significant at $p < 0.05$.

3.3. Association with individual traits

As a next step, we investigated the association between measures assessed by both self-reports and caregiver reports with an index to capture the individual affinity for rule-breaking behavior. For this purpose, we first calculated a difference score for the frequency of taking a shortcut when the gains equaled zero between the park and lane shortcut type ($D_{0gain} = F_{lane} - F_{park}$), with positive values indicating a higher frequency of using the rule-based shortcut and negative values indicating a higher frequency of using the rule-violating shortcut. We then computed bivariate correlations between the difference score and self-reported psychopathy, aggressive, and rule-breaking behaviors, as well as the caregiver-reported aggressive and rule-breaking behaviors as detailed in Table 2. For the conduct disorder group, this analysis yielded significant correlations between the proneness to rule violations in the experimental task and caregiver-reported rule-breaking behavior, as well as self-reported impulsivity. No significant correlations were observed for the control group.

4. Discussion

The present study investigated non-aggressive rule-breaking behavior in children with conduct disorder. We asked whether children with conduct disorder exhibited a decision bias toward rule-breaking behavior, and a potential proneness to rule violations even in the absence of external incentives. Furthermore, we were interested in whether this tendency was associated with key constructs identified by previous research, such as the subtypes of conduct disorder (aggressive vs. non-aggressive) and psychopathy. To approach these questions, we had control children and children with conduct disorder perform a task in which they had the option of using rule-conform and forbidden shortcuts to expedite task performance. The results of the study can be summarized as follows: (1) Consistent with our hypotheses, group differences emerged only in the condition in which taking a shortcut represented a rule violation, with the conduct disorder group committing significantly more rule violations than controls. Both groups performed similarly on rule-based shortcuts. (2) When compared to controls, this behavioral tendency was evident even when taking a shortcut did not yield any benefits and was of objectively equal length compared to the regular path. However, the frequency of rule-violating behavior was significantly below chance level even for children with conduct problems. (3) Preliminary results of the correlation analyses revealed that the affinity toward rule violations in the conduct disorder group was linked to caregiver-reported rule breaking, but not aggressive symptoms, as well as self-reported impulsivity.

The current study is the first to directly assess the behavioral tendency to violate rules using a realistic scenario in children with conduct disorder. Our data shows that children with conduct disorder exhibit a behavioral bias toward routine rule violations as compared to their healthy peers. These results are in accordance with previous research documenting an increased affinity to make risky choices in children with conduct disorder, psychopathy, and externalizing problems (Ernst et al., 2003; Fairchild et al., 2009; Finger et al., 2011; Schutter et al., 2011). The current study extends the findings reported in literature on decision-making by showing not only that this affinity refers to risks associated with the probability to receive incentives, but also that rule-violation is prevalent in children with conduct disorder even in the absence of external rewards.

What could underlie this proneness to risky behavioral choices in general and rule violations in particular? One possible explanation is that this may be rooted not only in a greater sensitivity to rewards but also in a reduced responsiveness to punishment information, which has been demonstrated in children with conduct disorder (Frick et al., 2014; Frick and White, 2008) and is consistent with neuroimaging work linking conduct disorder to impaired representations of reinforcement values and error signaling (Finger et al., 2011; Finger et al., 2008; Noordermeer et al., 2016; Rubia et al., 2009; White et al., 2013; White et al., 2016). Because the zero-gain condition in the current study lacked a clear incentive but still yielded substantial group differences, it is more likely that the enhanced tendency to break rules in children with conduct problems is due to an inadequate representation of punishment information rather than reward sensitivity. Future studies that manipulate and assess punishment salience in similar paradigms are needed in order to determine whether this may be a determining factor.

Another possible explanation for the proneness to rule-breaking behavior could be rooted in an impairment of rule representations. However, the analyses of the zero-gain condition indicated that the frequency of rule violations was significantly lower than 50%, i.e., chance level which would be compatible with a lacking representation of the rule. In other words, children with conduct disorder are clearly aware of which behavior is described by a rule and this rule representation guides their decision making. Furthermore, children with conduct disorder adapted their behavior to the framing as well as the magnitude of the gains, indicating that they understood both the contingencies and the rules of the game. Previous studies have shown that rule violations are associated with a cognitive conflict in healthy adult individuals, requiring effort to override even the most arbitrary rule (Jusyte et al., 2017; Pfister et al., 2016a; Pfister et al., 2016b; Wirth et al., 2016). Interestingly, convicted criminals with a history of habitual rule-breaking behavior show less cognitive conflict during rule violations than control participants without a criminal history, which is indicative of a perturbed cognitive rule representation (Jusyte et al., 2017). However, the findings of the current study (including additional results from a separate experimental paradigm to be reported in a

separate publication) do not suggest this mechanism to be in place in juvenile populations with conduct problems. On a speculative note, the dissociation between adult and child populations could be due to habituation processes which may develop as the frequency and severity of rule-breaking behaviors increase. Future studies on rule representations across the developmental course of antisocial populations are needed to clarify whether this may be an underlying mechanism.

The observation that the conduct disorder group exhibited a non-zero frequency of rule violations even in the absence of any incentives may also suggest that another mechanism could be at work. Following an influential taxonomy from cognitive psychology, violations are not always motivated by external incentives but may also come with an inherent reward value for specific persons in specific situations. Such "optimizing violations" (Reason, 1995,2000) are performed "for the kick", because violating a rule is perceived as exciting, rendering a boring task more thrilling (Gao et al., 2017; Lawton et al., 1997). Children with conduct disorder may be especially prone to these behaviors due to an enhanced impulsivity and reward sensitivity. Interestingly, our preliminary correlational analyses also show associations between the proneness to rule violations and self-reported impulsivity as well as caregiver-reported non-violent rule-breaking behaviors in the conduct disorder group. In line with these findings, previous research has documented a link between impulsivity and risky behavior (Dahlen and White, 2006; Machin and Sankey, 2008) as well as non-violent rule-violations (Burt, 2012a). This indicates for one, that the behavior assessed in the current decision making task may be relevant to rule-breaking behavior in real-world settings. Furthermore, this also shows that impulsivity is an important individual trait that may moderate rule-breaking behavior by, for instance, introducing a larger variability to decision-making, which, in the context of this task, leads to more rule breaking in the zero-gain condition. However, these explanations are speculative and the results of the correlation analysis must be interpreted with caution due to the limited sample size. A targeted assessment of this speculation would also require measuring affective responses to rule violations either via self-report or via implicit assessment of affective facets of rule-violating behavior (Wirth et al., 2018). Furthermore, future studies are needed in order to determine whether and to which extent impulsivity may be a crucial trait underlying objective rule-breaking behaviors.

Despite several positive features, such as an innovative study design, objective assessment of rule-breaking behavior, and external validation using caregiver reports, it is important to note that the current study comes with several limitations. First, the current sample was predominantly male, mirroring common gender differences in the prevalence of conduct disorder (Eme and Kavanaugh, 1995; Loeber et al., 2009), and it remains to be determined whether gender differences may play a role in the proneness to routine as well as optimizing rule violations. Furthermore, rule-breaking behavior and impulsivity are also common characteristics of other psychiatric conditions, such as ADHD, bipolar disorder, or emotional instability. Future studies are needed in order to investigate whether the results observed in the current study generalize to the externalizing behavior spectrum or may be specific to conduct disorder.

Taken together, our findings represent a first step to delineate the behavioral and motivational factors that underlie habitual rule breaking in conduct disorder using an implicit experimental approach. The preliminary findings indicate that children with conduct disorder exhibit a behavioral bias toward routine violations, which holds even when they are not associated with any incentives. Importantly, this tendency was associated with rule-violating behavior in real life and self-reported impulsivity. The current study represents a novel approach to assess objective markers of rule breaking that are relevant to real-world behavior. This approach has the potential to pinpoint the specific mechanisms that drive habitual rule breaking, which could then be utilized not only for diagnostic purposes but also to develop targeted programs for children with conduct disorder by training and incentivizing rule-abiding behavior and aiding in the acquisition of inhibitory control.

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Conflict of interest

None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2018.11.001.

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