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Identifying Cognitive Predictors of Reactive and Proactive Aggression

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The aim of this study was to identify implicit cognitive predictors of aggressive behavior. Specifically, the predictive value of an attentional bias for aggressive stimuli and automatic association of the self and aggression was examined for reactive and proactive aggressive behavior in a non-clinical sample (N = 90). An Emotional Stroop Task was used to measure an attentional bias. With an idiographic Single-Target Implicit Association Test, automatic associations were assessed between words referring to the self (e.g., the participants' name) and words referring to aggression (e.g., fighting). The Taylor Aggression Paradigm (TAP) was used to measure reactive and proactive aggressive behavior. Furthermore, self-reported aggressiveness was assessed with the Reactive Proactive Aggression Questionnaire (RPQ). Results showed that heightened attentional interference for aggressive words significantly predicted more reactive aggression, while lower attentional bias towards aggressive words predicted higher levels of proactive aggression. A stronger self-aggression association resulted in more proactive aggression, but not reactive aggression. Self-reports on aggression did not additionally predict behavioral aggression. This implies that the cognitive tests employed in our study have the potential to discriminate between reactive and proactive aggression. Aggr. Behav. 41:51–64 2015.

Keywords: reactive aggression; proactive aggression; cognitive predictors; automatic processes; Taylor Aggression Paradigm

INTRODUCTION

Aggression can be defined as any behavior that is carried out to another individual with the intention to cause harm. The perpetrator must believe that his/her actions will cause harm to others and the target must be motivated to avoid the behavior (e.g., Bushman & Anderson, 2001). Aggression is often divided into two subtypes, namely reactive/hostile aggression and proactive/instrumental aggression. Reactive or hostile aggression is defined as impulsive, driven by anger, and occurring as a reaction to provocation. In contrast, proactive or instrumental aggression is seen as planned aggression used to obtain a goal, occurring without any provocation (Anderson & Bushman, 2002). A strict distinction between reactive and proactive aggression has been criticized because of the difficulty in distinguishing the two types of aggression in real-life, and the finding that many people engage in both types of aggression. This led to the view of reactive and proactive aggression being (often highly correlated) dimensions rather than distinct

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categories (Poulin & Boivin, 2000). Previous studies have found that both aggression types display unique correlations with many behavioral, psychopathological, and etiological concepts (see Cima & Raine, 2009; Raine et al., 2006 for an overview), which indicates that distinguishing reactive from proactive aggression is important. Therefore, the aim of this study is to examine cognitive predictors of reactive versus proactive aggressive behavior based upon the Social Information Processing (SIP) model (Crick & Dodge, 1994).

Models on Social Information Processing and Aggression

Several theoretical models on social information processing propose that aggressive behavior is the result of (biases in) automatic cognitive processes (Anderson & Bushman, 2002; Crick & Dodge, 1994; Strack & Deutsch, 2004). According to the General Aggression Model (Anderson & Bushman, 2002), which is an integrative framework of existing theories on aggression, aggressive behavior is a product of an episodic cycle. In this model, the present internal state influences complex information processing mechanisms, which range from automatic to controlled. This results in impulsive or thoughtful action (Anderson & Bushman, 2002). Gawronski and Bodenhausen (2006) state that explicit self-reports assess the controlled process. It is assumed that implicit measures, such as the Implicit Association Task (IAT) (Greenwald, McGhee, & Schwartz, 1998) would mostly measure the automatic processes, although recent insights showed them to be partly influenced by controlled processes too (Conrey, Sherman, Gawronski, Hugenberg, & Groom, 2005). More recently, research on the role of implicit measures in understanding aggression has been increasing (e.g., Richetin & Richardson, 2008; Todorov & Bargh, 2002). Several types of implicit measures have been used to study underlying automatic processes of aggression, for example word completion tasks (DeWall & Bushman, 2009), lexical decision tasks (Lindsay & Anderson, 2000), and IAT measures (Saleem & Anderson, 2013).

According to the Social Processing Model (SIP; Crick & Dodge, 1994), which includes both automatic as well as controlled processes, mental processing of social cues follows six different steps. In the first step, the cues are encountered. During the second step, interpretation of these social cues occurs. In steps 3 and 4, goals are selected and possible actions are retrieved from memory. During step 5, these possible actions are evaluated and eventually, in step 6, one is selected. Crick and Dodge, (1996) state that biased or deficient processing during one of these steps can lead to aggressive behavior. Given that the bimodal differentiation of reactive versus proactive aggression is based on distinct intrinsic motivations for aggressive behavior (Raine et al., 2006), it is highly likely that both are steered by different cognitive processes too. Indeed, some information processing deficits such as a hostile interpretation style were already established as a unique correlate of reactive aggression (Crick & Dodge, 1996; Lobbestael, Cima, & Arntz, 2013). Specifically, it was suggested that reactive aggression would be related to biases in earlier stages of the SIP model, while biases in later SIP stages would be related to proactive aggression (Dodge, 1991). The current study therefore assessed the relation between one implicit measure indicative of a bias in early SIP processing (attentional bias) and one implicit measure indicative of disturbed later SIP phases (self-aggression association) on the one hand, and reactive and proactive aggression on the other hand.

Attention and Aggression

When encoding a social situation during this first stage of information processing, an attentional bias, which is the tendency to focus selectively on threatening information, can automatically occur. In research on patients with anxiety disorders, a large amount of evidence exists on the relation between an automatic attentional bias towards threat and anxiety symptoms (for a review, see Mogg & Bradley, 1998). In the field of aggression, some studies confirm that specific populations (i.e., batterers, violent offenders, and aggressive undergraduates) indeed show an automatic attentional bias for aggressive than to non-aggressive words (Chan, Raine, & Lee, 2010; Smith & Waterman, 2004). However, the number of studies on a possible relation between an attentional bias (measured by some type of a reaction time task) towards aggressive words as an individual difference variable and aggressive behavior as a continuous variable in a non-clinical sample is still limited (e.g., Krahe et al., 2011; Reidy, Zeichner, & Foster, 2009; Smith & Waterman, 2005).

Automatic Associations

An automatic association between the self and aggression is probably reflective of bias in the fourth response accessibility step of the SIP model because it is likely to indicate a limited, aggression-related response repertoire. This aggressive response repertoire embedded itself in long-term memory (Crick & Dodge, 1996). Associations between the self and aggression were mostly assessed with (variants of) the Implicit Association Task (Greenwald et al., 1998). Only a few studies exist on the relation between aggressive behavior and the association between the self and aggression (see this issue). Grumm, Hein, and Fingerle (2011) found that a stronger self-aggression association predicted higher scores on an aggressive behavior paradigm in children.

A study of Bluemke and Friese (2012) examined whether both an implicit measure and explicit measure predicted the number of emotionally disturbing pictures chosen by the participant to show to a fellow student. They found that the interaction of the automatic association between the self and aggression with an explicit measure of aggression predicted aggressive behavior. Furthermore, an automatic self-anger association was found in antisocial patients after an anger induction (Lobbestael, Arntz, Cima, & Chakhssi, 2009). Note that the (ST-)IAT has been found to be confounded by several contaminants such as cognitive skills (De Houwer et al., 2009), so that it might not exclusively measure automatic associations. However, these studies encourage further research on the possible predictive role of automatic associations between the self and aggression for aggressive behavior in a non-clinical sample of adults.

Cognitive Predictors of Aggression

Although previous research has demonstrated a relation between both an attentional bias towards aggressive stimuli and a self-aggression association on the one hand and aggressive behavior on the other (e.g., Chan et al., 2010; Grumm et al., 2011; Smith & Waterman, 2004), these studies have several limitations. First, they were mainly conducted in specific populations showing aggressive behavior. Since aggressiveness is a continuous concept, it would also be of interest to examine the relation of automatic processes and aggressive behavior in a non-clinical sample showing divergent levels of aggressive behavior. Second, with the exception of Chan et al. (2010), previous studies on the relationship between cognitive predictors and aggressive behavior could not differentiate reactive from proactive aggression. Third, to our best knowledge, the current study would be the first to simultaneously compare the predictive value of both early- and later-stage information processing biases.

The aim of the current study was to examine whether attentional interference by aggression-related stimuli and an automatic association between the self and aggression could predict aggressive behavior in male adults of a non-clinical population. Following Dodge (1991) it was expected that heightened attention towards aggressive words would predict higher levels of reactive aggressive behavior (cf. Chan et al., 2010). In contrast, we expected stronger self-aggression associations to be related to proactive aggression. Also, it was hypothesized that the self-reported aggression would not have additional predictive value over the implicit cognitive tasks in predicting aggressive behavior. Furthermore, we tested whether the cognitive tasks would add predictive value over and above self-reported aggression. Finally, because previous studies showed that an increase in age is associated with a decrease in aggression (for an overview, see Tremblay, 2000), the current study also included age as a predictor of aggression.

METHODS

Participants

In this study, 98 Dutch-speaking men ($M_{\text{age}} = 27.1$, $SD_{\text{age}} = 10.5$, age range: 18–54 years) of a non-clinical population participated in exchange for study credits or gift cheques of € 20,−. Only men were included, given gender differences in aggressive behavior with men more often showing physical aggression, while there are no appreciable differences in indirect aggression for adult samples (Archer, 2004). To enhance ecological validity, both students ($N = 70$) and non-students ($N = 28$) were recruited. Participants were recruited with the usage of posters, flyers, and social media. Some participants were contacted from a list of persons who had participated in previous studies at Maastricht University and were willing to participate in other studies.

Sample reduction. The manipulation check showed that 8 out of the 98 participants expressed some doubts about the cover story. These 8 participants were evenly distributed among the 6 conditions (condition 1 = 1 participant, condition 2 = 2 participants, condition 3 = 3 participants, condition 4 = 2 participants, condition 5 = 0 participants, condition 6 = 0 participants; $\chi^2(5, N = 98) = 4.91$, $p > .10$). Since these patients did not believe the cover story, they were excluded from the analyses, leaving a sample of 90 participants. Another four participants reported to be colorblind and were not included in the analyses, because of the colors of the words used in the Emotional Stroop. Furthermore, due to some technical problems in the Emotional Stroop and the ST-IAT, data of three participants were not complete and also excluded. These participants were also excluded. The total number of participants included in the regression analyses is 83.

MATERIALS

Emotional Stroop Task

Attentional interference, or the tendency to get distracted by the valence of stimuli, was measured with the Emotional Stroop Task. Participants were presented with neutral (e.g., train), negative (e.g., lonely), positive (e.g., happy), and aggression-related (e.g., violence) words in color red, yellow, green, or blue (see Table I) in the center of a computer screen. Stimuli were presented in a block-design and all participants

TABLE I. Stimuli of the Emotional Stroop

Neutral	Aggressive	Negative	Positive
Mand *basket*	Woede *rage*	Eenzaam *lonely*	Aardig *kind*
Sleutel *key*	Boos *mad*	Benauwd *worried*	Leuk *nice*
Lamp *lamp*	Aanval *attack*	Slecht *bad*	Slim *smart*
Telefoon *telephone*	Geweld *violence*	Vies *dirty*	Pret *fun*
Kat *cat*	Dolk *dagger*	Angstig *anxious*	Eerlijk *honest*
Kleding *clothes*	Conflict *conflict*	Eng *scary*	Levendig *lively*
Handdoek *towel*	Kwaad *angry*	Somber *sad*	Teder *gently*
Struik *bush*	Haat *hate*	Suf *dull*	Kalm *calm*
Trein *train*	Ruzie *quarrel*	Stom *stupid*	Schitterend *brilliant*
Keuken *kitchen*	Gevecht *fight*	Sloom *slow*	Rein *pure*
Oven *oven*	Vijand *enemy*	Ziekte *disease*	Vrolijk *cheerful*
Vloer *floor*	Wraak *revenge*	Angst *anxiety*	Blij *happy*
Bakker *baker*	Vechtpartij *hassle*	Gepieker *rumination*	Lach *smile*
Paraplu *umbrella*	Bedreiging *threat*	Pech *failure*	Tolerant *tolerant*
Radio *radio*	Mes *knife*	Goor *frowsy*	Blijdschap *happiness*
Schilderij *painting*	Woest *frantic*	Verloren *lost*	Vrede *peace*
Melk *milk*	Geweer *gun*	Verdrietig *sad*	Vriendschap *friendship*
Boot *boat*	Vijandig *hostile*	Vervelend *annoying*	Opgewekt *animated*
Potlood *pencil*	Discussie *discussion*	Bezorgd *worried*	Grappig *funny*
Laars *boot*	Moord *murder*	Gezeur *bother*	Groots *grand*

received the same block order (respectively neutral, negative, aggressive, and positive). A block-wise design was chosen over a trial-wise design, since research has shown that "pure" blocks elicit larger effects than mixed blocks, which are more prone to carry-over effects of previous trials (Holle, Neely, & Heimberg, 1997; Richards, French, Johnson, Naparstek, & Williams, 1992). The order of the blocks within the task was not counterbalanced or randomized, since we were interest in whether the scores on the overall task could predict aggressive behavior. Words were equal in their frequency of use in the Dutch language in order to eliminate any possible frequency-effect on reaction time. The task started with eight practice trials using neutral words, each presented in one of the four colors twice. Participants were asked to push a button that corresponded with the color of the shown word as quickly as possible. A fixation cross of 1000 ms appeared in the center of the screen before each trial. Each block consisted of 20 words, which were all presented once to the participant in random order. The total task consisted of 88 trials and lasted 10 minutes.

Calculation of bias scores. Reaction times were recorded for each participant. Mean reaction times were calculated for each of the four categories of words (neutral, negative, positive, and aggressive). To compute a specific aggressive bias score, the mean reaction time in the negative category was subtracted from the mean reaction time of the aggressive category ($M_{\text{aggressive}}$–M_{negative}). Interference of aggressive words in comparison with negative words was reflected by a positive score, while facilitation to react to aggressive words was reflected by a negative score. This specific attentional bias score for aggressive words was used in the regression models.

Single-Target Implicit Association Task (ST-IAT)

To measure the automatic association between the self and aggression, an adapted version of the IAT (Karpinski & Steinman, 2006) was used. An idiographic version of the ST-IAT was chosen, since research has been shown that this assesses self-related associations to a stronger degree than using generic stimuli (Bluemke & Friese, 2012). In this idiographic self-aggression ST-IAT, words were presented in the middle of a computer screen, belonging to the target category or one of the two attribute categories at the top corners of the screen. The target category was "I" (with e.g., participant's first name), and the attribute categories were "aggressive" (with aggressive verbs such as "fighting") and "peaceful" (with peaceful verbs such as "cooperate", see Table II). The participant was asked to categorize these words into the correct category as fast as possible by pushing the left or right response key. The ST-IAT consisted of 5 blocks, of which blocks 3 and 5 were test blocks. In the first block, consisting of six trials, participants were shown words related to themselves and were asked to push the right button that corresponded to the label "I" in the right corner of the screen. In the second block, consisting of 24 trials, participants were shown the labels "peaceful" in the upper left corner and

TABLE II. Stimuli of the Single-Target Implicit Association Task

Peaceful	Aggressive	I
Meewerken *contribute*	Aanvallen *attack*	[Voornaam *first name*]
Toegeven *admit*	Bedreigen *threat*	[Achternaam *last name*]
Instemmen *agree*	Uitschelden *abuse (verbally)*	[Leeftijd *age*]
Samenwerken *cooperate*	Beledigen *insult*	[Geboortedatum *date of birth*]
Overleggen *consult*	Mishandelen *abuse*	[Woonplaats *residence*]
Praten *talk*	Vechten *fight*	[Straat *street*]

"aggressive" in the right corner. They were shown verbs and were instructed to categorize these words by using the buttons that corresponded to the labels in the corners of the screen. In the third block of the task, consisting of 48 trials, the labels of the previous block remained and the category 'I' was added under the label 'aggressive" in the right corner. Participants were now both shown verbs and words related to themselves and were again instructed to categorize the words. In the fourth block, consisting of 12 trials, the label "I" was now shifted to the left corner and the other labels were removed. In the fifth block, consisting of 48 trials, the label "I" remained in the left corner. The category "peaceful" was added to the upper left corner and the category "aggressive" to the right. In total, the task existed of 138 trials and lasted 16 minutes.

Calculation of IAT-effect. For each participant, reaction times were measured. The extent to which the participant automatically associates the self with aggressive or peaceful words can be measured by comparing the mean reaction time on both test blocks (e.g., Greenwald, Nosek, & Banaji, 2003).

Reactive Proactive Aggression Questionnaire (RPQ)

The RPQ (Raine et al., 2006), consists of 23 items, divided into two subscales. In the present study the Dutch translation of the RPQ (Cima, Raine, Meesters, & Popma, 2013) was used to measure self-reported aggressiveness. Participants were asked to indicate how often each statement occurred using a 3-point scale with 0 for "never" to 2 for "often." Twelve of the items report on proactive aggression (e.g., Used physical force to get others to do what you want), while 11 items report on reactive aggression (e.g., Reacted angrily when provoked by others). In previous research, the internal consistency for both the subscales as well as the total aggression scale was shown to be high ($\alpha = 0.81$ for reactive aggression, $\alpha = 0.84$ for proactive aggression, $\alpha = 0.90$ for total aggression; Raine et al., 2006). The recent study on the Dutch version of the RPQ showed similar results regarding internal consistency ($\alpha = 0.83$ for reactive aggression, $\alpha = 0.87$ for proactive aggression, $\alpha = 0.91$ for total aggression; Cima et al., 2013).

Taylor Aggression Paradigm (TAP)

The TAP (Taylor, 1967) was used to measure aggressive behavior. In this task, the participant was told that he was going to play a competitive reaction time game against another participant in the room next to him, while in fact there was no opponent. The participant was instructed to mouse-click on a rectangle as fast as possible, when it turned from yellow to red. The amount of time it took before the rectangle changed from yellow to red was random, ranging from 1000 to 2000 ms. The experimenter always checked with the "other participant" to see if he was also ready to start the game before starting this task, to strengthen the cover story. Also, a connection screen was shown to let the participant believe that the computers were connecting with each other. This connection screen was shown for 2000 ms. The amount of win or lose trials were pre-programmed in the same order for every participant (see the sequence of trials in Table III). A valid reaction time range was set between 0 and 2000 ms before automatic loss of the participant, to enhance the idea that the participant was playing against an actual opponent. Participants were told that the winner of a trial could administer a loud noise to his opponent and this noise could influence the performance of the opponent on the next trial. Before each trial, the participant was asked to choose the duration and volume of this noise blast. Sliders were used for both duration and volume, with a range between 0 and 10. Regarding volume, 0 represented no noise at all and 10 was equal to 100 dB, which is as loud as the noise of a jack hammer at 1 m distance. As for duration, 0 represented 0 seconds and 10 stood for 5 seconds.

PROCEDURE

After signing informed consent, demographic information was obtained. When participants reported hearing problems, they were not allowed to participate in the study because of the noises administered in the TAP. Participants were then assigned to one of six conditions, in which task order was counterbalanced. In each condition, the RPQ and TAP were administered last. The complete experiment, which also included other tasks not relevant for this article, lasted around

TABLE III. Preprogrammed Trials of the Taylor Aggression Paradigm

Trial number	Intensity	Duration	Win/Lose
1	0	0	win
2	0	0	win
3	0	0	win
4	0	0	lose
5	0	0	lose
6	0	0	win
7	6	7	lose
8	1	1	win
9	6	5	lose
10	3	7	lose
11	5	2	lose
12	5	9	win
13	2	6	lose
14	1	3	win
15	3	3	win
16	6	5	lose
17	10	2	win
18	4	6	win
19	7	9	lose
20	3	10	lose
21	6	5	win
22	2	10	lose
23	10	6	lose
24	4	10	win
25	9	10	lose
26	6	4	win
27	2	3	lose
28	9	7	lose
29	10	3	win
30	2	6	lose

2.5 hours, including a 10 minute break halfway.[1] At the end of the experiment, participants filled out a manipulation check and afterwards they received information about the cover story and nature of the study. This study was approved by the Ethical Committee Psychology of Maastricht University, The Netherlands.

RESULTS

Preliminary Analyses

TAP. There are no guidelines on the best way to calculate subscales for the assessment of reactive and proactive aggression in the TAP. Sometimes, mean intensity/duration is calculated (e.g., Giancola, Godlaski, & Roth, 2012), or a measure of extreme aggression is inferred on the basis of high scores (e.g., Giancola et al., 2009), while others use separate indicators of different aggression types like overt and covert (e.g. Kuepper & Hennig, 2007) or provoked and unprovoked (e.g., Giancola & Parrott, 2008; Kuepper & Hennig, 2007). Besides the numerous possibilities for calculating aggression on the TAP, many of these scales are non-normally distributed. Even after the use of transformations (e.g., square root), many of these scales remain non-normally distributed. Given the absence of a standard calculus, the problems with normal distributions and to avoid "cherry picking," we decided to first examine the underlying dimensional structure of the TAP responses with principal components analysis (PCA). Since both intensity and duration of the sounds are registered for all 30 trials, resulting in 60 variables, our sample size was too small for a PCA on single responses. Therefore, it was decided to cluster the trials beforehand on the basis of three characteristics: type of response (intensity/duration), type of preceding experience (win/lose trial), and phase of experiment (before the first time a participant received any noise from the opponent versus output after the first time a participant received noise). This resulted in eight new variables of mean sum scores, based upon the classification of trials along these characteristics, which were subjected to PCA. Descriptive statistics for intensity level, duration, and the new variables of mean sum scores can be found in Table IV.

Factor analysis of TAP-variables. To establish factors that were unrelated to each other, orthogonal rotation was chosen. Based on a scree plot and eigenvalues larger than one, the analysis revealed two factors, together explaining 83.1% of the variance: the first factor included all scores on trials after the first time the participants received noise from the opponent, while the second factor included the scores on trials before the participants received noise. The Kaiser-Meyer-Olkin measure of sampling adequacy was .72, above the recommended value of .6, and Bartlett's test of sphericity was significant ($\chi^2(28) = 716.53$, $p < .01$). Factor loadings can be found in Table V. The other characteristics (intensity/duration and win/lose) did not have any influence on the division of the factors. To conclude, this PCA showed that two factors accounted for the aggression measurement, which are further referred to as "reactive aggression" (scores after the first provocation) and "proactive aggression" (scores before the first provocation). Descriptives of the two factors used in this article can be found in Table VI.

Next, normality tests for the factor scores of the reactive and proactive variable of the TAP revealed that proactive aggression was not normally distributed. Inspection of the responses loading on this factor revealed skewed distribution. A square root transformation of all scores

[1] Besides this study, the experiment also included four other reaction time tasks, two questionnaires, a vignette task, and a listening task. We made sure that in every condition, two reaction time tasks never followed each other directly. The Emotional Stroop and the ST-IAT, which are relevant to this study, are mixed between the other tasks in every condition. The RPQ and the TAP were always administered last.

TABLE IV. Descriptives of Taylor Aggression Paradigm Variables (N = 90)

	Mean (SD)	Median	Kurtosis (SD)	Skewness (SD)
Trials won before first provocation—volume	2.35 (1.99)	1.70	−.73 (.50)	.66 (.25)
Trials won before first provocation—duration	2.11 (1.82)	1.60	.81 (.50)	1.08 (.25)
Trials lost before first provocation—volume	1.88 (2.18)	1.00	1.99 (.50)	1.55 (.25)
Trials lost before first provocation—duration	1.87 (2.11)	1.00	3.23 (.50)	1.71 (.25)
Trials won after first provocation—volume	3.52 (2.14)	3.60	−.34 (.50)	.31 (.25)
Trials won after first provocation—duration	3.44 (2.06)	3.40	.11 (.50)	.40 (.25)
Trials lost after first provocation—volume	4.04 (2.11)	4.19	−.23 (.50)	−.10 (.25)
Trials lost after first provocation—duration	3.83 (2.01)	4.08	−.78 (.50)	−.18 (.25)

on the trials of the TAP was done and the PCA as described above was repeated. This analysis revealed the highly similar components with a comparable factor loadings pattern, together explaining 88.2% of the variance. For this analysis, the Kaiser-Meyer-Olkin measure of sampling adequacy was .74, and Bartlett's test of sphericity was also significant ($\chi^2(28) = 922.38$, $p < .01$). Since the normal distribution of the variable "reactive aggression" deteriorated (i.e., deviated from normal) as a result of the transformation, it was decided to use the reactive factor from the first principal components analysis and the proactive factor from the second analysis with the square root scores.

Outliers on the TAP. An outlier analysis was conducted for reactive and proactive aggression on the TAP separately. Boxplots were used to detect any univariate outliers, while relplots (using R statistics, version 2.15.1) were created to look for multivariate outliers. A relplot can be seen as a graph of a bivariate boxplot, in which two ellipses are drawn. The smaller ellipse contains half of the data points, while the data points outside the larger ellipse might be considered as outliers. To test the influence of an outlier found in the relplot or boxplot, Cook's distance values ($4/n$-k-1; Cook, 1977) and Mahalanobis' distance ($\alpha = .001$, df (2) = 13.82) were calculated. For reactive aggression, one multivariate outlier was detected and excluded from further analyses, leaving a sample of 82 for the regression analyses for reactive aggression. For proactive aggression, no outliers were detected.

Validity of the TAP-factors. We replicated this factor analysis in an independent sample of American students ($N = 100$). The TAP was conducted with the same procedure and parameters as in this study (Lobbestael, Baumeister, Fiebig, & Eckel, 2014). Consistent with this study, two factors were found that could be separated on the basis of the first provocation of the opponent. Just as in this study, the factor that represented the trials before the first provocation was skewed and thus a second factor analysis with the square roots of the scores on the trials was necessary. This second factor analysis again revealed the same two

TABLE V. Factor Loadings Based on a Principles Component Analysis With Varimax Rotation for Eight Non-Transformed Variables and Eight Transformed Variables of the Taylor Aggression Paradigm

	Reactive Aggression	Proactive Aggression
Trials won before first provocation—volume	.37	.87
Trials won before first provocation—duration	.39	.85
Trials lost before first provocation—volume	.15	.91
Trials lost before first provocation—duration	.19	.91
Trials won after first provocation—volume	.87	.35
Trials won after first provocation—duration	.89	.30
Trials lost after first provocation—volume	.90	.25
Trials lost after first provocation—duration	.90	.20
Trials won before first provocation—volume—square root variable	.36	.87
Trials won before first provocation—duration volume—square root variable	.36	.85
Trials lost before first provocation—volume volume—square root variable	.19	.91
Trials lost before first provocation—duration volume—square root variable	.20	.90
Trials won after first provocation—volume volume—square root variable	.87	.35
Trials won after first provocation—duration volume—square root variable	.89	.31
Trials lost after first provocation—volume volume—square root variable	.90	.25
Trials lost after first provocation—duration volume—square root variable	.90	.20

TABLE VI. Descriptives of TAP Factors

	Mean (SD)	Median	Kurtosis (SD)	Skewness (SD)
TAP factor reactive aggression	.00 (1.00)	−.03	−.05 (.50)	.11 (.25)
TAP factor proactive aggression	.00 (1.00)	.10	−.69 (.50)	.00 (.25)

factors, dividing the trials by the first provocation of the opponent.

RPQ. To examine the predictive value of the subscales reactive aggression and proactive aggression independently, standardized residuals were saved for each subscale and used in later stepwise regression models. Standardized residuals were used as this method makes it possible to measure reactive and proactive aggression independently of one another (Cima et al., 2009; Raine et al., 2006). Internal consistency of the RPQ ($N = 90$) was calculated for reactive aggression (Cronbach's $\alpha = .73$), proactive aggression (Cronbach's $\alpha = .71$), and total aggression on the RPQ (Cronbach's $\alpha = .81$).

Emotional stroop. Reaction times smaller and greater than two standard deviations from the overall mean and reaction times on incorrect trials (c.f. Smith & Waterman, 2003) were not used in the analyses. Regarding reaction times, 3.3% of the trials in the neutral block were greater than two standard deviations from the mean. For the negative block, 3% of the trials were greater than two standard deviations from the mean. Only 2.6% of the trials in the aggressive block and 2% of the trials in the positive block were greater than two standard deviations from the mean. In the neutral condition, only 0.5% of the answers on the trials were incorrect. For the negative condition, 1.2% incorrect trials were excluded. In the aggressive block, 0.6% of the trials were answered incorrectly. In the positive block, 0.6% incorrect trials were excluded. To examine reliability of the difference scores which were used in the analyses, split-half reliability following an odd-even procedure was performed (Parrott, 1991). For the contrast between positive and neutral, a moderate-to-good reliability was found ($\rho = .73$). A moderate split-half reliability was found for the difference score between negative and neutral ($\rho = .67$). For the contrast between aggression and neutral, the corrected Spearman correlation was moderate-to-good as well ($\rho = .72$). Finally, the split-half reliability for the contrast between the aggression bias score and the negative bias score was relatively low ($\rho = .50$). Internal consistencies for mean reaction times within the four blocks were also calculated with the same split-half procedure, showing excellent internal consistencies (corrected Spearman-Brown correlations for positive: $\rho = .92$; negative: $\rho = .92$; aggressive: $\rho = .93$; neutral: $\rho = .92$).

ST-IAT. To measure the predictive validity of an automatic self-aggression association, the ST-IAT was used. Positive outcome scores reflect stronger association between the self and aggression. The reaction times on the ST-IAT were analyzed according to the improved scoring algorithm developed by Greenwald et al. (2003), which means that the data on the ST-IAT were calculated following a stepwise procedure. First, subjects for whom more than 10% of the trials had latency less than 300 ms were deleted. In this study, there were no participants having more than 10% of the trials with latency less than 300 ms. Second, the mean latency for all responses in the test blocks were calculated. Third, for each incorrect trial a penalty was computed, meaning that the reaction time was replaced with the mean of that block and an additional 600 ms. In this study, only 3.3% of all the trials were answered incorrectly. Fourth, the inclusive standard deviation for all trials in the two test blocks (i.e., blocks 3 and 5) were computed. Fifth, the mean difference of the ST-IAT-effect was computed. Sixth, the mean difference was divided by the inclusive standard deviation. The outcome is called the D-600 score, which is defined as the equal-weight average of the two ratios previously calculated. Split-half reliability following an odd-even procedure was calculated for mean latency differences between the two test blocks ($\rho = .83$). The same procedure was replicated for mean reaction times within the test blocks, which indicated excellent internal consistency (block 3: $\rho = .95$ and block 5: $\rho = .97$).

Regression Analyses

To examine whether an attentional bias towards aggressive behavior and an automatic self-aggression association predicted reactive and proactive aggressive behavior, two stepwise multiple regression analyses were conducted for each type of aggression with the following independent variables: step 1 included age, specific aggressive attentional bias ($M_{\text{aggressive bias}} - M_{\text{negative bias}}$) and automatic self-aggression association; step 2 included age, specific aggressive attentional bias,

TABLE VII. Intercorrelations of Predictors With Reactive Aggression

	Age	STIAT-Effect	Emotional Stroop Effect	RPQ Reactive Aggression	RPQ Proactive Aggression
Age					
STIAT-effect	$r = -.04$ $N = 83$				
Emotional Stroop effect	$r = .12$ $N = 84$	$r = .11$ $N = 83$			
RPQ reactive aggression	$r = -.19$ $N = 85$	$r = -.00$ $N = 83$	$r = -.11$ $N = 84$		
RPQ proactive aggression	$r = .00$ $N = 85$	$r = .07$ $N = 83$	$r = .07$ $N = 84$	$r = -.47$*** $N = 85$	
TAP factor score reactive aggression	$r = -.24$* $N = 85$	$r = -.02$ $N = 83$	$r = .21^{a}$ $N = 84$	$r = .00$ $N = 85$	$r = -.11$ $N = 85$

Note. *$P < .05$; **$P < .01$; ***$P < .001$.
[a]The correlation between TAP factor reactive aggression and Emotional Stroop Effect is $p = .05$.

automatic self-aggression association, and the reactive or proactive subscale of the RPQ (depending on the outcome variable). Correlations among the variables used in the regression analyses can be found in Tables VII and VIII.

Reactive aggression. The first step shows a significant p-value ($F(3,79) = 3.66$, $p < .05$, $R^2 = .12$). Further examination of the results in this step of the model indicated that age was a significant predictor for reactive aggression ($\beta = -.28$, $t = -.2.61$, $p = .01$). The older participants were, the lower the level of reactive aggression. Besides age, attention significantly predicted reactive aggression as well ($\beta = .25$, $t = 2.36$, $p = .02$), meaning that the more the participants' attention was directed to aggressive words, the more reactive aggression they showed on the TAP. An automatic association between the self and aggression did not have any predictive value for reactive aggression. The second step of the model did not have additional predictive value for aggressive behavior (F-Change $(1,78) = .07$, $p > .5$), indicating that the self-report measurement of reactive aggression did not additionally predict aggressive behavior on the TAP.

Proactive aggression. The same stepwise multiple regression approach was used for proactive aggression, indicating a significant result for the first step of the model ($F(3,80) = 3.15$, $p < .05$, $R^2 = .11$). Participants whose attention was less directed towards aggressive words exhibited a significant increase of proactive aggressive behavior ($\beta = -.23$, $t = -2.16$, $p = .03$). Also, a stronger association between the self and aggression predicted an increase of proactive aggression on the TAP ($\beta = .24$, $t = 2.24$, $p = .03$). Age was not a predictor for proactive aggression. The second step of the model, in which the self-report measure of proactive aggression was added, did not have additional value in predicting aggression (F-Change$(1,79) = .12$, $p = .74$).[2,3]

Incremental validity of cognitive predictors. In line with the scope of present special issue, we examined whether the cognitive predictors had incremental value of the over and above self-reports of aggression. Therefore, the regression analyses were repeated with a change in entering order of the predictors and self-reported aggressiveness.

Reactive aggression. For reactive aggression, both the reactive scale of the RPQ and age were entered in step 1, and in step 2 age and the RPQ-reactive subscale

[2] In the regression analyses, only participants who believed the cover story were included. The analyses were re-run with all participants to see whether results remained the same. For reactive aggression, the regression model became non-significant ($p = .07$). The results for proactive aggression remained significant with the same beta-weights pattern. However, it is crucial to filter out the participant that did not believe the cover story, as they are mostly the ones giving strange answer patterns (e.g., all zeros).

[3] To examine whether the results could be replicated with a more conventional statistical approach, both regression analyses were re-run with mean sum scores of duration before and after the first provocation of the TAP. For reactive aggression, results of the model in step 1 could be replicated ($F(3,79) = 2.86$, $p < .05$). Both age ($\beta = -.22$, $t = -2.00$, $p < .05$) and the Emotional Stroop ($\beta = .25$, $t = 2.25$, $p < .05$), were significant predictors in this model. For proactive aggression, the model was marginally significant ($F(3,80) = 2.39$, $p = .08$). Results were only replicated for the ST-IAT ($\beta = .26$, $t = 2.36$, $p = .02$). The effect of the Emotional Stroop on proactive aggression could not be replicated. Finally, to check whether the results for proactive factor depended on the approach of transforming the variable, the non-transformed proactive TAP factor from the first factor analysis was entered as a dependent variable into the regression analysis. Again, the results could be replicated ($F(3,80) = 3.69$, $p < .05$). Further inspection of the model showed that both the effect of the ST-IAT ($\beta = .27$, $t = 2.51$, $p < .05$) and the Emotional Stroop were significant ($\beta = -.25$, $t = -2.38$, $p < .05$). In sum, the majority of the findings that have been reported in the paper could thus be replicated with a more conventional statistical approach.

TABLE VIII. Intercorrelations of Predictors With Proactive Aggression

	Age	STIAT-effect	Emotional Stroop Effect	RPQ Reactive Aggression	RPQ Proactive Aggression
Age					
STIAT-effect	$r=-.04$ $N=84$				
Emotional Stroop effect	$r=.12$ $N=85$	$r=.10$ $N=84$			
RPQ reactive aggression	$r=-.18$ $N=86$	$r=-.01$ $N=84$	$r=-.09$ $N=85$		
RPQ proactive aggression	$r=.00$ $N=85$	$r=.07$ $N=84$	$r=-.08$ $N=85$	$r=-.47$*** $N=86$	
TAP factor score proactive aggression	$r=.11$ $N=86$	$r=.21$ $N=84$	$r=-.19$ $N=85$	$r=-.02$ $N=86$	$r=.02$ $N=86$

Note. *$P<.05$; **$P<.01$; ***$P<.001$.

were entered together with specific aggressive attentional bias and automatic self-aggression association. Step 2 showed a marginally significant change in R^2 ($R^2 - Change = .06$, $F(2,78)=2.72, p=.07$). Step 1 was marginally significant in predicting reactive aggressive behavior ($F(2,80)=2.63$, $p=.08$). Step 2 of the model significantly predicted reactive aggression on the TAP ($F(4,78)=2.73$, $p<.05$). In this step, both age and an aggressive attentional bias predicted reactive aggressive behavior on the TAP (age: $\beta=-.28, p<.05$; attentional bias: $\beta=.25$, $p<.05$). Since an aggressive attentional bias was the only significant cognitive predictor of aggressive behavior in previous analyses for reactive aggression, it was decided to test whether a regression model with the attentional bias as the only cognitive predictor would have incremental value over and above the self-report of reactive aggression. Therefore, the regression analysis described in this paragraph was repeated with the reactive scale of the RPQ and age in step 1 and RPQ-reactive and age together with attentional aggressive bias added in step 2. The second step of the model showed significant incremental value of aggressive attentional bias ($R^2 - Change = .06$, $F(1,80)=5.33$, $p<.05$), indicating that the measurement of an attentional bias has predictive value for aggressive behavior over and above self-reported reactive aggression ($\beta=.24$, $p<.05$).

Proactive aggression. For proactive aggression, age and the proactive scale of the RPQ were entered in step 1. In step 2, age and the proactive scale of the RPQ were entered together with the cognitive predictors. The cognitive predictors had incremental value over and above the self-report measure of aggression ($R^2 - Change = .10$, $F(2,79)=4.35$, $p=<.05$). Step 1 showed that RPQ proactive together with age did not predict proactive aggressive behavior ($F(2,81)=.36$, $p=.70$). Step 2 showed a marginally significant result, indicating a trend for the predictive value of the cognitive factors in proactive aggression (Step 2: $F(4,79)=2.36$, $p=.06$; attentional bias: $\beta=-.23$, $p<.05$, self-aggression association: $\beta=.24$, $p<.05$).

DISCUSSION

The present study indicates that aggressive behavior, measured with a laboratory aggression paradigm, can be predicted by measuring automatic processes with cognitive tasks when controlling for the effect of age. Both an attentional bias for aggressive words and an automatic association between the self and aggression were shown to play a predictive role in the occurrence of aggressive behavior. In line with our expectations, we showed that biases in earlier stage of SIP were related to reactive aggression. The results for proactive aggression and the stages of the SIP-model were partly in line of our hypotheses.

According to the results, the distinction between reactive and proactive aggression is important to make, since the two types of aggression were predicted by different variables. For example, age was only related to reactive aggression and not to proactive aggression. Tuvblad, Raine, Zheng, and Baker (2009) also found that reactive aggression decreased with age measured with the RPQ, whereas proactive aggression did not decline substantially with age.

The effect of an attentional bias for aggressive words was different for reactive and proactive aggression. In line with our expectations, a stronger attentional bias for aggressive words predicted reactive aggressive behavior on the TAP. This result is in line with the findings in the study of Chan et al. (2010) with male batterers. It implies that people who are emotionally more affected by the content of aggressive words are also more prone to show aggressive behavior when being provoked. A possible mechanism is that when a person's attention is focused more on aggressive stimuli, the cognitive aggression-related schemata are more likely to dominate as is the likelihood to act on these schemas. This could mimic real-life social situations, where aggression-triggers appear and become so distracting for people high in reactive aggression that they are no longer able to focus on their actual task and goal.

A faster attentional response on aggressive words in comparison with negative words resulted in a higher level of proactive aggression. To our knowledge, this rather puzzling yet interesting finding has not been reported before. It could be that aggressive words are less emotionally disturbing for people showing more proactive aggressive behavior. This could be an indication of ego-syntonicity of aggression and therefore these stimuli do not take up a large amount of attentional capacity. Proactive aggression might be characterized by a lack of emotional arousal, which could be similar to cold-blooded aggression in psychopathy (e.g., Porter, Woodworth, Earle, Drugge, & Boer, 2003). Another explanation could be that aggressive stimuli trigger stronger goal-directed behavior in these participants, as their use of aggression is mostly goal-directed. In the Emotional Stroop, the goal is to be as fast as possible and aggressive stimuli could therefore enhance their performance. This is based on the assumption that the aggressive words in the Emotional Stroop exert a very immediate and temporal increased focus on aggressive goals.

The current findings regarding automatic associations are partly in line with the results of the study of Grumm et al. (2011) in which the researchers showed that an automatic self-aggression association predicts behavioral aggression. However, Grumm and colleagues did not make the distinction between reactive and proactive aggression, whereas in this study only proactive aggression was predicted by the self-aggression association. In this study, the ST-IAT was designed to measure behavioral schemas. It might be that in people showing more proactive aggression, aggressive behavioral schemas are activated without the need of a trigger or provocation, while it might be impossible to measure the aggressive behavioral schemas of people showing more reactive aggression when these schemas are not activated by a trigger or provocation. It would be interesting to test this hypothesis using a provocation before examining automatic associations with the ST-IAT. Richetin, Richardson, & Mason (2010) showed that an aggression IAT predicted aggressive reactive behavior (i.e., negative evaluation of experimenter) after participants were provoked by rude behavior displayed by this experimenter. Thus, they found the automatic self-aggression association only to be predictive of provoked aggressiveness and not of unprovoked aggressiveness. These results contradict the findings in our study on proactive aggressive behavior, although this could be explained by the difference in measurement of aggressive behavior. The relation between an automatic self-aggression association and proactive aggression that we found could also be the result of ego-syntonicity as it comes to this form of aggression, while the absence of the association is due to ego-dystonicity of reactive aggression.

We predicted that an automatic association between the self and aggression is possibly reflective of a bias in the fourth step of the SIP model, indicating that this type of bias is a late(r)-stage processing bias in contrast to the early-stage attentional bias that the Emotional Stroop measures. However, it could also be that an automatic self-aggression association bias works in a top-down processing manner, influencing all information processing stages. In this sense, a strong automatic self-aggression association could be seen as a disposition, predisposing the person to attend to aggression-related cues, interpret ambiguous cues as threatening or aggressive, and to select aggressive behavioral scripts (Bluemke, Friedrich, & Zumbach, 2010). This assumes that an automatic self-aggression association is more trait-like, which could also be said of proactive aggression that we measured in our study (i.e., behaving aggressively without any provocation of the opponent). So this top-down theory might be an alternative explanation of the relation between the automatic self-aggression association and proactive aggression that has been found in this study.

It has to be noted though that the explained variances of our findings were in the medium range (R-square values around .11). This may be because both reactive and proactive aggression originate from multiple causes such as high anger and low self-control in the case of reactive aggression (DeWall, Baumeister, Stillman, Gailliot, 2007; Gottfredson & Hirschi, 1990) and positive outcome expectancies in the case of proactive aggression (Walters, 2007).

Self-reported aggression did not appear to have additional predictive value for behavioral aggression over the implicit cognitive tasks. This may relate to the ongoing discussion on whether the TAP actually measures aggressive behavior (e.g., Giancola & Parrott, 2008; Tedeschi & Quigley, 1996). The lack of correlation between the scores on the RPQ and the TAP ($r = -.05$ between RPQ reactive and the TAP reactive factor and $r = -.03$ between RPQ proactive and the TAP proactive factor)[4] could be due to several reasons. First, self-reported aggressiveness is measured

[4] Note that using the more conventional TAP scores (e.g., mean loudness or duration) would not have increased validity because we failed to find these to correlate with the RPQ too.

with the RPQ, which means that the participant is asked whether he generally behaves in an aggressive manner. In contrast, the TAP is a measure of aggressive behavior in this particular moment and situation, which is thus more state-like aggression. Second, the RPQ is designed to measure a broader concept than the TAP that specifically measures physical aggression by means of administering loud tones to an opponent, which may lead to a lack of correlation among the tasks. Third, the validity of self-report is questionable when trying to measure and predict aggressive behavior. An important reason for the limited validity of self-report measures of aggressive behavior is that responses can be unreliable due to lack of insight (e.g., Scheier, Buss, & Buss, 1978) or social desirable responding. Examining the incremental value of the cognitive predictors over and above the self-report of aggressiveness, on the other hand, is problematic as well for the same reasons as noted above. As seen in this study, self-reported aggressiveness did not predict aggressive behavior, so it would be questionable to talk about "incremental" value of cognitive predictors.

Strengths and Limitations

A major strength of this study is the comparison between a self-report measure and implicit measures to predict aggressive behavior. Despite the caveats in the knowledge about which processes underlie implicit measures (see e.g., De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009), the current findings do show them to be of value in predicting aggressive behavior. Another strength of this study is that an innovative method was used to analyze the scores on the TAP. The reason for this new method was to analyze the data more objectively and refrain from choosing one of the many different possibilities based upon previous studies. To our best knowledge, this is the first study to analyze the data from the TAP in a data-driven rather than a theory-based way. The existence of these two factors was however replicated in an independent, cross-cultural sample. To further validate this method, future studies should focus on the question whether identical factors can be found in other samples as well.

Despite the strengths of the study, results need to be seen in light of some limitations. First, in this study, only male participants were included. The exclusion of women in the study can be seen as a limitation, as the findings can only be generalized to the male population. As already pointed out, women show different types of aggressive behavior than men. However, future studies might be able to answer the question of whether cognitive predictors can be found in women as well as men.

Furthermore, the sample size was relatively small, which limited us in performing the appropriate tests to eliminate order effects. The order of the tasks given to the participant (i.e., condition) did not correlate to any variables used in this study (i.e., age, ST-IAT effect, Emotional Stroop effect, reactive aggression, and proactive aggression on the TAP, and reactive and proactive aggression on the RPQ). However, due to the limited number of participants, it is not possible to test whether possible order effects do *interact* with main findings of our study. Another possible limitation of this study is the number of students in the sample. It could be argued that students are different in their level of aggression or cognitive performance than the general population. Therefore, the large number of students may make the results less generalizable to the general population.

Although the internal consistency scores of the mean latencies of the cognitive tasks were excellent, a limitation of this study was that the internal consistency of the contrast and difference scores of the Emotional Stroop and the ST-IAT were moderate. Although it is known that internal consistencies for difference scores on cognitive tasks are generally lower than mean latency scores (e.g., Dresler et al., 2012; Rosenthal & Rubin, 1996), the moderate internal consistencies should be considered when interpreting the results of this study.

Implications

The current study has some implications for clinical practice. Cognitive tasks that are able to predict aggressive behavior could be of use in forensic settings, since one of the main tasks of a clinician in a forensic setting one is to predict whether a patient is likely to show future delinquent behavior. This task is both important as well as difficult, since an incorrect prediction could have major societal impact. To make a prediction, risk assessment instruments are available (e.g., Historical-Clinical-Risk Management-20 or HCR-20; Webster, Eaves, Douglas, & Wintrup, 1995) and widely used in forensic clinics. However, these risk assessment instruments have some limitations. First, most of these instruments focus on static factors (e.g., number of crimes committed, age of first conviction), while only some of the instruments include a scale measuring dynamic factors (e.g., HCR-20). Measuring dynamic factors is important, especially when patients receive treatment aimed to change certain behavior and/or cognitions. Second, risk assessment is mostly based upon information in the files of the patients and this information often comes from self-reports by the patient. So, the information could be unreliable due to lack of insight or self-presentation of the patient. Third, current risk assessment is often based upon the clinical judgment of the staff, what leads to the question of whether the decisions on risk assessment are made objectively. To conclude, there is a need for alternative strategies to measure the risk of a patient showing future deviant behavior. To enhance the quality of the predictions, tasks measuring cognitive factors that predict the risk of aggressive behavior could be used as an addition to current risk assessment instruments. In line with this, Polaschek, Bell, Calvert and Takarangi (2010) found a stronger implicit preference for weapons with an IAT to relate to increased estimates of future violence in male offenders. The results of the current study also showed that cognitive tasks can be valuable in predicting aggressive behavior. Future studies need to focus on the question whether these cognitive tasks are also able to predict aggressive behavior in a clinical sample of delinquents.

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