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## Cognitive predictors of violent incidents in forensic psychiatric inpatients



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### ABSTRACT

This study tested the predictive value of attentional bias, emotion recognition, automatic associations, and response inhibition, in the assessment of in-clinic violent incidents. Sixty-nine male forensic patients participated and completed an Emotional Stroop to measure attentional bias for threat and aggression, a Single Target – Implicit Association Task to assess automatic associations, a Graded Emotional Recognition Task to measure emotion recognition, and an Affective Go/NoGo to measure response inhibition. Violent incidents were derived from patient files and scored on severity level. The predictive value of level of psychopathy was tested with the Psychopathy Checklist – Revised (PCL-R). Generalized linear mixed model analyses showed that increased attention towards threat and aggression, difficulty recognizing sad faces and factor 2 of the PCL-R predicted the sum of violent incidents. Specifically, verbal aggression was predicted by increased attention towards threat and aggression, difficulty to recognize sad and happy faces, and PCL-R factor 2; physical aggression by decreased response inhibition, higher PCL-R factor 2 and lower PCL-R factor 1 scores; and aggression against property by difficulty recognizing angry faces. Findings indicate that cognitive tasks could be valuable in predicting aggression, thereby extending current knowledge on dynamic factors predicting aggressive behavior in forensic patients.

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### 1. Introduction

Aggressive behavior is one of the main problems that staff members in forensic psychiatric settings cope with (Nijman and Geurkink, 2004; Kobes et al., 2012; Ros et al., 2013; Wilson et al., 2013). Minimizing incidents in forensic settings is therefore essential and being able to predict incidents might facilitate this. Various risk taxation instruments are used to predict future violent behavior of patients. Recently, an increase exists in studies on risk assessment tools that include dynamic factors (e.g. Wilson et al., 2013; Chan and Chow, 2014), as these factors are changeable and targetable. Cognitive processes can be seen as dynamic and have theoretically been linked to aggressive behavior (Crick and

Dodge, 1994), indicating that research on the predictive value of these processes could be promising. Although the *correlation* between cognitive factors and aggressive behavior in different populations has been studied numerously (e.g. Brugman et al., 2015; Chan et al., 2010; Dambacher et al., 2014; Domes et al., 2013; Eckhardt et al., 2012; Iria et al., 2012; Lobbestael et al., 2009; Pham and Philippot, 2010; Schönenberg et al., 2014; Smith and Waterman, 2003; Snowden et al., 2004; Wilson et al., 2011) little is known on the *predictive value* of these cognitive factors in the assessment of future aggressive behavior of forensic psychiatric patients (i.e. criminal offenders with a psychiatric disorder). The aim of this study is to examine whether cognitive factors predict in-clinic aggressive behavior of forensic psychiatric patients.

Recent literature on implicit cognitive factors related to violent behavior has addressed four dimensions. The first dimension is that of *attention*. An attentional bias towards negative stimuli has been observed in male batterers (Chan et al., 2010). Furthermore, Brugman et al. (2015) showed that a heightened attentional bias

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towards aggressive stimuli predicted more reactive aggressive behavior in a male sample of the general population. Although both studies did not assess forensic psychiatric patients, the results indicate that attentional interference of negative and aggressive stimuli is associated with violent behavior in men. The studies of Bass and Nussbaum (2010), Domes et al. (2013), and Smith and Waterman (2003) on forensic psychiatric patients found a similar relation between attentional interference and aggression. Deficits in attentional performance have been associated with anger-related aggression in forensic psychiatric patients (Bass and Nussbaum, 2010). Domes et al. (2013) showed that forensic psychiatric patients (i.e. criminal offenders with antisocial personality disorder) showed a stronger attentional bias towards negative and violence-related stimuli than offenders without this disorder and non-criminal controls. Finally, violent offenders showed an attentional bias towards aggressive words as opposed to non-violent offenders and undergraduates (Smith and Waterman, 2003).

The second dimension is that of *automatic associations*. Automatic associations between concepts like 'violent' and evaluations like 'good' have proven to be related to aggressive behavior in different populations. In non-forensic populations it was found that participants enrolled in an intimate partner violence treatment program had a more positive implicit association with violence than controls (Eckhardt et al., 2012). The results of Richetin et al. (2010) indicated that measuring an automatic self-aggression association after provocation predicted aggressive behavior in undergraduates. The study of Banse et al. (2015) indicated that the IAT with aggressive stimuli had predictive value for aggressive behavior in the laboratory as well as more natural settings (i.e. ice hockey). Moreover, in forensic psychiatric samples a relation between automatic associations and aggression was found. Psychopathic murderers showed an abnormal implicit attitude towards violence compared to non-psychopathic murderers and non-murderers (Snowden et al., 2004). Also, after an anger induction an automatic self-aggression association was shown in antisocial patients (Lobbestael et al., 2009). Furthermore, Zwets et al. (2015) showed that a more positive association with violence was associated with the antisocial facet of psychopathy and self-reported hostility, while a more negative association with violence was related to more socially adapted behavior. Following these studies, automatic associations with aggression may be predictive of violent incidents in forensic psychiatric inpatients.

The third dimension is *emotion recognition*. A variety of studies exists on facial processing in psychopathic offenders (e.g. Wilson et al., 2011) indicating that psychopaths are impaired in recognizing fearful and sad expression. Non-psychopathic criminals showed difficulty in recognizing emotional faces in comparison to controls (Pham and Philippot, 2010). Antisocial violent offenders interpreted ambiguous facial cues as more hostile than healthy controls (Schönenberg and Jusyte, 2014), showing that antisocial offenders not only have problems recognizing emotional faces but also have an interpretation bias when viewing faces.

The fourth dimension is *response inhibition*, or the ability to refrain from selecting social inappropriate responses (such as aggressive behavior). Dambacher et al. (2014) showed that the anterior insula cortex is involved in behavioral inhibition and aggressive behavior in response to a provocation, indicating similar brain structures for poor response inhibition and reactive aggression. Decreased response inhibition in emotional contexts has also been shown to be associated with aggressive behavior. Iria et al. (2012) showed that psychopathic and non-psychopathic criminals have a tendency of over-responsiveness (i.e. more false alarms) to angry and fearful faces in comparison with non-criminal participants with low psychopathy scores.

Although the above biases and distortions in attention, automatic association, emotion recognition, and response inhibition have been linked to aggressive behavior in different populations,

their value for *predicting* aggressive behavior in forensic psychiatric patients remains unknown. This explorative study therefore examined whether an attentional bias for threatening and aggressive words; distortions in recognizing and interpreting expressive faces; a positive attitude towards violence; and response inhibition in context of affective stimuli were predictive for the number and severity of violent incidents displayed by forensic psychiatric patients. To control for the predictive value of static factors, we included the level of psychopathy, a stable characteristic that has been shown to predict violent behavior and recidivism (e.g. Hare et al., 2000). Violent incidents over a one-year period were assessed, enabling the examination of the predictive value of the cognitive measures of long-term in-clinic aggressive behavior in a forensic sample. To our best knowledge, this is the first study to test the predictive value of different cognitive factors in a longitudinal way for violent behavior in a forensic patient sample.

## 2. Methods

### 2.1. Participants

Sixty-nine Dutch male forensic psychiatric inpatients of two forensic psychiatric hospitals or so-called 'TBS-clinics'<sup>1</sup> (i.e. Pompekliniek, Nijmegen, and FPC Oldenkotte, Rekken, the Netherlands) participated in the study. Descriptive statistics for age, educational level (Verhage, 1964), mean IQ, DSM axis I and II diagnoses (established by means of extensive observation by mental health professionals), type of index crime, mean age at first conviction, and amount of participants with a PCL-r score of 26 or higher (i.e. the European cut-off score of psychopathy; Grann et al., 1999) can be found in Table 1. Child molesters were excluded from this study because research indicates a very distinct set of cognitive distortions in this group (e.g. automatic association between children and sexual words, self-serving interpretations of victim experience; Gannon and Polaschek, 2006). Also, violent behavior is not often used in these patients when committing offenses (Rebocho and Gonçalves, 2012), indicating that aggressive behavior is not the main issue for these patients. Patients with current/history of psychosis or dissociative disorder were excluded from this study, as violent behavior in these patients is linked to their psychotic symptoms (e.g. threat/control-override symptoms such as 'Others tried to poison me'; Nederlof, et al., 2011), whereas we were interested in the influence of aggression-related cognitions.

### 2.2. Materials

#### 2.2.1. Emotional Stroop

For attentional interference, two versions of the Emotional Stroop were used: one with neutral and general threat-related words, the other with neutral and aggression-related words<sup>2</sup>. Both included a practice block of 16 trials and 2 blocks of 44 trials. In each block, 22 words were neutral and 22 words were either threat-related (e.g. "illness") or aggression-related (e.g. "attack"). Stimuli were used once and randomized per block. The words

<sup>1</sup> TBS or 'terbeschikkingstelling' can be translated as "disposal to be treated on behalf of the state". By the Dutch law, one cannot be sentenced without criminal liability. If a person commits a serious criminal offense that is linked with his mental disorder, he is not liable or has diminished responsibility for this crime. However, if he is a serious danger to himself or others, the Dutch court will order the person to be submitted to a secure institution through an entrustment act.

<sup>2</sup> In both Stroop-versions, words were matched on type, length and frequency based on information from the CELEX database. A 'test panel' of 15 persons rated how well the words fitted into the categories on a Likert-scale (1–5).

**Table 1**  
Descriptive Statistics for Demographic and Clinical Variables.

Descriptives	
Age, mean (SD)	37.9 (7.9)
Educational level <sup>a</sup> , N (%)	
Less than six years of primary education	2 (2.9)
Finished six years of primary education	4 (5.8)
Six years primary education and less than two years of low level secondary education	34 (49.3)
Four years of low level secondary education	20 (29.0)
Four years of average level secondary education	5 (7.2)
Five years of high level secondary education	2 (2.9)
University degree	1 (1.4)
IQ <sup>b</sup> , mean (SD)	96.6 (11.1)
Axis I diagnosis, N (%)	
Substance-related disorder (one substance)	19 (27.5)
Substance-related disorder (multiple substances)	34 (49.3)
Mood disorder	2 (2.9)
Anxiety disorder/PTSS	3 (4.3)
Pervasive developmental disorder	1 (1.4)
Attention deficit and disruptive behavior disorder	6 (8.7)
Impulse control disorder	8 (11.6)
Paraphilia	4 (5.8)
Missing	1 (1.4)
Other (i.e. cognitive disorder NOS; pain disorder)	2 (2.8)
No diagnosis on axis I	9 (13.0)
Diagnosis on axis I deferred	1 (1.4)
Axis II diagnosis, N (%)	
Paranoid PD	1 (1.4)
Antisocial PD	26 (37.7)
Narcissistic PD	8 (11.6)
Borderline PD	6 (8.7)
Personality disorder NAO	33 (47.8)
With Cluster B features	16 (23.2)
With Cluster C features	2 (2.9)
With features of multiple clusters	14 (20.3)
Features not specified	1 (1.4)
Type of index crime	
Violent crime <sup>c</sup>	65 (94.2)
Sexual crime	22 (31.9)
Property crime	23 (33.3)
Mean age at first conviction, mean (SD)	19.7 (6.4)
Amount of participants with PCL-R score of $\geq 26$ , N (%)	31 (44.9)

<sup>a</sup> Information on educational level was not available for one participant.

<sup>b</sup> Information on IQ-score was unavailable for two participants.

<sup>c</sup> For one participant it remained unclear whether violence was used during the offense.

were presented for 200 ms, without backward masking and with interval duration of 1300 ms. Participants were asked to push the button corresponding to the color of the word. Reaction times on neutral, threat-related, and aggression-related stimuli were recorded and excluded from analyses when shorter than 150 ms or larger than 1500 ms. Incorrect trials were also excluded. A Stroop-effect was calculated following [Smith and Waterman \(2003\)](#):  $RT_{\text{general threat}} - RT_{\text{neutral}}$  for the general threat-version and  $RT_{\text{aggression}} - RT_{\text{neutral}}$  for the aggression-version.

### 2.2.2. Signal Detection Task

The Signal Detection Task measured vigilance for threatening stimuli. Following the research of [Öhman et al. \(2001\)](#) matrices of 9 schematic faces were presented. The participant was asked to decide whether all faces in the matrix showed the same

expression or whether one was different. The task consisted of 4 blocks with 25 target-trials (i.e. one different expression) and 25 non-target trials (i.e. all faces with the same expression): block 1: target=happy, distractors=neutral; block 2: target=angry, distractors=neutral; block 3: target=neutral, distractors=angry; block 4: target=neutral, distractors=happy. Matrices were presented for 180 ms and backward masking (200 ms, stripe pattern over the schematic faces) was used. Responses faster than 150 ms and longer than 1500 ms were eliminated. Following the signal detection theory of [MacMillan and Creelman \(1991\)](#), four sensitivity indexes ( $d'$ ) were used to examine vigilance for emotional faces among neutral faces and difficulty to disengage from emotional faces when detecting a neutral face: 1)  $d'$  for a happy face among neutral faces, 2)  $d'$  for an angry face among neutral faces, 3)  $d'$  for a neutral face among happy faces and, 4)  $d'$  for a neutral face among angry faces. To examine vigilance and difficulty to disengage for angry faces specifically, the following calculations were done: 1)  $d'$  for angry faces among neutral ones minus  $d'$  for happy faces among neutral ones, 2)  $d'$  for a neutral face among angry faces minus  $d'$  for a neutral face among happy faces. A higher score reflected higher vigilance or more difficulty to disengage from angry than happy faces.

### 2.2.3. Graded Emotional Recognition Task (GERT)

With the GERT, we measured the ability to recognize and interpret emotional faces of different intensity levels. Participants were shown male and female faces ([Ekman and Friesen, 1976](#)) displaying anger, disgust, anxiety, happiness, sadness, surprise or a neutral expression. The emotions were expressed on 40%, 70% or 100% intensity level. The task consisted of 252 trials and each emotion was presented 36 times in random order (12 trials per emotion intensity). Difficulty to recognize emotional faces at 100%, 70%, and 40% intensity was measured by the number of incorrect responses on these trials.

### 2.2.4. Implicit Association Task (IAT)

To assess whether a positive automatic association with violence predicted aggressive behavior, an IAT was used. The task consisted of 7 blocks: 1) participants categorized positive and negative words<sup>3</sup> according to labels 'positive' and 'negative' by using the left and right cursor, 2) pictures<sup>4</sup> of violent or nonviolent situations were categorized under 'violent' and 'nonviolent', 3) positive words and violent pictures were categorized using the right cursor and negative words and nonviolent pictures with the left cursor, 4) test block with same instructions as third block, 5) violent pictures were categorized to the left and nonviolent pictures to the right, 6) nonviolent pictures were categorized together with positive words and violent pictures were categorized together with negative words, 7) test block with same instructions as sixth block. Reaction times during the test blocks were recorded. The IAT-effect was calculated (reaction times on block 7 – reaction times on block 4) following the procedure of [Snowden et al. \(2004\)](#). A higher IAT-effect reflected faster reaction times on the incompatible block in contrast to the compatible block, indicating a more positive attitude towards violence.

### 2.2.5. Affective Go/NoGo

With the Affective Go/NoGo task, response inhibition on emotional stimuli was measured. Participants pushed the spacebar in reaction to some pictures (i.e. go-trial), while not reacting to other pictures (i.e. no-go trial). The task consisted of 6 blocks with 32

<sup>3</sup> Words were selected from the CELEX-database.

<sup>4</sup> Pictures were selected from IAPS (International Affective Picture System; [Lang et al., 1997](#)) and the internet, which were matched on complexity and color scheme.

trials (16 go-trials and 16 no-go trials), differing in instructions: 1) Go=positive pictures, No/Go=negative pictures, 2) Go=negative pictures, No/Go=positive pictures, 3) Go=positive pictures, No/Go=neutral pictures, 4) Go=neutral pictures, No/Go=positive pictures, 5) Go=negative pictures, No/Go=neutral pictures, and 6) Go=neutral pictures, No/Go=negative pictures. Pictures were derived from the International Affective Picture System (IAPS; Lang, et al., 1997). Information about which pictures were used, can be found in the [Supplementary material](#) online<sup>5</sup>. Reaction times and response accuracy were recorded. Following Nosek and Banaji (2001),  $d'$  indexes were calculated.  $D'$  indexes indicated sensitivity to discriminate target positive pictures from negative or neutral pictures, to discriminate negative from positive or neutral pictures, and to discriminate neutral pictures from positive and negative pictures. The higher the  $d'$  score, the higher the sensitivity to discriminate the target pictures from the distractor pictures.

#### 2.2.6. Psychopathy-Checklist revised (PCL-R)

To indicate the level of psychopathic traits, the PCL-R (Hare, 2003) was used (ICC between 0.85 and 0.95; Hare, 2003), which is shown to be a good indicator of violent recidivism (e.g. Hare et al., 2000). PCL-R scores were derived from the patient files. PCL-R scores were missing for 3 participants. For one additional patient, only the PCL-R total score was available. The PCL-R scores from the patient files were obtained by certified clinicians, using interviews and patient file information to reach one consensus score. Inter-rater reliability and internal consistency of the Dutch version of the PCL-R were found to be high (ICC=0.88 and  $\alpha$ =0.87, respectively; Hildebrand, et al., 2002).

#### 2.2.7. Aggressive incidents

All aggressive incidents were selected from the MITS (monitoring information system of TBS) taking place during one year after administering the cognitive task. Each incident was scored by the first author on severity using the Modified Overt Aggression Scale (MOAS; Sorgi et al., 1991), which exists of four scales: verbal aggression, aggression against property, auto-aggression, and physical aggression. In this study auto-aggression incidents were not scored. Severity on each scale ranges from 0 (not present, e.g. "No verbal aggression") to 4 (severely present, e.g. "Threatens violence toward others or self repeatedly or deliberately"). Multiple severity scores on the same scale could be scored and summed to a total severity score. Also, multiple types of aggression could be present within one incident. One of the co-authors (F.D.) randomly scored 50 incidents, which resulted in an inter-rater reliability of 0.97 on verbal aggression, 1.00 on aggression against property, and 0.97 on physical aggression. The number and severity (expressed as average per incident in case of multiple incidents) of incidents per month were used as outcome measures for the patients.

#### 2.3. Procedure

Clinicians were asked for permission to contact patients meeting the inclusion criteria. Next, selected patients were asked for participation and provided with information about the study. If the patient agreed on participating, meetings were planned to conduct the experiment (three sessions of 2 h maximum). Debriefing was not necessary, since the goal of the study was explained beforehand. This study was approved by the 'Medische Ethische Toetsingscommissie' of CMO Arnhem-Nijmegen (METC; Medical Ethical Committee).

#### 2.4. Regression analyses

Generalized linear mixed model analyses were used to predict the number of aggressive incidents per month within one year after each cognitive task. Each cognitive task was tested in a separate regression analysis, as the  $N$  varied per cognitive task. PCL-R factor scores were included in the analyses to examine the predictive value of the cognitive measurements next to the static factor of psychopathy. As the number of aggressive incidents was negatively skewed and to eliminate the influence of overdispersion, negative binomial regression with a log link was chosen over linear and Poisson regression. Compound symmetry was chosen for the repeated part, as this led to the best fitting models. An exception was made for the Affective Go/NoGo task, as the full model did not converge with negative binomial mixed regression with a log link. Data on this task was analyzed with a Poisson regression and compound symmetry covariance structure. Backwards stepwise regression was used to eliminate variables that did not predict violent incidents ( $\alpha_{\text{criterion}}=0.10$ ). Predictors with  $p < 0.05$  were interpreted as significant. Only the final fitting model will be reported. As time, both as factor and as linear covariate, was not significant in most models in the fixed part, it was deleted, except for the Affective Go/NoGo task. Adding random intercept and both random intercept and time as random slope to the model led to estimation failure. To examine whether the cognitive measures predicted the severity of violent incidents, generalized linear mixed model analysis was used in a similar manner. As severity of violent incidents was negatively skewed, gamma regressions were used to analyze the data. Compound symmetry resulted in the best fitting models. Time was a significant predictor in the fixed part only for the Affective Go/NoGo and therefore not included in the other models, and adding a random intercept and time as random slope caused estimation failure, so these were not included in the model.

### 3. Results

#### 3.1. Descriptives

Patients had a mean PCL-R score of 23.97 (SD=7.92, range=5–38), a mean factor 1 score of 9.9 (SD=3.85, range=1–16), and a mean factor 2 score of 11.08 (SD=3.75, range=2–17). Descriptives of number of incidents and severity of aggressive behavior can be found in [Table 2](#).

#### 3.2. Predicting the number ([Table 3](#)) and severity ([Table 4](#)) of violent incidents

##### 3.2.1. Emotional stroop

For both versions of the task a higher attentional interference for threat-related or aggressive stimuli and a higher PCL-R factor 2 score predicted more aggressive incidents. For the aggression version a higher PCL-R factor 1 score predicted less aggressive incidents. For both versions of the task, a stronger attentional bias for threat or aggression and a higher PCL-R 2 score predicted higher severity of verbal aggression. Also for both models, a higher PCL-R factor 1 predicted less severity of physical aggression, whereas a higher PCL-R factor 2 score predicted higher severity of physical aggression.

##### 3.2.2. Signal Detection Task

No significant effects were found for this task or the PCL-R factors. A higher PCL-R factor 2 predicted higher severity of verbal aggressive incidents as well as physical aggression.

<sup>5</sup> A 'test panel' of 27 persons rated the pictures along a Likert scale on each used category, to be able to select the pictures that represented the category best.

**Table 2**  
Descriptives of Number and Severity of Violent Incidents for each Cognitive Task.

	Number of participants	Number of violent incidents within one year after task	Severity of verbal aggression	Severity of aggression against property	Severity of physical aggression
Emotional Stroop General Threat	N=63	$\Sigma=89$ M=1.41 SD=2.57 range=0–12	M=2.69 SD=4.53 Range=0–22	M=0.21 SD=0.71 Range=0–3	M=0.36 SD=0.96 Range=0–5
Emotional Stroop Aggression	N=61	$\Sigma=85$ M=1.39 SD=2.60 range=0–12	M=2.63 SD=4.61 Range=0–22	M=0.22 SD=0.72 Range=0–3	M=0.37 SD=0.98 Range=0–5
Signal Detection Task	N=63	$\Sigma=85$ M=1.13 SD=2.23 Range=0–11	M=1.98 SD=3.84 Range=0–16.5	M=0.12 SD=0.50 Range=0–3	M=0.32 SD=0.96 Range=0–5
IAT	N=52	$\Sigma=62$ M=1.19 SD=2.29 Range=0–11	M=1.90 SD=3.59 Range=0–14.83	M=0.11 SD=0.48 Range=0–3	M=0.41 SD=1.06 Range=0–5
GERT	N=51	$\Sigma=67$ M=1.31 SD=2.55 Range=0–12	M=2.24 SD=4.58 Range=0–22	M=0.16 SD=0.64 Range=0–3	M=0.46 SD=1.13 Range=0–5
Affective Go/NoGo	N=67	$\Sigma=82$ M=1.22 SD=2.14 Range=0–11	M=2.22 SD=3.69 Range=0–16.5	M=0.17 SD=0.56 Range=0–3	M=0.31 SD=0.92 Range=0–5

### 3.2.3. IAT

No significant effects were found for this task or the PCL-R factors. A higher PCL-R factor 2 predicted higher severity of verbal as well as physical aggression.

### 3.2.4. GERT

The number of errors on anxious, angry, happy, disgusted and surprised faces did not predict violent incidents. For all the models, except the model for sad faces, the PCL-R factor 2 significantly positively predicted the number of violent incidents. For sad faces, a higher number of errors on 70% intense sad faces predicted a higher number of violent incidents, while a higher number of errors on 40% and 100% sad faces did not. More errors on sad faces

with 70% intensity indicated higher severity of verbal aggression, while more errors on sad faces with 40% and 100% did not. Also, more errors on 40% happy faces predicted higher severity of verbal aggression. A higher PCL-R factor 2 predicted higher severity of verbal aggression in the models for anxious, angry, sad, disgusted, and surprised faces. A higher PCL-R factor 2 score predicted higher severity of physical aggression in all models. A higher severity of aggression against property was predicted by more errors on 40% angry faces.

### 3.2.5. Affective Go/NoGo

No significant results were found for the  $d'$ -values on the Affective Go/NoGo task or the PCL-R factors. A significant result for

**Table 3**  
Prediction of Number of Violent Incidents.

Task	Variable	F-test	B	SE(B)	t	p	Exp(B)
<b>Emotional Stroop General Threat</b>	Corrected Model	5.543				< 0.01	
	Attentional bias	4.599	0.007	0.003	2.145	< 0.05	1.007
	PCL-R factor 2	7.603	0.175	0.064	2.757	< 0.01	1.192
<b>Emotional Stroop Aggression</b>	Corrected Model	4.482				< 0.01	
	Attentional bias	4.301	0.007	0.003	2.074	< 0.05	1.007
	PCL-R factor 1	4.415	-0.166	0.079	-2.101	< 0.05	0.847
<b>Signal Detection Task</b>	PCL-R factor 2	11.77	0.303	0.088	3.431	< 0.01	1.353
	PCL-R factor 2	3.453	0.144	0.078	1.858	< 0.10	1.155
	PCL-R factor 2	5.840	0.175	0.073	2.417	< 0.05	1.191
<b>GERT anxious faces</b>	PCL-R factor 2	5.840	0.175	0.073	2.417	< 0.05	1.191
<b>GERT angry faces</b>	PCL-R factor 2	5.840	0.175	0.073	2.417	< 0.05	1.191
<b>GERT sad faces</b>	Corrected Model	2.153				< 0.10	
	Sad 100%	4.147	-0.521	0.256	-2.036	< 0.05	0.594
	Sad 70%	6.359	0.646	0.256	2.522	< 0.05	1.907
	Sad 40%	4.016	-0.309	0.154	-2.004	< 0.05	0.734
<b>GERT happy faces</b>	Corrected Model	4.961				< 0.01	
	Happy 40%	3.599	0.178	0.094	1.897	< 0.10	1.195
	PCL-R factor 2	3.405	0.129	0.070	1.845	< 0.10	1.138
<b>GERT disgusted faces</b>	PCL-R factor 2	5.840	0.175	0.073	2.417	< 0.05	1.191
<b>GERT surprised faces</b>	PCL-R factor 2	5.840	0.175	0.073	2.417	< 0.05	1.191
<b>Affective Go/NoGo</b>	Corrected Model	3.435				< 0.05	
	Time	4.031	-0.072	0.036	-2.008	< 0.05	0.931
	PCL-R factor 2	2.839	0.104	0.062	1.685	< 0.10	1.109

Note: In this table, only significant results are presented. Models that did not include any significant variables in the final model (e.g. IAT), were thus excluded from this table. P-values of < 0.10 were also displayed as the  $\alpha$ -criterion to eliminate variables was 0.10. These effects are, however, not interpreted in the paper as significant results.

**Table 4**  
Prediction of Severity of Verbal Aggression, Physical Aggression, and Aggression against Property.

Task	Variable	F-test	B	SE(B)	t	Sig. (p)
<b>Emotional Stroop Threat</b>	<b>Verbal Aggression</b>					
	Corrected Model	7.290				< 0.001
	Attentional bias	11.436	0.002	0.001	3.382	< 0.01
	PCL-R factor 1	3.509	−0.022	0.012	−1.873	< 0.10
<b>Emotional Stroop Threat</b>	<b>Physical Aggression</b>					
	Corrected Model	6.491				< 0.01
	PCL-R factor 1	3.970	−0.006	0.003	−1.993	< 0.05
	PCL-R factor 2	12.599	0.012	0.003	3.549	< 0.001
<b>Emotional Stroop Aggression</b>	<b>Verbal Aggression</b>					
	Corrected Model	4.582				< 0.01
	Attentional bias	4.326	0.001	0.001	2.080	< 0.05
	PCL-R factor 1	3.211	−0.023	0.013	−1.792	< 0.10
<b>Emotional Stroop Aggression</b>	<b>Physical Aggression</b>					
	Corrected Model	6.553				< 0.01
	PCL-R factor 1	3.910	−0.006	0.003	−1.977	< 0.05
	PCL-R factor 2	12.734	0.012	0.003	3.568	< 0.001
<b>Signal Detection Task</b>	<b>Verbal Aggression</b>					
	PCL-R factor 2	4.961	0.021	0.009	2.227	< 0.05
<b>Signal Detection Task</b>	<b>Physical Aggression</b>					
	Corrected Model	5.411				< 0.01
	PCL-R factor 1	3.325	−0.006	0.004	−1.823	< 0.10
<b>IAT</b>	<b>Verbal Aggression</b>					
	Corrected Model	3.173				< 0.05
	PCL-R factor 1	3.326	−0.022	0.012	−1.842	< 0.10
<b>IAT</b>	<b>Physical Aggression</b>					
	Corrected Model	5.411				< 0.01
	PCL-R factor 1	3.325	−0.006	0.004	−1.823	< 0.10
<b>GERT anxiety</b>	<b>Verbal Aggression</b>					
	Corrected model	4.857				< 0.01
	Sad 100%	5.477	−0.061	0.026	−2.340	< 0.05
<b>GERT anger</b>	<b>Verbal Aggression</b>					
	Corrected model	4.857				< 0.01
	Sad 70%	11.254	0.075	0.022	3.355	< 0.01
<b>GERT sadness</b>	<b>Verbal Aggression</b>					
	Corrected model	4.857				< 0.01
	Sad 40%	6.159	−0.042	0.017	−2.482	< 0.05
<b>GERT happy</b>	<b>Verbal Aggression</b>					
	Corrected Model	5.448				< 0.01
	Happy 40%	4.696	0.032	0.015	2.167	< 0.05
<b>GERT surprised</b>	<b>Verbal Aggression</b>					
	Corrected Model	5.448				< 0.01
	Happy 40%	4.696	0.032	0.015	2.167	< 0.05
<b>GERT disgusted</b>	<b>Verbal Aggression</b>					
	Corrected Model	5.448				< 0.01
	Happy 40%	4.696	0.032	0.015	2.167	< 0.05
<b>GERT anxious</b>	<b>Verbal Aggression</b>					
	Corrected model	7.627				< 0.01
	Sad 40%	3.258	0.008	0.005	1.805	< 0.10
<b>GERT anger</b>	<b>Verbal Aggression</b>					
	Corrected model	7.627				< 0.01
	Sad 40%	3.258	0.008	0.005	1.805	< 0.10
<b>GERT sadnes</b>	<b>Verbal Aggression</b>					
	Corrected model	7.627				< 0.01
	Sad 40%	3.258	0.008	0.005	1.805	< 0.10
<b>GERT happy</b>	<b>Verbal Aggression</b>					
	Corrected model	7.627				< 0.01
	Sad 40%	3.258	0.008	0.005	1.805	< 0.10
<b>GERT surprised</b>	<b>Verbal Aggression</b>					
	Corrected model	7.627				< 0.01
	Sad 40%	3.258	0.008	0.005	1.805	< 0.10
<b>GERT disgusted</b>	<b>Verbal Aggression</b>					
	Corrected model	7.627				< 0.01
	Sad 40%	3.258	0.008	0.005	1.805	< 0.10
<b>GERT angry</b>	<b>Verbal Aggression</b>					
	Corrected model	7.627				< 0.01
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<b>GERT surprised</b>	<b>Verbal Aggression</b>					
	Corrected model	7.627				< 0.01
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<b>GERT disgusted</b>	<b>Verbal Aggression</b>					
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	Corrected model	7.627				< 0.01
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	Corrected model	7.627				< 0.01
	Sad 40%	3.258	0.008	0.005	1.805	< 0.10
<b>GERT angry</b>	<b>Verbal Aggression</b>					

the time factor was found: a longer time between the Affective Go/NoGo and measurement of the violent incidents predicted fewer incidents. Less sensitivity to correctly react to neutral go-trials versus negative no-go trials predicted higher severity of physical aggression, in addition to the predictive value of the PCL-R factor 2 score.

#### 4. Discussion

This study indicated that cognitive processes are valuable predictors of aggressive in-clinic incidents. An attentional bias towards aggression and threat, difficulty to recognize emotional faces, and a decreased sensitivity to respond to neutral stimuli and inhibit responses to negative stimuli predicted the number and severity of aggressive incidents within one year after the cognitive task. A schematic figure of the results can be found in Fig. 1.

A higher attentional bias towards aggressive or threatening stimuli predicted more violent incidents and more severe verbal aggression, next to the predictive value of the PCL-R. This adds to current knowledge on the relation between an attentional bias towards aggression and aggressive behavior (e.g. Chan et al., 2010; Brugman et al., 2015). In this study, however, the predictive validity of an attentional bias is not specific for aggressive stimuli, but also for stimuli related to general threat. The finding that attentional bias towards aggression and threat predicted the number of violent incidents and the severity of verbal aggression might be because in this population verbal aggression was most severe when violent incidents occurred. Verbal aggression is often the most used type of aggression in psychiatric hospitals (e.g. Foster et al., 2007; Stone et al., 2011), possibly because of the controlled environment of a forensic setting. Patients might be inclined to abstain from more severe forms of aggression, but still ‘release’ their frustration in terms of verbal aggression.

Difficulty recognizing mild sad faces, subtle happy faces, and subtle angry faces predicted the number and severity of violent incidents. Difficulty recognizing sad faces by antisocial patients in comparison to controls was also shown by Dolan and Fullam (2004) and Marsh and Blair (2008). Theoretically, detecting distress in others would inhibit antisocial behavior (e.g. Blair, 2005) and increase pro-social behavior (Marsh et al., 2007), but the current study showed that deficits in this process lead to

aggressive behavior. Difficulty recognizing mild sad faces (i.e. 70% intensity) predicted more violent incidents and more severe verbal incidents, even when controlling for the number of errors on subtle (40%) and obvious (100%) sad faces and the PCL-R factor scores. Subtle sad faces seem difficult and obvious faces easy to recognize for most patients (creating floor and ceiling effects), while difficulty to recognize mild sad faces (70%) is crucial for predicting aggressive incidents. It is noteworthy that the level of sad face intensity that showed to be discriminative in our study (70%) is highly similar to the level that has been found to be the threshold for recognition in samples of healthy men (72%; Coupland et al., 2004). Apparently, it is at the normative threshold level of sad face detection that the predictive power of sad face recognition is manifested.

More severe verbal aggression was also predicted by more errors on subtle happy faces, which cannot be explained by the Integrated Emotion System (IES) model (Blair, 2005). Deficits in recognition of happy faces is generally not seen in antisocial populations (e.g. Marsh and Blair, 2008; Bowen et al., 2014). Possibly, happy faces with 40% intensity elicited aggressive behavior in those patients interpreting these faces as more mocking or provoking.

More errors on subtle angry faces predicted more severe aggression against property, indicating that subtle anger cues do not inhibit aggression against property, while mild or strong cues of anger do. Although antisocial patients do not generally show deficits in recognition of obvious angry faces (e.g. Marsh and Blair, 2008), it remains unclear how they perform on subtle angry faces in comparison to healthy participants. According to the results of Coupland et al. (2004) on recognition of angry faces in healthy males, the majority of the participants in our study would have difficulty in recognizing subtle angry faces. As aggression against property was rare in this sample, these results may be due to relatively few patients with a high level of errors on angry faces and higher levels of aggression against property.

Sensitivity to detect a neutral stimulus among negative stimuli predicted physical aggression. Patients who are more distracted by negative stimuli and less able to discriminate between neutral and negative stimuli are at more risk to display physical aggression. Little is known from previous studies on this issue. Verona et al. (2012) measured frontal P3-activity with EEG, which is heightened when inhibitory control is carried out on Go/NoGo tasks and in

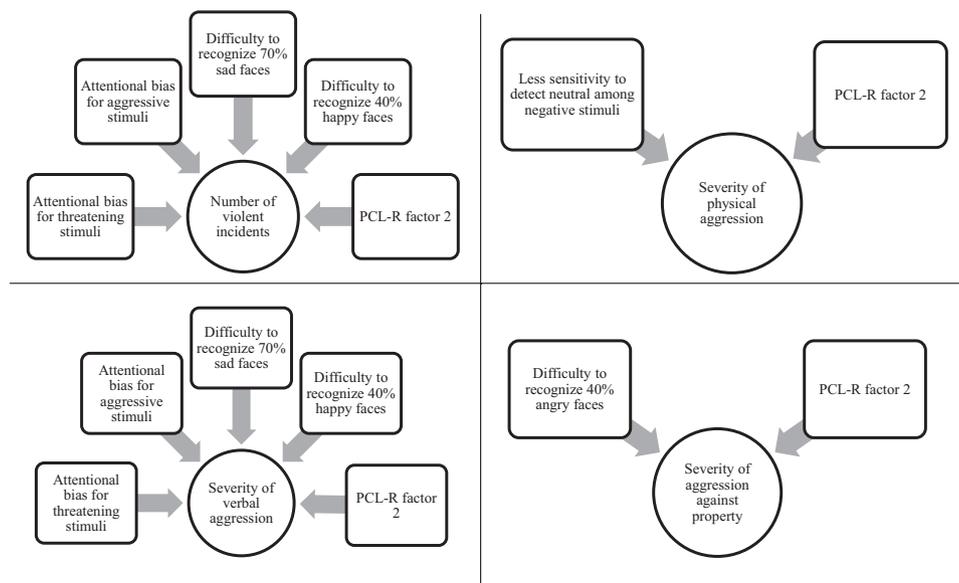


Fig. 1. Schematic Reproduction of Results.

processing emotional information, in psychopathic offenders with antisocial offenders and controls. Antisocial offenders failed to refrain from emotional processing of negative stimuli on No/Go trials. Furthermore, enhanced processing of negative stimuli was related to more verbal and physical aggression, similar to the results in our study.

The number of aggressive incidents and severity of verbal and physical aggressive behavior was also predicted by the PCL-R factor 2. Kennealy et al. (2010) reported that PCL-R factor 2 was a stronger predictor of violent recidivism than factor 1. Likewise, Coid et al. (2011) showed that violent reconvictions were correlated with 13 items of the PCL-R, which included all items of factor 2 of the PCL-R and only 3 of factor 1. Although the PCL-R factor 2 is thus an important predictor of aggressive incidents, it should be noted that the cognitive factors measured in this study have predictive value in addition to the PCL-R factors included in the analyses.

Contrary, the result that a higher PCL-R factor 1 predicted less violent incidents in the model of the aggression-version of the Emotional Stroop could indicate a difference between primary and secondary psychopaths. While the secondary psychopath is the more 'hot-headed' variant showing more impulsive/reactive aggression, the primary psychopath more often shows premeditated or proactive violence (Skeem et al., 2007). The primary psychopath would more likely refrain from aggressive behavior when there is no benefit for him at that moment and only negative consequences. It is possible that the violent incidents we measured during a year consisted mostly of reactive/impulsive aggression.

No significant effects were found for the variables of the Signal Detection Task and the IAT. As patients reported that they found the Signal Detection Task to be quite difficult, a lack of significant effect could be due to a high number of random answers. As for the IAT, both words and pictures were used to categorize under the labels. Previous studies (e.g. Foroni and Bel-Bahar, 2010) showed that the magnitude of the IAT-effect is dependent on the stimuli-type, whereas IAT's using words as stimuli often show stronger IAT-effects than pictures, due to the fact that words and pictures differ on the level with which they represent the categories used (i.e. level of representation; Foroni and Bel-Bahar, 2010). Possibly, using only words would have yielded a stronger IAT-effect.

There was no significant reduction over time in the number of incidents or their severity for all models, except the model of the Affective Go/NoGo, in predicting the number or severity of violent incidents. One might expect that due to treatment, aggressive incidents would diminish over time. The overall time span between the cognitive measures and violent incidents might have been too short for treatment effects to become significant.

#### 4.1. Strengths and limitations

This study was one of the first to test whether cognitive tasks predicted violent behavior of patients, extending the knowledge on these dynamic factors in aggressive behavior. Also, several cognitive tasks were tested on their predictive value of aggressive behavior in one study. Furthermore, using actual reports on violent in-clinic incidents strengthened the ecological validity of the results. A large time frame was used between the cognitive tasks and the violent incidents, making statements about the long-term predictive value of the cognitive tasks possible.

This study also has several limitations. First, only male offenders were included. While the sample is representative of the male-dominant offender population, the results may not be generalizable to female offenders. Second, the controlled environment of a forensic institution limits the number and severity of violent incidents, making it difficult to translate these results to an

environment outside the clinic. It remains unclear whether the cognitive tasks maintain their predictive value outside the forensic clinics. Third, since the GERT and the Affective Go/NoGo provided multiple predictors (e.g. sad faces with 40%, 70%, and 100%), results on these tasks could be influenced by high inter-correlations among these variables. However, the alternative of including these variables into separate regression analyses would yield into too many regression analyses. Fourth, the problem of increased risk of type 2 errors due to multiple comparisons should be considered when interpreting the results. Thus, this study can be seen as hypothesis-generating.

#### 4.2. Clinical implications

This study showed that the Emotional Stroop, GERT, and the Affective Go/NoGo predicted the amount and severity of violent incidents of forensic psychiatric patients. These results indicate that, after replication of these findings, cognitive tasks could have potential to complement current risk taxation instruments and facilitate and improve risk assessment in the future. Using cognitive tasks could give clinicians more insight in cognitive processes playing a role in aggressive behavior of forensic patients, which could then be targeted in treatment. Attentional bias modification (ABM), for example, potentially normalizes attentional bias. Most studies on ABM were conducted with anxiety patients (for a meta-analysis, see Mogoșe et al., 2014), indicating that ABM reduces anxiety symptoms. So far, the effect of ABM on aggressive behavior has not yet been studied, but could be promising. Also, trainings exist on improving recognition of emotional faces in different patient populations (e.g. Frommann et al., 2003), even in violent offenders (e.g. Schönenberg et al., 2014). More research on these types of interventions in forensic populations is needed to target cognitive biases and emotion recognition deficits.

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#### Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.psychres.2016.01.035>.

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