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Neurobiological Factors as Predictors of Prisoners' Response to a Cognitive Skills Training

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A R T I C L E I N F O

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A B S T R A C T

Purpose: The current study investigates the predictive value of neurobiological factors in relation to detainees' treatment outcome, in order to better understand why some individuals respond favorably to treatment while others do not. It was hypothesized that low levels of heart rate activity are associated with poor treatment outcome and that weak neurocognitive functioning is predictive of more benefit from therapy.
Methods: Background characteristics, behavioral measures, neurocognitive functioning and heart rate activity of 121 male detainees selected for cognitive skills training were assessed. Outcome measures included program completion, evaluations by trainers and ward staff, and detainees' self-reported motivation and treatment evaluation.
Results: Concentration performance, a neurocognitive skill, significantly predicted treatment dropout over and above background and behavioral measures, including self-reported motivation. In addition, high selfreported 'meanness', a psychopathic feature, was associated with low treatment motivation and an expectation bias seemed to be present among highly motivated detainees. These results did not confirm the hypotheses.
Conclusions: Offenders who are characterized by a decreased concentration performance, low motivation and increased meanness, are less likely to benefit from treatment. The results have the potential to improve the current treatment assessment procedures in order to reduce dropout rates and, eventually, recidivism rates.

Introduction

Throughout the world, more than ten million people are confined in penal institutions (Walmsley, 2013). Incarcerating people with criminal behavior is the most widely used strategy to protect society against crime, but the recidivism rate after confinement is high. For this reason, several rehabilitation models have been introduced to develop effective interventions aimed to reduce antisocial behavior and, eventually, to reduce recidivism rate. Of these models, the Risk-Need-Responsivity (RNR) model is currently most prominent for treating offenders (e.g. Andrews, Bonta, & Wormith, 2011; Ward, Melser, & Yates, 2007).

The RNR model was developed in the 1980s and is primarily based on personality and socio-psychological perspectives on human behavior (Andrews & Bonta, 2010). According to this model, the assessment and treatment of offenders should be based on three principles. The *risk* principle proposes that the level of treatment intensity should correspond to the offender's risk level; the *need* principle determines which specific criminogenic needs should be targeted in treatment; and the *responsivity* principle suggests that cognitive/behavioral interventions work best for offenders and prescribes that the intervention should be tailored to the offender's learning style, motivation, abilities and strengths.

There is strong meta-analytic evidence suggesting that current behavioral, cognitive-behavioral and multimodal intervention strategies are successful in influencing factors that are known to predict recidivism (e.g. Andrews & Bonta, 2010; Genoves, Morales, & Sanchez-Meca, 2006; Lipsey & Cullen, 2007; Pearson, Lipton, Cleland, & Yee, 2002). For instance, cognitive-behavioral therapy (CBT) aims to ameliorate dysfunctional (i.e. antisocial) thinking processes by improving specific cognitive skills such as empathy, moral reasoning, planning and problem solving (McDougall, Perry, Clarbour, Bowles, & Worthy, 2009; Sadlier, 2010; Vaske, Galyean, & Cullen, 2011). Examples of well-known CBT programs are Reasoning and Rehabilitation (Ross & Hilborn, 2008), Aggression Replacement Training (Goldstein, Glick, & Gibb, 1998) and Enhanced Thinking Skills therapy (Clark, 2000).

Nevertheless, response rates of these intervention programs vary widely between different effect studies. For example, the effectiveness

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of CBT varies between less than 10% up to almost a 50% reduction of criminal recidivism (Lipsey & Cullen, 2007; Lipsey, Landenberger, & Wilson, 2007; McDougall et al., 2009). Additionally, the rates of treatment non-completion range from 20% to 40% (Hollin et al., 2008; Olver, Stockdale, & Wormith, 2011; Polaschek, 2010). These high percentages are concerning, especially since 'non-completers' are six to eight times more likely to reoffend compared to treatment 'completers' (e.g. Dowden & Serin, 2001; Hollin et al., 2008; Seager, Jellicoe, & Dhaliwal, 2004). This implies that non-completers may represent the harder-to-treat cases that are especially in need of treatment (Wormith & Olver, 2002).

According to the RNR model, several factors are assumed to affect treatment outcome: gender, ethnicity, age, clinical status, verbal intelligence, motivation and personality (Andrews & Dowden, 2007). In addition, factors such as treatment integrity, program setting, and different offender's characteristics, such as a prior offense history and drug abuse, have been suggested as explanations for the wide variability in treatment outcome (Lipsey et al., 2007; Serin & Kennedy, 1997; Sterling-Turner, Watson, & Moore, 2002). Nevertheless, it remains unclear which mechanisms exactly underlie a wide treatment response variety and which factors can 'predict' whether the offender is likely to adhere to and complete therapy. According to Lipsey and Cullen (2007), "(…) there are many questions about the sources of variability in the effects of rehabilitation treatments that have not been adequately addressed by the research available to date" (p. 313). This indicates the need to better understand why some individuals respond well to correctional treatment and others do not, for both the eventual improvement of treatment selection and success, and the reduction of recidivism rates.

In recent years, more attention has been paid to a neurobiological view on antisocial behavior, which has become a valuable additional perspective for its understanding (Glenn & Raine, 2014). The increasing neurocriminological knowledge has led to the suggestion that specific impairments in neurobiological systems, such as poor frontal brain functioning, may disrupt the types of cognitive or emotional processing that usually play a prominent role in therapeutic interventions (Fishbein et al., 2006; Van Goozen & Fairchild, 2008). In addition, Vaske et al. (2011) argue that CBT is effective in reducing antisocial behavior because it targets specific cognitive deficits and corresponding brain areas associated with these cognitive deficits. Therefore, information about underlying neurobiological mechanisms related to effective CBT is what eventually may improve our understanding of why some offenders benefit from CBT while others do not.

To illustrate, cognitive and emotional empathy are central concepts to CBT and to criminology in general (Jolliffe & Farrington, 2004; Van Langen, Wissink, Van Vugt, Van der Stouwe, & Stams, 2014). In addition, neuropsychological studies have shown that both types of empathy are associated with activation in specific brain regions, such as the medial prefrontal cortex, temporo-parietal junction and cingulate cortex[1] (Vaske et al., 2011). It is likely that effective CBT does not only change behavioral aspects of empathy, but also changes frontal brain functioning associated with cognitive and emotional empathy. In addition, not only might CBT change brain functioning, but it is also very likely that a reciprocal relationship exists between the outcome of CBT on behavior and brain functioning (CBT ← → brain functioning) (Vaske et al., 2011). In other words, individual differences in brain functioning may moderate the effectiveness of CBT. This raises the question whether brain functioning, and perhaps other neurobiological factors, may present a responsivity concern to correctional therapy.

In a recent literature review, we have studied what is known about the association between neurobiological factors and different types of behavioral treatment for individuals with antisocial behavior (Cornet, De Kogel, Nijman, Raine & Van der Laan, 2014). Although only ten relevant studies were found, it appears that specific neurobiological factors actually can predict treatment outcome. Especially low levels of physiological arousal, such as a low resting heart rate and low cortisol levels, were predictive of poor treatment outcome. None of the included studies provided a full explanation for this relationship. Yet, one possible reason is that individuals with antisocial behavior and low arousal levels are often characterized by callous, unemotional or psychopathic traits (Cima, Smeets, & Jelicic, 2008). It is known that individuals with high levels of psychopathic traits display several impaired learning processes, such as social learning and error learning, which probably impairs their ability to benefit from behavioral treatment (Blair, Mitchell, & Blair, 2005; Von Borries et al., 2010).

Results from this literature review show that a neurobiological perspective on the treatment outcome of individuals with antisocial behavior may provide additional exploratory value to the current psychological and sociological perspectives central to the RNR model. However, several limitations exist with regard to the studies included in the review. For example, the majority of the studies included a sample of children, while the included studies also differed substantially with regard to antisocial behavior problems, the content of the treatment programs, and treatment outcome measures. Given the newness of this line of research and the limited number of studies, more research is needed.

Therefore, the aim of the present study is to further explore the predictive value of specific neurobiological factors in relation to a cognitive skills training in a sample of convicted adult offenders. Based on the literature review, it was hypothesized that: 1) low levels of heart rate activity are associated with poor treatment outcome and 2) weak neurocognitive functioning, as measured with a variety of neuropsychological tasks, is associated with more benefit from treatment, since there is greater potential for improvement.

Method

Participants

The current sample consisted of 121 male detainees with a mean age of 28.79 ($SD = 8.57$), who had been selected by the Probation Service to take part in a cognitive skills training aimed at reducing cognitive deficits (see the Cognitive Skills Training Section). Participants were recruited in several prisons in the Netherlands between 2011 and 2013. The only reason for exclusion from participation in the study was an unstable psychological or physical condition at the time of measurement. The study was approved by the Medical Ethics Committee of the VU University Medical Center Amsterdam (NL36062.029.11), while informed consent to participate in this study was sought from the detainees.

The mean intelligence level of the sample was 81.24 ($SD = 9.71$).[2] Almost 60% was born in the Netherlands, 11.6% in the Netherlands Antilles, 10% in Surinam, 6% in Morocco, 2.5% in Turkey and 10.7% in other Western or non-Western countries. Compared to the total Dutch prison population (CBS, 2014), there were slightly more Dutch (7%), Antillean (5%) and Surinamese (4%) participants in the current study. The majority (78%) had been convicted for a violent offense and 22% for a non-violent offense (e.g. drug trafficking).

Cognitive skills training

Participants in this study took part in a cognitive skills training called 'CoVa' (Cognitieve Vaardigheden, i.e. cognitive skills) training, which is an adapted and translated version of the English 'Enhanced Thinking Skills' (ETS) program (Clark, 2000). This type of cognitive behavioral treatment is provided by the Probation Service and consists of twenty sessions, made up of two two-hour sessions per week. The training takes place in prison (Van Poppel, Tackoen, Verhaeghe, & Bogaerts, 2004). Different cognitive skills are central to the treatment; inhibition, problem solving, critical and moral reasoning/thinking, and perspective taking. In research conducted in the UK, it has been shown that the ETS program can actually reduce impulsive behavior and reconviction rates among offenders (McDougall et al., 2009; Sadlier, 2010). For detainees, participating in the CoVa training is voluntary, but refusing treatment may affect their progression through the system.

In order to meet the selection criteria to participate in the CoVa training, detainees have to display cognitive deficits. In the Netherlands, a screening instrument based on the RNR model called the 'RISc' (Recidive Inschattings Schalen, a Dutch translation of the Offender Assessment System (OASys; Howard, Clark, & Garnham, 2003)) is used by the Probation Service on a national scale to investigate criminal needs (Vinke, Vogelvang, Erftermeijer, Veltkamp, & Bruggeman, 2003). In order to complete RISc records, Probation Service officers use criminal record information, interviews with the detainee and detainee's references, and their own professional judgment to identify relevant cognitive deficits, including impulsivity, goal-directed behavior and a lack of problem-solving skills. Other treatment inclusion criteria are: age ≥18, sufficient Dutch language proficiency, no special psychiatric care, a valid residence permit and a remaining sentence duration > 4 months (Ferwerda, van Wijk, Arts, & Kuppens, 2009). RISc information completed by Probation Service officers indicates that, on average, two-thirds of the sample displayed mild cognitive deficits (e.g. 'client shows impulsive behavior in some situations' or 'client has no clear life goal, but reports few realistic long-term goals'). In addition, about 20% of the detainees displayed severe cognitive deficits (e.g. 'client has a 'day by day' lifestyle and does not have any, or unrealistic, goals' or 'client denies the fact he has problems he cannot handle').

Design and procedure

Fig. 1 represents the recruitment process. At the start, lists of selected participants for treatment were requested from the prisons. Based on these lists, 280 male adults were sent a letter in which they were invited for an intake interview. Of the approached detainees, 251 showed up at the intake interview, of which 156 detainees agreed to partake in the study. If a detainee agreed immediately to participate during the intake interview, the pre-measure assessment was scheduled directly. A few detainees requested more time to think it over. Several days later, ward staff was called to ask whether these detainees had decided to participate in the current study. In case a detainee had agreed, a date and time were scheduled. Of the detainees who agreed to participate, 121 actually underwent the pre-measure assessment. Attrition between the intake phase and the actual pre-measure assessment was mainly due to a loss of interest, a 'no-show' without reason, a psychological or physical inability to participate or external circumstances (e.g. detainee was not correctly informed about the scheduled assessment). In total, 35 detainees (29%) did not complete treatment. Reasons for dropout are described hereafter. If participants did not complete treatment, no post-treatment assessment was scheduled. To the remaining sample of 86 detainees, a second letter was sent including details (e.g. the location and time) of the post-measure assessment. Of the 86 treatment completers, 74 detainees completed the post-measurement. Attrition in this final phase was mainly caused by a loss of interest and different practical reasons.

Researchers and Master students with a background in psychology, who were independent of the correctional facility, recruited participants and completed assessments. First, a 15-minute, one-to-one intake interview was scheduled to explain the aim and design of the study. Participation was voluntary and was compensated with €25. At the end of the intake, participants were presented with five questionnaires concerning treatment motivation, youth trauma experiences, psychopathic traits, aggressive behavior and moral reasoning skills. These questionnaires were returned at the pretreatment assessment or were sent back by mail. The experimenter verified whether the participants had filled out the questionnaires in accordance with the instructions. Data were collected at different time intervals. Before the start of treatment, participants completed a neurobiological assessment, including neuropsychological tasks and physiological measures. Shortly after the start of treatment, both trainers and prison officers were asked to evaluate the behavior of the participant. This was repeated shortly before the end of the treatment. The average number of days between the first and second evaluation for prison officers was 50.99 (SD = 13.93) and for trainers 46.85 days (SD = 18.92). Finally, participants were asked to complete a self-evaluation questionnaire after treatment completion. The average number of days between the pre– and post-measure assessments for detainees was 93.19 (SD = 13.53).

Materials

Measure of general intellectual ability

The Dutch version (NLV) of the National Adult Reading Test (Nelson, 1982; Nelson & O'Connell, 1978; Schmand, Lindeboom, & van Harskamp, 1992).[3] The total NLV score appears to correlate highly with the Wechsler Adult Intelligence Scale total IQ score (.74) and the total verbal IQ score (.85) (Schmand et al., 1992). The NLV score is not valid for subjects who have not grown up with the Dutch language; for this reason, participants who did not complete at least primary school in the Netherlands were not eligible to complete the NLV test (N = 14) (personal communication B. A. Schmand, 22 December, 2010).

Neurocognitive functioning

Neurocognitive function tasks were selected based on the following information: relevant literature showing the relationship between

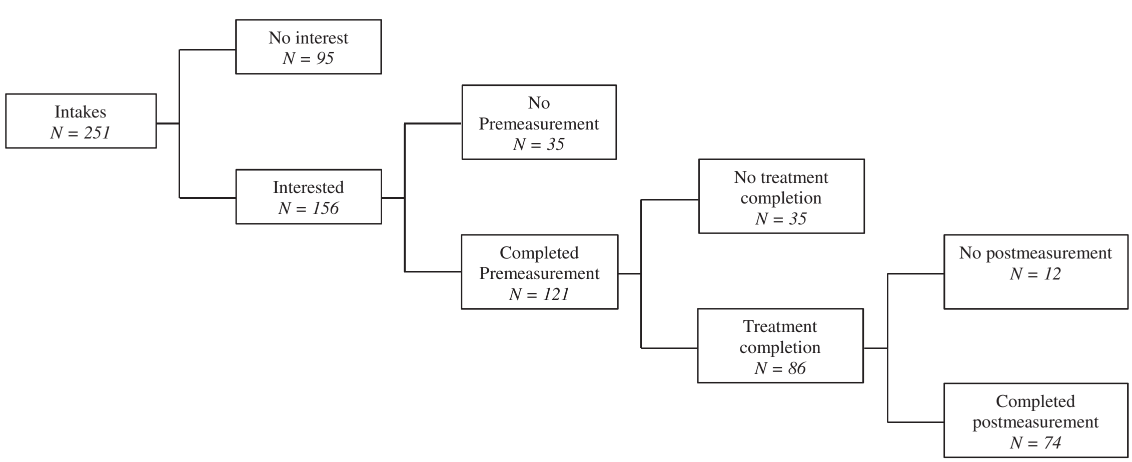

Fig. 1. Details of Recruitment Process.

cognitive dysfunctioning and antisocial behavior (Brower & Price, 2001; Morgan & Lilienfeld, 2000; Ogilvie, Stewart, Chan, & Shum, 2011); domains of cognitive functioning addressed by the CoVa training (planning, perspective taking, inhibition and social/moral reasoning/thinking); and studies included in the literature review that found a predictive value of specific cognitive function tasks in relation to CBT for detainees (Fishbein et al., 2009; Mullin & Simpson, 2007). This resulted in the selection of the following neurocognitive tasks: the Stroop Color Word Task, the D2 Cancellation Task, the Wais-III Digit Span, the Modified Wisconsin Card Sorting Task (M-WCST), the Tower of Hanoi, the Stop it Task, the Reading the Mind in the Eyes Task, and the Controlled Oral Word Association Task (COWAT). A detailed description of the selected neurocognitive tasks can be found in the supporting information (Table S1).

Physiological functioning

Autonomic nervous system (ANS) activity was measured using the VU-AMS ambulatory monitoring system (VU University, Amsterdam) (De Geus, Willemsen, Klaver, & Van Doornen, 1995; Willemsen, De Geus, Klaver, Van Doornen, & Carroll, 1996). The device continuously recorded heart rate (HR, in beats per minute; bpm) and heart rate variability (Respiration Sinus Arrhythmia (RSA) in milliseconds; msec), which is a measure of parasympathetic functioning (Berntson, Cacioppo, & Quigley, 1991). VU-AMS software package 3.5 automatically scored all beats in the electrocardiogram (ECG). A trained junior researcher used the VU-AMS Manual version 1.1 to manually check the entire recording to detect irregularities. The RSA was derived from the ECG together with respiration signals, in accordance with the peak-to-trough technique, by subtracting the shortest inter-beat interval (IBI) during the HR acceleration in the inspiration phase from the longest IBI during HR deceleration in the expiration phase (De Geus et al., 1995). The dependent measures were HR reactivity (= HR during stress minus HR during baseline) and RSA reactivity (RSA during stress minus RSA during baseline). The stressful period entailed a 4-minute VU-AMS recording during the D2 Cancellation Task. Baseline ANS activity was measured during a 5-minute relaxation moment, in which the participant was sitting behind a laptop screen with headphones on and was presented with emotionally neutral pictures (e.g. nature pictures) and relaxing classical music.

Consistent with prior research, several control variables were included in order to account for potentially confounding effects on the heart rate – treatment outcome relationship (e.g. Armstrong, Keller, Franklin, & MacMillan, 2009; Portnoy et al., 2014; Scarpa, Haden, & Tanaka, 2010).[4] Country of birth, body mass index (BMI), physical activity, smoking, medication and history of brain injury were examined. Country of birth[5] was defined as 0 = born in the Netherlands, 1 = born in a country outside the Netherlands. The BMI was derived from self-reported height and weight and calculated in kilograms/m2. To develop a measure of physical activity, participants were asked to report the average minutes of sports activity per week (e.g. fitness, jogging and football). The total amount of minutes was recalculated into hours. In addition, subjects were asked whether they smoked and if they did, how many cigarettes on an average day they smoked. Subjects were asked to report whether they used some type of medication (e.g. antihistamine, sleep medication or antidepressants). Subjects who reported the usage of medication were given a score of 1, while no medication use was coded as 0. In addition, subjects were asked whether they had experienced some form of brain injury recently or in the past (e.g. loss of consciousness, serious brain damage due to an accident or fight). Again, the presence of brain injury was coded as 1, while the absence of any form of brain injury was coded as 0. Control variables were only included in analyses if they were related to both the predictor variables and to the treatment outcome measures.

Questionnaires

Participants completed five self-report questionnaires regarding: reactive/proactive aggressive behavior (Reactive Proactive Questionnaires; RPQ), psychopathic traits (Triarchic Psychopathy Measure; TriPM), youth trauma experiences (Childhood Trauma Questionnaire; CTQ), social and moral reasoning skills (Socio-Moral Reflection Measure – Short Form; SRM-SF) and treatment motivation (Treatment Motivation Questionnaire; TMQ). Although treatment motivation was primarily included in this study to predict treatment outcome, it was decided to also investigate whether background characteristics, behavioral measures and neurobiological factors predict the extent to which detainees perceive themselves as motivated for treatment. Previously, Fishbein et al. (2009) showed a relationship between specific neurobiological factors (e.g. neurocognitive functioning and cortisol levels) and treatment readiness. A detailed description of the selected questionnaires can be found in the supporting information (Table S2).

Criminal record information

Comparable research has shown the relationship between specific sentence-related characteristics and treatment outcome in offenders (Fishbein et al., 2009; Mullin & Simpson, 2007). For this reason, we included available sentence-related characteristics. Information with regard to the index offense and the age at first judicial confrontation was derived from criminal records. The index offense was classified as violent (e.g. manslaughter, kidnapping) or non-violent (e.g. burglary, drug trafficking). Information on the total number of previous imprisonments was delivered by the Custodial Institutions Agency (DJI) of the Ministry of Security and Justice, The Hague, the Netherlands.

Treatment outcome measures

In total, four different treatment outcome measures were assessed. First, detainees' behavior during treatment was assessed with the English questionnaire *Treatment Gain: Short Scale*, used by Fishbein and Sheppard (2006). The questionnaire was translated and edited for the current study. Trainers were asked to complete the questionnaire comprising seven multiple-choice questions on the participant's knowledge, participation and competence during treatment. The questionnaire was completed at two points in time; shortly after the start of treatment and before the end of treatment.

Secondly, prison officers were asked to complete the *Social Dysfunction Aggression Scale (SDAS)* (Wistedt et al., 1990). This is an eleven-item, scaled (0 to 4), period-based instrument that records a variety of aggressive behaviors, ranging from mild to moderate to severely aggressive behavior. The reliability of the SDAS has been found to be sufficient (Kobes, Nijman, & Bulten, 2012; Wistedt et al., 1990). The SDAS was also completed twice; shortly after the start and before the end of treatment. Prison officers were asked to rate a detainee's aggressive behavior in the past week with questions such as "To what extent did the detainee show verbal aggression in the past week?".

Changes in pre-test and post-test scores on trainers' and prison officers' behavioral evaluations will be expressed in 'residualized' change scores. These have advantages compared to 'simple' pre-test – post-test difference scores. A recent intervention effect study that included sex offenders argued that it is difficult to interpret therapeutic changes if pre-test differences are ignored, which is the case when using simple change scores (Woessner & Schwedler, 2014). A residualized change score assesses whether a person's post-test change is larger or smaller than the predicted value for that person based on the pre-test score. Although it has been argued that, in this way, residualized scores are not really *change* scores (Waltz, Strickland, & Lenz, 2010), it does reflect the relative benefit from treatment by assuming that everyone has started out equal.

Thirdly, for the current research, a three-item questionnaire was developed to assess self-reported treatment gain. Participants were asked to answer the following questions: 'Do you think you benefitted from the training?', 'Do you notice any changes in the way you think/behave after completing treatment?' and 'Do you think you are able to apply the acquired skills outside prison?'. The dependent variable is the total score on the three items. The internal reliability of this measure appears to be sufficient (Cronbach's $\alpha = .70$). A principal axis factor analysis was conducted on the three items with oblique rotation (direct oblimin). This analysis revealed that the three items loaded on one similar factor (only one factor with an eigenvalue greater than 1 was found that explained more than 60% of the variance).

Finally, in the current study, treatment dropout is studied as a treatment outcome measurement. If participants dropped out of treatment, no information with regard to behavioral changes after treatment (e.g. trainers' evaluations, self-evaluation) was available. Although reasons for dropout were not always systematically recorded by trainers, the following information was provided: exclusion for disruptive behavior or participant's loss of interest (N = 17), transition (N = 10), psychological of physical problems (N = 4), unclear reasons (N = 4). A dichotomous variable for treatment non-completion was created.

Analyses

Missing values and imputation strategy

Missing values were detected on predictor variables, with a mean of 7% missing values per variable (range: 0-19%). Missing data on predictor variables was mainly due to incomplete questionnaires or non-response by mail. In addition, technical difficulties (e.g. the heart rate measure was not working), participant's fatigue or a misunderstanding concerning appointments were other reasons for missing data. Furthermore, an average of 34% (range: 30-37%) missing values per variable was detected on treatment outcome measurements. Missing values on these measures were mainly caused by detainees who dropped out of treatment, which amounted to 29%, as mentioned earlier. A complete case approach – in which subjects with missing values are simply excluded from analyses – would lead to a decrease in power and can results in a bias if the remaining cases are not representative of the complete sample. Therefore, we decided to impute missing values with a multiple imputation (MI) technique (Rubin, 1987; Van Buuren, 2012). Details on how MI was performed can be found in the supporting information.

Analytic approach

The present analyses examine whether neurobiological measures predict treatment outcome in addition to background variables (e.g. age, IQ) and behavioral measures (e.g. aggression, psychopathy). In order to decide which variables were entered in the regression equations, a correlational analysis was performed, showing the relationship between each of the predictor variables and the five outcome variables. Mullin and Simpson (2007), who conducted a comparable study, have argued that a more inclusive approach for entry into and removal from the regression model would be appropriate. They used a liberal probability level of .10 to ensure that all possible relationships between predictors and outcome variables would be explored. This argumentation was followed in the selection of variables for the equation in the current study.

We employed regression models to assess the influence of background, behavioral and neurobiological factors on treatment outcome measures. The predictor variables with a significant correlation with one of the outcome measures were tested for the following regression analysis assumptions: normality of distribution, homoscedasticity, linearity and multicollinearity (Field, 2013). Log transformations were applied if the assumption of normality was violated. Hierarchical or 'sequential' regression models were performed if more than one predictor was significantly correlated with the treatment outcome measure. This regression approach makes it possible to find out whether neurobiological measures add to the prediction of treatment outcome over and above background variables (e.g. age, country of birth) and psychological or behavioral measures (e.g. motivation level, aggression).

We also performed a logistic regression to examine the association between predictor variables and treatment completion, coded as "0" (treatment completed) and "1" (non-completion). Furthermore, we examined the predictive power of significant neurobiological tests in correctly classifying non-completers utilizing plots of sensitivity/specificity, generated from a Receiving Operator Characteristics (ROC) graph, and by examining the area under the curve (AUC). This test assesses the clinical relevance to correctly predict who is more likely to dropout from treatment, based on relevant characteristics.

Results

Descriptive statistics of participants' results in terms of pre-assessment performance are presented in Table 1. Furthermore, results on treatment outcome measures are also displayed.

Trainers reported a significant positive change in detainees' behavior following treatment. For those who completed treatment, the mean scores on the 'behavior during treatment' questionnaire rose significantly, from 17.56 ($SE = 0.39$) to 18.64 ($SE = 0.34$) ($t = 3.21$, $p = .001$). However, this positive change in detainees' behavior was not

Table 1
Means (and Standard Deviations) of Detainees' Performance on Neurocognitive Tasks, Heart Rate Measures, Questionnaires, and Treatment Outcome Measures

Measure	Subtest	M	SD
Neurocognitive tasks			
Stroop Color Word Task	Interference control (sec)	30.47	15.77
D-II Cancellation test	Correct minus mistakes (CP)	165.18	29.61
WAIS Digit Span	Total correct backward	4.45	1.23
M-WCST	Categories correct	4.76	1.72
	Perseverative errors	2.75	3.70
Tower of Hanoi	Total planning time (sec)	73.95	32.77
	Errors	6.42	4.67
Stop it	SSRT (msec)	221.50	49.67
Reading the Mind in the Eyes	Total correct	19.97	2.91
COWAT	Total words correct	27.18	8.76
Heart rate measures			
Heart rate	Rest (bpm)	68.55	9.91
	D-II task (bpm)	76.28	10.62
RSA	Rest (msec)	86.04	51.45
	D-II task (msec)	65.55	39.47
Questionnaires			
RPQ	Reactive aggression	9.76	4.31
	Proactive aggression	4.92	4.41
TriPM	Disinhibition	18.94	10.60
	Meanness	14.28	8.73
	Boldness	34.49	6.63
CTQ	Total score	37.73	14.29
SRM-SF	Total score	211.58	44.30
TMQ	Total score	23.20	4.75
Treatment outcome measures			
Trainer evaluation[a]	First assessment	17.56	3.62
	Second assessment	18.64	3.17
SDAS[a]	First assessment	2.82	4.5
	Second assessment	2.11	3.14
Self-evaluation[a]	Total score	4.77	2.12

Note: WAIS = Wechsler Adult Intelligence Scale, M-WCST = Modified Wisconsin Cart Sorting Test, COWAT = Controlled Oral Word Association Task, RSA = Respiration Sinus Arrhythmia, RPQ = Reactive Proactive Questionnaire, TriPM = Triarchic Psychopathy Measure, CTQ = Childhood Trauma Questionnaire, SRM-SF = Socio-Moral Reflection Measure Short Form, TMQ = Treatment Motivation Questionnaire, SDAS = Social Dysfunction Aggression Scale.
$N = 121$ for all variables because of imputation technique.
[a] $N = 86$, only information for those who completed treatment is provided.

reported by the ward staff, since the mean scores on the SDAS, reflecting aggressive and disruptive behavior on the ward, did not change significantly ($t = .748$, $p = .454$). Furthermore, more than half of the sample did not report a significant change in their behavior and/or thinking after treatment. As previously described, 29% dropped out of treatment. The non-completers did not differ significantly from treatment completers with regard to age, IQ and country of birth. In addition, a correlational analysis revealed no significant associations between the different treatment outcome measures.

Table 2 shows correlational analyses between the five outcome variables, including the level of treatment motivation, and predictor variables. Spearman's rho analysis was conducted since most variables were non-normally distributed. In addition, a point-biserial correlation was run between the measure of dropout and predictor variables. Overall, the results reveal that there are several, though relatively weak, correlations between predictor variables and treatment outcome measures. In addition, in contrast to our first hypothesis, no significant correlations were found between heart rate measures and any of the treatment outcomes measures.

Based on Table 2, five variables were found eligible for inclusion in the regression model, aimed at predicting treatment motivation (Table 3). A hierarchical regression analysis revealed that treatment motivation was strongly and negatively related to the subscale 'Meanness' of the psychopathy measure TriPM ($t = -3.211$, $p = .001$). The final regression model on motivation explained 15.4% of the variance, of which Meanness explained 8%. No other predictor variables significantly contributed to the explained variance of Motivation.

Table 2
Correlations Between Treatment Outcome Measures and Detainees' Characteristics, Neurocognitive Functioning, Heart Rate Measures, and Questionnaire Response

	Motivation	Change Trainer Report[1]	Change in SDAS[2]	Self-evaluation	Dropout
Age	**.253**	-.053	-.053	**.273**	-.045
NLV IQ	-.067	.119	-.014	-.149	.036
Age first judicial contact	**.162**	**.217**	.019	.151	.155
Index offence	-.056	.041	.057	.002	-.104
Imprsionments	.006	-.022	.056	.033	.069
Stroop interference	.026	.074	.057	**.213**	.016
Digitspan backward	-.004	-.059	-.159	**-.202**	.099
D2 CP	-.129	-.112	-.033	**-.292**	**-.241**
Eyes correct	.061	-.121	-.110	-.011	.145
COWAT total	.048	.081	.007	**-.193**	-.044
SSRT stop it	.028	.020	.098	.064	.074
TOH errors	.107	.051	-.091	.179	.059
TOH planning time	.109	-.037	-.042	.001	-.017
MWCST correct categories	.161	-.059	-.061	-.036	-.051
MWCST perseverative errors	-.056	.054	-.073	.101	-.091
SRM-SF	.104	.217	-.006	-.024	-.083
HR reactivity	-.008	.094	.028	-.059	-.062
RSA reactivity	.019	-.064	.089	.069	.028
TriPM Boldness	-.145	-.116	-.097	-.121	.126
TriPM Meanness	**-.351**	.146	**.287**	**-.265**	.100
TriPM Disinhibition	-.090	.057	.026	-.095	.110
RPQ Reactive	**-.208**	**.220**	.117	-.122	.109
RPQ Proactive	**-.155**	.080	.096	-.076	.125
CTQ Total	-.027	.104	.087	-.026	.088
TMQ	-	-.012	.068	**.503**	**-.190**

Note. Significant correlations ($p < .10$) are in boldface. NLV IQ = Verbal Intelligence, D2 CP = D2 Concentration Performance, COWAT = Controlled Oral Word Association Task, SSRT = Stop Signal Reaction Time, TOH = Tower of Hanoi, MWCST = Modified Wisconsin Cart Sorting Task, SRM-SF = Socio-Moral Reflection Measure Short Form, HR = Heart Rate, RSA = Respiratory Sinus Arrthymia, TriPM = Triarchic Psychopathic Measure, RPQ = Reactive Proactive Questionnaire, CTQ = Childhood Trauma Questionnaire, TMQ = Treatment Motivation Questionnaire, SDAS = Social Dysfunction Aggression Scale.

1 A positive change indicates a positive behavioral evaluation by trainers.

2 A positive change indicates increased aggressive/disruptive behavior on the ward.

Table 3
Results of Hierarchical Regression Demonstrating Contribution of Meanness to Variance in Motivation

Predictors	*B*	*SE B*	*β*	*p*	*Confidence interval B*	
					Lower bound	Upper bound
Step 1						
Constant	7.483	5.718		.191		
Age	3.743	2.020	.211	.064	-.220	7.706
Age first judicial contact	1.141	2.044	.063	.577	−2.869	5.150
Step 2						
Constant	13.370	6.386		.037		
Age	2.218	2.065	.125	.283	−1.838	6.273
Age first judicial contact	1.451	1.995	.080	.467	−2.462	5.364
TriPM Meanness	-.193	.060	-.355	.001	-.311	-.075
Proactive aggression	.615	.781	.012	.431	-.918	2.148
Reactive aggression	.013	.145	.105	.926	-.270	.297

Note. SE = Standard Error. R^2 for Step 1 = .065 ($p = .019.$), ΔR^2 for Step 2 = .089 ($p = .009$). No control variables needed to be included. $N = 121$.

Furthermore, based on Table 2, two variables (age at first judicial contact and RPQ - Reactive Aggression) were entered in the regression equation aimed at predicting change in trainers' evaluation. Table 4 shows that the age at the first judicial contact significantly accounted for a small proportion (4.5%) of the variance of change in trainers' evaluation, indicating that a first judicial contact at a later age predicts a greater benefit from treatment. RPQ - Reactive Aggression did not significantly contribute to the variance of change in trainers' evaluation.

Only level of self-reported Meanness significantly correlated with change in aggressive behavior as reported by prison officers. Table 5 shows the positive linear regression between TriPM Meanness and a change in aggressive behavior as reported by prison officers ($t = 2.092$, $p = .037$). This indicates that individuals with relatively higher self-reported meanness traits, showed more disruptive behavior at the end of treatment, as reported by ward staff. TriPM Meanness explained 5% of the variance in change in negative/disruptive behavior following treatment.

As shown in Table 2, several predictor variables, including age, D2 concentration and Meanness, were associated with detainees' self-evaluation after treatment. Table 6 represents the multiple hierarchical regression model on self-evaluation, including relevant background variables, behavioral measures and neuropsychological measures. Overall, a higher level of motivation predicts a more positive self-evaluation reported by detainees following treatment ($t = 4.210$, $p = .000$). Twenty percent of the variance is explained by treatment motivation. No other predictor variables significantly contributed to the variance in self-evaluation.

A logistic regression was performed to predict treatment completion and non-completion (Table 7). It appeared that treatment motivation

Table 4
Results of Hierarchical Regression Predicting Change in Trainers Evaluation Demonstrates Contribution of Age at First Judicial Contact to Variance in Trainers' Evaluation

Predictors	*B*	*SE B*	*β*	*p*	*Confidence interval B*	
					Lower bound	Upper bound
Step 1						
Constant	−2.338	1.194		.050		
Age first judicial contact	.818	.416	.217	.049	.002	1.634
Step 2						
Constant	−2.874	1.236		.020		
Age first judicial contact	.869	.415	.210	.036	.055	1.683
Reactive aggression	.042	.028	.180	.132	-.013	096

Note. SE = Standard Error. R^2 for Step 1 = .045 ($p = .049$), ΔR^2 for Step 2 = .029 ($p = .113$). No control variables needed to be included. $N = 86$.

Table 5
Results of Linear Regression on Change in Evaluation by Ward Staff Demonstrates Contribution of Meanness to Variance in Ward Staff Evaluations

Predictors	*B*	*SE B*	β	*p*	*Confidence interval B*	
					Lower bound	Upper bound
Step 1						
Constant	-.364	.203		.073		
TriPM Meanness	.027	.013	.234	.037	.002	.052

Note. SE = Standard Error. R^2 for Step 1 = .050 (p = .038). No control variables needed to be included. N = 86.

again significantly contributed to the regression model and explained up to 6% of the variance. The results indicate that detainees who report low levels of motivation pretreatment, run a greater risk of dropping out of therapy. In addition, the neuropsychological measure D2 CP, which is a measure of concentration performance, also contributes significantly to the model and appears to explain 12.7% of the variance. The model indicates that a low level of concentration is associated with increased chances to drop out of treatment.

In addition, the ability of D2 CP to correctly classify treatment non-completion was continued by generating a Receiver Operating Characteristic (ROC) analysis and an associated area under the curve (AUC) graph. The ROC graph indicates the trade-off between sensitivity and specific over different cutoff-points on the measure (Dolan & Doyle, 2000). An AUC value of 1.0 indicates perfect predictive discrimination, whereas a value of .5 indicates a chance level of discrimination. The D2 task was able to discriminate between non-completers and completers acceptably, with an AUC of 0.65 (SE = .053, p = .008). In addition, motivation discriminated non-completers from completers poorly, with an AUC of 0.62 (SE = .056, p = .04).

Discussion

The present study addressed the predictive value of neurobiological factors in relation to detainees' treatment outcome, in order to better understand why some individuals respond well to treatment while others do not. In general, various individual characteristics (e.g. background information, behavioral measures and neurobiological factors) were included in the current study, but only a small proportion was associated with treatment outcome. Nevertheless, the present study yielded three important key findings. First, a logistic regression analysis indicated that detainees exhibiting a relatively poor concentration performance, as measured with the D2 task, are more likely to drop out of treatment. This neurocognitive task explained almost 13% of the variance in dropout. In addition, a ROC-AUC analysis indicated that the D2 task was able to discriminate acceptably between non-completers and completers with an AUC of more than 0.65.

Table 6
Results of Hierarchical Regression on Detainees' Self-evaluation Demonstrates Contribution of Motivation to Variance in Self-reported Evaluation

Predictors	*B*	SE *B*	β	*p*	*Confidence interval B*	
					Lower bound	Upper bound
Step 1						
Constant	−2.201	3.089		.476	−8.260	3.858
Age	2.099	.925	.264	.023	.284	3.914
Step 2						
Constant	−4.100	3.379		.228	−10.811	2.611
Age	1.042	.886	.131	.241	-.704	2.787
Motivation	.227	.050	.509	.000	.128	.326
TriPM Meanness	−0.00	.028	.000	.999	-.056	.056
Step 3						
Constant	−3.238	5.685		.569	−14.403	7.927
Age	.734	.898	.092	.414	−1.032	2.501
Motivation	.208	.049	.465	.000	.111	.305
TriPM Meanness	-.009	.028	-.039	.740	-.065	.047
Stroop interference	.892	1.005	.087	.375	−1.081	2.865
COWAT total	-.025	.023	-.104	.271	-.071	.020
D2 CP	-.009	.008	-.124	.268	-.025	.007
Digitspan backward	-.186	.176	-.108	.291	-.532	.160

Note. SE = Standard Error. R^2 for Step 1 = .060 (p = .023), ΔR^2 for Step 2 = .246 (p = .000), ΔR^2 for Step 3 = .078 (p = .052). No control variables needed to be included. N = 86.

Concentration performance is a typical attention process that involves the capacity to focus on a goal while ignoring distractors. Possibly, an inability to pay attention to, for example, treatment instructions while ignoring distractors (e.g. other detainees' murmur or one's own distress) increases the chances of dropout. Interestingly, the D2 task has been found to have a robust relationship with antisocial behavior. A recent meta-analysis on the relationship between neuropsychological functioning and antisocial behavior has shown a medium effect size of D2 (d = .45), indicating that individuals with antisocial behavior perform .45 standard deviations worse on the D2 task compared to controls (Ogilvie et al., 2011). In addition, it has been demonstrated that *within* a group of inmates, psychopathic detainees performed more poorly on the D2 task compared to non-psychopathic detainees (Pham, Vanderstukken, Philippot, & Vanderlinden, 2003). This may suggest that individuals in the current sample who performed poorly on the D2 task are characterized by higher psychopathic traits. However, a post-hoc analysis did not support a relationship between D2 concentration performance and psychopathic traits. Overall, the existing literature and results from the current study indicate that detainees in general have relative deficits in concentration performance, but when this become more problematic or reaches a certain threshold, detainees' chances of dropping out of treatment increase.

The relationship between a poor concentration level and higher chances of dropout is in contrast with our second hypothesis ('weak neurocognitive functioning is associated with more benefit from treatment since there is greater potential for improvement'). This hypothesis was based on previous, and comparable research, done by Mullin and Simpson (2007), who showed that prisoners with lower scores on cognitive measures (e.g. the planning task and cognitive flexibility measure) tended to show the greatest behavioral improvement after following the ETS program. Nevertheless, the current results are more in support of a study conducted by Fishbein et al. (2009), who investigated neurocognitive predictors in prisoners related to CBT, and found an overall effect of severity of neurocognitive deficits, related to poor treatment outcome. Future research on the relationship between antisocial behavior and neurobiological factors should reveal more empirical knowledge, which may then lead to the development of substantiated hypotheses.

Furthermore, a ROC-AUC analysis indicated that motivation level discriminated non-completers from completers with an AUC of 0.62. There is empirical evidence that lower motivation levels increase the likelihood that offenders will not complete treatment (e.g. Dowden & Serin, 2001; Stokes, Dixon, & Beech, 2009). In addition, the RNR model also stresses the importance of offenders' motivation level and suggests that behavioral therapy should be tailored to it (Andrews & Bonta, 2010; Andrews & Dowden, 2007). Nevertheless, an AUC of 0.62, as found in the current study, is considered as poor, whereas an AUC of 64 or higher is considered as moderate (Rice & Harris, 2005). This indicates that a neuropsychological task (D2) better discriminates non-completers from completers compared to a more traditional treatment outcome predictor (motivation level), even though the 'predictive' power of this task is only moderate.

Secondly, we found that individuals with relatively high levels of self-reported 'meanness' are more likely to display an unmotivated attitude towards treatment (with an explained variance of 8%). Meanness is a psychopathy construct, also described as the 'affective' aspect of psychopathy, including characteristics like callousness, shallow affect, and blame externalization (Patrick, 2010). This finding provides insight in what *kind* of individuals are less motivated to change their behavior

Table 7
Results of Logistic Regression on Treatment Dropout Showing Group Differences Between Completers and Non-Completers on Attention Performance Skills and Motivation Level

Predictors			95% CI Odds Ratio			Specificity %	Sensitivity %	Correctly predicted %
	B	*p*	Lower	Odds	Upper			
Step 1								
Constant	1.346	.235						
TMQ	-.099	.049	.821	.906	.999			
Total						99.28	2.88	71.42
Step 2								
Constant	6.726	.003						
TMQ	-.138	.016	.778	.871	.974			
D2 CP	-.028	.002	.955	.973	.990			
Total						92.34	24.00	72.52

Note. CI = Confidence Interval. Nagelkerke R^2 for Block 1 = .058 Model 1 displayed F = 4.263, df = 1 and 182 (p = .040), Nagelkerke R^2 for Block 2 = .185 Model 2 showed F = 7.618, df = 2 and 342 (p = .000). No control variables needed to be included. N = 121.

and is in line with other studies that found a negative relationship between psychopathy and treatment readiness (e.g. Hobson, Shine, & Roberts, 2000; Ogloff, Wong, & Greenwood, 2006). No other individual characteristics, such as age or IQ, significantly predicted treatment motivation. In addition, meanness exerted a small, but significant and positive effect on aggressive/disruptive behavior after treatment on the ward as reported by prison staff. This finding is in line with other studies that found moderate, but significant correlations between scores on the Psychopathic Checklist Revised (PCL-R) and verbally and/or physically aggressive, institutional behavior (e.g. Buffington-Vollum, Edens, Johnson, & Johnson, 2002; Edens, Poythress, & Lilienfeld, 1999; Hildebrand, de Ruiter, & Nijman, 2004; Kroner & Mills, 2001).

Thirdly, treatment motivation level was strongly and positively associated with an increased self-reported change in behavior and thinking following treatment. Motivation level explained 20% of the variance in the self-reported evaluation after treatment, which is a medium to large effect (Kotrlik & Williams, 2003). Since no other variables significantly predicted this self-reported behavioral change, the results may indicate that highly motivated detainees have an 'expectation bias' that results in a positive evaluation after treatment, regardless of any individual characteristic.

Finally, the age at the first judicial contact exerted a small but significant and positive effect on trainers' reports. A well-replicated finding concerns the relationship between an early onset of antisociality and the presence of more persistent and severe antisocial behavior (e.g. Calkins & Keane, 2009; DeLisi & Vaughn, 2011; Murray, Irving, Farrington, Colman, & Bloxsom, 2010). More specifically, it has been found that the police contact/arrest onset is the most consistent indicator of delinquent career severity (DeLisi, Neppl, Lohman, Vaughn, & Shook, 2013). The results indicate that, according to trainers, severity of antisocial behavior reduces treatment success. However, from file record information it is unclear whether the age at first judicial contact represents the real 'onset' of criminal behavior or whether it represents the capability of antisocial individuals to avoid judicial confrontation as long as possible.

The current study is not without limitations. A remarkable finding is the low average verbal intelligence level of the current sample (slightly over 80), where almost one-third of the detainees have a verbal IQ of 75 or lower. According to the Probation Service, detainees with a total IQ of 90 or lower are generally assigned to an adjusted version of the CoVa training ('CoVa-plus'). However, an official IQ measurement is not part of the pre-treatment selection procedure performed by the Probation Service (Ferwerda et al., 2009). This suggests that the assignment to the regular CoVa and CoVa-plus treatment based on IQ could be improved with help of some adjustments. The success rate of correctional therapy might benefit from adequate intelligence assessment, especially since there is literature suggesting that treatment response and treatment completion is influenced by detainees' verbal intelligence level (Andrews & Dowden, 2007; Dowden & Serin, 2001). Nevertheless, post-hoc analysis revealed that the relative low level of intelligence did not influence the relationship between predictor variables and treatment outcome measures, because IQ level was not related to any of the outcome variables and relevant predictors (e.g. concentration performance, meanness, motivation, age at the first judicial contact).

Additionally, there are other neurobiological variables that have been empirically linked to offenders' treatment outcome (e.g. hormone levels and genetic information), which the current authors were unable to examine. Moreover, our results did not confirm our first hypothesis with regard to the relationship between low physiological arousal and poor treatment outcome, as demonstrated by prior studies (e.g. Motamedi, Amini, Siavash, & Attari, 2008; Stadler et al., 2008; Van de Wiel, van Goozen, Matthys, Snoek, & van Engeland, 2004). Although there is empirical evidence for the involvement of heart rate and RSA in the arousal – treatment outcome relationship, this has only been found in children samples with ages ranging from three to ten (Cornet et al., 2014). Future research is warranted to further investigate whether this relationship between physiological arousal and treatment outcome holds for adult samples.

Furthermore, in contrast to Fishbein et al. (2009), no distinction was made between 'negative' reasons for treatment non-completion (e.g. disruptive behavior during treatment) and 'neutral' reasons (e.g. a mandatory transfer, obtaining a job). Since trainers do not systematically document reasons for treatment dropout, we were unable to discriminate 'negative' from 'neutral' reasons with absolute certainty. However, we reasoned that non-completion caused by 'neutral' factors, such as a transfer, could still be the result of detainees' unwillingness or resistance to receive treatment. In line with this, the results of the current sample showed that non-completers, as a group, reported significant lower motivation levels compared to completers. Furthermore, a comprehensive meta-analysis showed that without making a distinction between different treatment dropout reasons, non-completers significantly differed from completers on treatment responsivity characteristics such as denial, motivation and treatment engagement/change (Olver et al., 2011). However, this does not suggest that there are no individual differences in treatment unwillingness or resistance when controlling for different dropout reasons. Nevertheless, since Fishbein et al. (2009) excluded non-completers with neutral dropout reasons from all analyses, no evidence could be deducted from their study that individuals with negative and neutral dropout reasons have different individual characteristics.

Finally, correctional treatment programs such as CoVa aim to reduce criminal recidivism rates. However, in the current study only proximal measures of change (e.g. trainers' evaluations directly after treatment) were assessed. To date, the relationship between these proximal measures and recidivism rates has not been truly understood. Literature on sex offenders has revealed mixed results; some studies have found a predictive effect of immediate treatment outcome measures on recidivism (e.g. Beggs & Grace, 2011), while others have not (Barnett, Wakeling, Mandeville-Norden, & Rakestrow, 2013; Seager et al., 2004; Woessner & Schwedler, 2014). In addition, the period-based SDAS measure concerning aggressive behavior on the ward provides a general impression of one's behavior. We need to keep in mind that focusing on two weeks within a timeframe of two months only provides a 'snapshot' of one's behavior and may have led to an under –or overestimation of detainees' aggressive behavior. Also, the mean SDAS score of 2.82 at baseline in the current sample was low compared to other studies in forensic or psychiatric samples (e.g. Rossberg & Friis, 2003; Zaalberg, Nijman, Bulten, Stroosma, & van der Staak, 2010; Zaalberg et al., in press) (with the mean SDAS scores being 9.9, 5.1, and 12.2, respectively), which may have reduced the possibilities for a (statistically significant) decline of these scores in the present sample. In contrast to behavioral evaluations, treatment dropout appears to be a more consistent and strong predictor of reconviction, as it has been demonstrated that non-completers are six to eight times more likely to reoffend compared to treatment completers (Dowden & Serin, 2001; Seager et al., 2004).

Overall, this suggests that increased insight into the individual characteristics underlying treatment dropout might potentially decrease the chances of reconviction. Traditionally, psychosocial factors such as age, motivation and verbal intelligence level, have been suggested to cause dropout (Dowden & Serin, 2001). The results of the current study indicate, however, that concentration performance as measured with the D2 task could discriminate non-completers from completers to some extent, with a moderate AUC of 0.65. This effect appeared to be stronger than the discriminative value of self-reported motivation level on dropout. An AUC of 0.65 is slightly better than chance, however, most well-known risk assessment instruments appear to have an AUC of around 0.70 or higher (Singh, Grann, & Fazel, 2011). For example, the well-known Historical, Clinical, Risk Management-20 (HCR-20) instrument has a discriminative value of 60 to 80% (Dolan & Doyle, 2000; Douglas & Reeves, 2010).

Although, the results of the current study are modest, it provides evidence, along with previous empirical research, that specific neurocognitive skills, such as attention performance, might have an added value in the treatment selection procedure above and beyond existing psychosocial measurements, including self-reported motivation level. Yet, neurocognitive tasks, and other relevant neurobiological factors, do not play a role at all in current risk assessment procedures. To illustrate, the RISc instrument, used by the Dutch Probation Service to select detainees for treatment, includes the following cognitive aspects: impulsiveness, problem insight, problem management, future orientation and thinking/learning style. In addition, group suitability is estimated by a detainee's level of self-control and the degree of dominant behavior. Relevant RISc subscales are completed based on interviews with the inmates and referees, and based on criminal record information (ReclasseringNederland, 2009). No neuropsychological or physiological measurements are part of this selection procedure.

There are several reasons why the forensic field is reluctant to embrace neurobiological knowledge. One reason is the idea that it is difficult to incorporate neurobiological measures (Cornet, accepted). This argument definitely holds for specific measurements, such as functional brain imaging techniques (fMRI) or genetic sampling. However, the neurocognitive task central to the current study is very easy to administer (both paper-pencil method and computerized versions exist) and it takes less than five minutes to complete (Brickenkamp, 2007). The incorporation of relevant neuropsychological measures, such as the D2 task, into current risk assessment procedures has several important implications: first, both the empirical validity and predictive value of current risk assessment instruments might potentially improve. In addition, for those detainees who are less likely to benefit from treatment due to neurocognitive deficits (e.g. concentration or inhibition problems), extra guidance through the treatment, alternative treatment options (e.g. medication), or a preparatory course such as the Cogmed training (Brehmer, Westerberg, & Backman, 2012), to improve concentration capacity before the actual treatment could be offered.

Conclusion

The results of the current study suggest the following: detainees who are perhaps most in need of treatment (e.g. individuals with increased concentration problems, psychopathic traits and early-onset antisocial behavior) may be less likely to benefit from treatment. The incorporation of neuropsychological measures, such as the D2 task, might better detect detainees who are less likely to benefit from treatment. Future research is warranted to gain more insight into the relationship between neurobiological factors and offenders' treatment outcome and to explore which (treatment) options might be offered to those who are less likely to benefit from treatment based on specific neurobiological characteristics.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jcrimjus.2015.02.003.

Notes

[1] See http://homepage.smc.edu/russell_richard/Psych2/Graphics/2013_Brain_Orientation_pictures.pdf for an illustration of the anatomy of the brain.

[2] Intellectual abilities were measured with the Dutch version of the National Adult Reading Test, see the Materials section.

[3] IQ is not measured in a standard way in the treatment selection procedure assessed by the Probation Service.

[4] Although socioeconomic status (SES) is often considered a control variable for the heart rate – antisocial behavior relationship, we did not have access to detainees' SES information.

[5] This is not similar to 'ethnicity', since ethnicity requires information about the parental birth country. Unfortunately, this information was often lacking in the criminal records. We therefore decided to only take into account participants' birth country.

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