

Neuropsychological Subtypes of Violent Behaviour: Differences in Inhibition between Affective and Instrumental Violence

Thijs W Van De Kant^{1*}, Swaantje F Boers², Maaïke Kempes^{1**}, Jos IM Egger^{3**}

¹The Netherlands Institute of Forensic Psychiatry and Psychology, Utrecht, The Netherlands; ²Free University Amsterdam, Amsterdam, The Netherlands; ³Donders Institute for Brain, Cognition and Behaviour, Radboud University, Nijmegen, The Netherlands

ABSTRACT

Background: Forensic assessment is primarily focused on psychosocial factors to understand aggressive behaviour. However, evidence suggests a relation between neurocognitive factors and violence. Inhibition is one of those factors possibly related to violent behaviour, but prior research regarding inhibition remains inconclusive. One explanation may be the existence of distinct neuropsychological profiles for subtypes of violent offenders. This study aims at differentiating groups of affective and instrumental violent defendants on their ability to inhibit behaviour.

Methods: We compared a group of 26 affective defendants with a group of 37 instrumental defendants on several tasks for executive functioning.

Results: Affective defendants have more trouble inhibiting an ongoing response on the Stop Signal Task. There were no further differences between affective and instrumental defendants.

Conclusion: Violent defendants constitute of a heterogeneous group, as affective violent defendants possibly have more trouble inhibiting an ongoing response and may therefore be more prone to evoke impulsive violent acts than instrumental defendants.

Keywords: Forensic assessment; Executive functions; Inhibition; Offenders; Affective violence; Instrumental violence

INTRODUCTION

Violent behaviour is a complex problem, not only for the society but also from a scientific perspective. It is not a generic, homogeneous phenomenon, but it is associated with social, psychological and biological determinants that interact and contribute to the violent act [1]. There is growing evidence that different types of violent behaviour vary in terms of neurocognitive profiles [2,3]. Until now, however, very little is known about performance differences between subtypes of violent offenders on standard neuropsychological measures [4]. In this paper, we study these differences on standard neuropsychological measures for response inhibition between affective and instrumental violent defendants that undergo forensic assessment.

In the Netherlands prior to the trial the court can request a forensic assessment. Around 90% of all inpatient forensic assessments are carried out by the Pieter Baan Center (PBC), the official forensic psychiatric observation clinic of the Dutch Ministry of Justice.

Forensic assessment plays an important role in advising the court about the influence of assumed psychopathology of the defendant on crimes, recidivism risk, and treatment options.

Despite evidence suggesting a relation between neurocognitive factors and violence, it appears that forensic assessment is still predominantly based on professional judgment and observations focusing on psychosocial factors [5-7], the narrative of the offender and psychiatric classifications, rather than on objective measurements [8]. In a systematic analysis of 60 inpatient and 30 outpatient evaluations between 2000 and 2009, Ter Harmsel et al. [6] found that the use of standardized psychological measures increased over a decade. However, the use of neuropsychological tests and neurological evaluations is still limited.

This is remarkable because in recent years, a growing body of research on risk factors associated with antisocial behaviour recognizes the robust association between neuropsychological variables and the onset, persistence, and desistance of antisocial behaviour over the

Correspondence to: Thijs W Van De Kant, The Netherlands Institute of Forensic Psychiatry and Psychology, Utrecht, The Netherlands, Tel: + 31 (0)88 07 10 550; E-mail: thijsvdkant@dji.minjus.nl

**Both authors correspond equally

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developmental life span [9,10]. With the growing knowledge of these neurocognitive factors in relation to antisocial or criminal behaviour [11,12], it seems plausible to include the neurocognitive domain, particularly executive functioning, in forensic assessment.

Executive functioning (EF) can be described as a complex concept that consists of different cognitive abilities, such as inhibition, working memory, cognitive flexibility and planning [13]. These functions are needed to plan, execute and regulate behaviour [14,15]. Impairments can affect behaviour and cause impulsivity, carelessness, rigidity, irritability [16] and disorganized action sequences [17].

Response inhibition is one of the central mechanisms in executive functioning and can be described as the extent to which and the duration over which individuals must

- a) Inhibit their responses to prepotent events,
- b) Restrain their actions, and
- c) Otherwise subordinate their immediate interests for the sake of the goal [18].

It is likely that irregular mental flexibility and difficulties to adequately inhibit impulses and prepotent response may limit cognitive strategies to control angry feelings and hostile thoughts, expressing them towards the environment and eliciting impulsive aggressive behaviour [3]. In line with this postulate, several studies found a positive relation between inhibitory problems and antisocial and impulsive behavior [19,20] using standardized neuropsychological tests such as the Stroop Color Word Test (SCWT) [9,21,22] or a Go/No-go task [10,20,23]. However, studies aimed at finding inhibitory deficits in psychopathy and antisocial personality disorder are inconclusive [3,24-26]. An explanation for this can be found by looking at the results of the two largest studies regarding the relation between antisocial behaviour and EF [9,10]. These authors conclude that antisocial individuals may not constitute a homogeneous group. The inconsistent findings may be due to differential associations between response inhibition, types of aggression and dimensions of psychopathy [26] and antisocial behaviour. This implies we should look at different types of violent offenders instead of treating them as a homogeneous group.

A broadly supported classification of violent behaviour is based on the external goals of the offender. Predatory or instrumental aggression requires good response inhibition [27]. The reaction is controlled, unemotional and used to achieve a particular goal and is often related to psychopathy [27]. Reactive or affective aggression is emotional, impulsive, unplanned and a response to a perceived threat, danger or insult [28], and might be related to more difficulties with response inhibition [26,29]. Recent studies suggest overlap between reactive and instrumental aggression, specifically in the more severely violent subjects [23]. However, despite the overlap and the oversimplification of the dichotomous approach, Hanlon et al. [4] found significant differences with large effect sizes between a group of affective murderers and instrumental murderers on intelligence, memory, attention and overall EF, with the affective group performing worse. Although there were no statistically significant differences specifically for response inhibition, affective murderers showed several deficits compared to the instrumental group.

For the purpose of this study, we had access to a unique sample of suspects of offences covering a heterogeneous group of severe

criminological and psychiatric cases. A better understanding of the specific executive impairments in these offenders is important for both risk assessment and the determination of criminal responsibility and may be instrumental in the development of more appropriate rehabilitation programs [7,20,30].

The primary objective of this study was to analyse whether there are differences between affective and instrumental violent defendants on several neuropsychological tasks that measure response inhibition. An important prerequisite of this study was the usefulness of the results for clinical practice of forensic assessment. Although some neuropsychological tests are being used in forensic assessment, there is no current standard as to which tests are most useful and should be structurally incorporated in forensic assessments. For the purpose of this study we chose to include neuropsychological tasks that cover all processes relevant for response inhibition [31] using measures that are easily translated to clinical practice. To measure inhibition of the initial prepotent response we used the random number generation task (RNG). Stopping of an ongoing response was measured with the stop signal task, and the ability to subordinate the immediate interests for the sake of the goal was measured with the Stroop Color Word Test (SCWT).

Based on prior findings we hypothesized that affective defendants would show poorer performance on the Stroop Color Word Test (SCWT) [32], on the Random Number Generation Task (RNG) [33] and on a Stop Signal task [34] as compared to the instrumental group. In line with these expectations, we predicted that trained professionals would rate the affective defendants as more impulsive on the BRIEF-A impulsivity items (Dutch version) [35] than the instrumental defendants. Furthermore, we wanted to know if the used measures for inhibition could predict the type of violence committed and whether the combined use of measures would lead to a better prediction.

RESEARCH METHODOLOGY

Participants

Participants were all defendants who stayed in the PBC. The population of the PBC covers severe criminological and psychiatric cases and cannot be seen as representative of the entire Dutch forensic population whose mental status is assessed. All defendants were evaluated during six weeks by a multidisciplinary team of forensic experts, including a forensics psychiatrist, a forensic psychologist, a social worker, and a team of ward staff members. The diagnostic and forensic findings as well as the conclusions are based on information obtained from the offender, observations of social conduct on the ward, multiple psychiatric and psychological assessment interviews and psychological tests. Data from external sources (e.g., judicial files) is also included. Hetero- and developmental anamnestic information, e.g. childhood trauma and information about the defendant's biography is obtained from close relatives, (ex-) partner(s), employer(s), and other relevant informants. Additionally, previous reports and (previous and current) criminal files are included and integrated in the assessment.

All participants underwent a pre-trial assessment because of assumed psychopathology. The psychological tests administered varied according to the specific questions regarding the mental state of the defendant. Intelligence tests were always performed.

The neuropsychological tests used for this study were also part of the standard assessment procedure. However, defendants could refuse to cooperate with the complete assessment. In that case no data could be collected.

The data was collected between December 2016 and June 2018. In this period, 328 out of 394 defendants refused to cooperate (half of the defendants) or were excluded from the data. Reasons for exclusion were the mental state of the defendant (e.g., manifest psychotic symptoms), reading or language disabilities, colour-blindness or a very low intelligence (<70). Refusal to cooperate was mainly due to the position with regard to the upcoming trial and was not expected to influence the type of pathology shown. In fact, defendants who are able to uphold their refusal for six weeks are likely to show less severe pathology.

Because neuropsychological assessment in criminal samples is often complicated by malingering or symptom exaggeration [36], participants needed to pass a symptom validity test based on the forced choice procedure [37]. All participants passed the test.

This procedure resulted in a total of 66 participants (M age = 36.76 ± 11.1), of which 92.4% were men and 7.6% women. Within this group of participants there was a wide range of personality disorders, psychiatric disorders (Table 1), and types of violent crime. Using the criteria formulated by Meloy [38], 26 participants were included in the affective violence group, and 37 were included in the instrumental violence group. For 3 participants, a classification could not be made because there appeared to be no aggression or the crime had elements of both types of violence.

PROCEDURE

In the first three weeks of their stay in the PBC, participants were invited for the psychological assessment. The SCWT, a stop-signal test and the RNG test were used to assess inhibition. All tests, except for the RNG, were administered using MINDS [39], a software program for neuropsychological assessment. The used measures were part of the standard assessment procedure, and a trained test assistant explained the tasks to the participant and supervised the assessment. These test assistants were blind for the type of violence used and the professional judgment made by the psychiatrist and the wards. In the fourth week of the assessment period, the psychiatrist and the ward filled in the BRIEF-A items

concerning inhibition, based on their findings. Both raters were blind for the results of the neuropsychological assessment. In the weeks after the assessment period, two independent raters (trained psychology students) read the forensic assessment reports to classify the type of violence. Not all participants completed every test, resulting in different sample sizes for each test. Since the neuropsychological tests used for this study were also part of the standard assessment procedure, no separate informed consent was collected. The research was done according to the declaration of Helsinki (2008) and approved by the Ethics Commission of the Radboud University Nijmegen (ECSW2016-2006-411a) and the Institutional Review Board of the Dutch Forensic Psychiatric Institute (NIPP).

MATERIAL

The SCWT [32] is generally considered a test of response inhibition or selective attention. The SCWT is widely used and studied in forensic populations, and the task is relatively simple and easy to comprehend [10]. As a measure for inhibition, only the interference score of the SCWT was used (condition C - (A+B)/2).

The Stop-signal task [34] is based on the two choice Go/No-go task, but it is focused on action cancellation rather than action restraint. Participants see an arrow on the screen and need to press the corresponding arrow on the computer keyboard, unless an auditory stop signal is presented. In order to measure response inhibition an already started action sequence needs to be inhibited. Because there is no observable endpoint for the response inhibition to be completed, a model of estimating the finishing point of the stop process was used to calculate the stop signal response time (SSRT) [40]. This model proposes that the 'stop' and 'go' processes are independent of one another, competing in a race to finish first. If the go process wins, a response occurs, and if the stop process wins, a response is inhibited. An estimate of SSRT is calculated from the inhibition function and distribution of go-trial reaction times (GoRT) using the mean method [41]. In general, lower, flatter inhibition functions indicate deficits in inhibitory control [42]. Previous studies showed that impulsive individuals have a prolonged SSRT as compared to non-impulsive individuals [43,44].

The RNG task [33] was used to measure multiple executive functions, including response inhibition. In this task, participants were instructed to generate a random sequence of 100 numbers

Table 1: Frequencies DSM 5 classifications*.

Variables	Frequency	Percentage
Schizophrenia Spectrum and Other Psychotic Disorders	15	22.7
Bipolar Disorder	2	3
Autism Spectrum Disorder	5	7.6
Attention Deficit and Hyperactivity Disorder	1	1.5
Cluster A Personality Disorder	1	1.5
Cluster B Personality Disorder	22	33.3
Cluster C Personality Disorder	3	4.5
Intellectual Disability	1	1.5
Paraphilia	2	3
Substance Use Disorder	3	4.5
No disorder	6	9.1
Unknown	5	7.6
Total	66	100

between 0 and 9 at a standard pace of one number every second. The concept of randomness was illustrated by the analogy of picking a number out of a hat, mentioning the number, putting it back, and then picking another [15]. The participants received a brief practice period consisting of 10 beeps. People usually perform poorly because of their difficulty to inhibit stereotyped or repetitive behaviour [45]. This inability to give random responses is often attributed to imperfections of the central executive and working memory [46,47]. EF can be assessed using this task by measuring departures from randomness. The adjacency index, A, which measures the degree to which prepotent ordinal counting sequences are produced was calculated using Towse and Neil's [48] Rg Calc program.

The BRIEF-A informant report (Dutch version; 35) was used by the ward staff members and the psychiatrists to structure their professional judgment on the inhibitory functions of the participants. The 8 items consist of questions regarding impulsivity and can be scored 0 (never), 1 (sometimes) or 2 (often), leading to a total score range from 0 to 16.

Meloy's forensic criteria [38] were used to classify participants into the affective and instrumental defendant groups. Two independent Raters who were blind for the test results and each other's ratings scored the forensic assessment reports, including the psychological and psychiatric evaluations made by the forensic examiners, statements by the defendant, victims, and witnesses, police reports and court transcripts. Intraclass correlation was good (average intraclass $r = .74, p < 0.05$) and inconsistencies were resolved through consensus.

ANALYSES

Because the assumption of normality failed, Spearman's rho was used to examine whether the different inhibition variables used in this study correlated with each other. A Mann-Whitney U test for nonparametric testing was used to compare the two groups on

the inhibition variables. A binomial logistic regression analysis was used to ascertain the effect of the inhibition variables on the prediction of the type of violence committed.

RESULTS

Table 2 shows the correlations between the inhibitions variables used in this study. As can be seen, there is a moderate correlation between the RNG Adjacence and the structured professional judgment with the BRIEF-A. Other measures for inhibition did not correlate. Table 3 shows the inhibition variables for the affective and instrumental group.

A Mann-Whitney U test was performed to determine if there were differences in the inhibition variables between the two groups. None of the distributions of the inhibition scores were similar for affective and instrumental violence, as assessed by visual inspection. Contrary to our expectation the SCWT scores for the affective group (mean rank = 32.04) and instrumental group (mean rank = 31.97) were not statistically significantly different, $U = 480, z = -.69, p = 0.99$.

There was no significant difference between the ratings of the affective (mean rank = 27.10) and instrumental (mean rank 24.43) group on the BRIEF-A, $U = 268.0, z = -.63, p = 0.52$. Neither was the difference between the groups on the Adjacence variable of the RNG affective (mean rank = 23.83), instrumental (mean rank = 26.71), $U = 339.50, z = -.688, p = 0.49$ significant. However, a significant difference was found when comparing the SSRT scores of the affective defendants (mean rank = 37.9) with the instrumental defendants (mean rank = 27.85), $U = 327.50, z = -2.14, p = .03$. It appears that affective defendants have more trouble inhibiting an ongoing response as measured with the SSRT.

Next, a stepwise binomial logistic regression analysis was performed to ascertain the effect of the inhibition variables on the prediction of the type of violence committed. The logistic regression model with only the SSRT was statistically significant, $\chi^2(1) = 4.43, p =$

Table 2: Correlations between inhibition variables.

Variables	RNG Adjacence	SCWT Interference	SSRT	BRIEF-A
RNG Adjacence	1.00	.168	.054	.356*
SCWT Interference	.168	1.00	.114	.203
SSRT	.054	.114	1.00	.180
BRIEF-A	.356*	.203	.180	1.00

* Correlation is significant at the .05 level (1-tailed)

Note: RNG = Random Number Generation task, SCWT = Stroop Color Word Test, SSRT = Stop Signal Reaction Time, BRIEF-A = The Behavior Rating Inventory of Executive Function Adult version

Table 3: Group comparison on inhibition variables.

Variables	Type of violence	N	M	SD
RNG Adjacence	Affective	21	29.21	11.12
	Instrumental	29	30.85	9.66
SCWT Interference	Affective	26	149.27	129.63
	Instrumental	37	147.20	110.97
SSRT*	Affective	26	.76	.29
	Instrumental	37	.62	.24
BRIEF-A	Affective	20	11.25	4.96
	Instrumental	30	11.12	6.11

*Correlation is significant at the 0.05 level

0.04. The model explained 9.2% (Nagelkerke R²) of the variance in violence and correctly classified 61.9% of cases. Sensitivity was 30.8%, and specificity was 83.8%. Contrary to our expectations, the addition of the SCWT, BRIEF-A, and RNG Adjacency variables lead to a poorer prediction of the type of violence committed. The logistic regression model was no longer significant, $\chi^2(4) = 3.47$, $p = .48$, the model explained only 1.13% of the variance in violence (Nagelkerke R²), and the sensitivity (26.7) and specificity (80.6) decreased.

Results were controlled for intelligence and psychosis (as diagnosed by the psychiatrist and psychologist) during the criminal offense. However, this did not lead to different outcomes.

DISCUSSION

This study's primary objective was to differentiate between two groups of violent defendants in their ability to inhibit behaviour, using neuropsychological measurements. Furthermore, we were specifically interested in the predictive value of inhibition in the type of violence committed. Four neuropsychological tests were administered, but only the Stop Signal Task seems to be able to differentiate between affective and instrumental violence.

This could mean that affective defendants have more trouble inhibiting an ongoing response than instrumental defendants, reflected by a worse performance on the Stop Signal Task. A longer reaction time appears to be a significant predictor of the type of violence committed; the longer it takes to inhibit an ongoing response, the more likely it is that the defendant committed an affective violent act. Albeit that the SSRT accounts for a modest 9,2% of the variance in the overall type of violence committed, in the context of a crime and the countless factors contributing to and resulting in the act of aggression, this could be a factor of importance in risk assessment and risk management.

The results regarding the SSRT are consistent with and extend prior findings regarding the neurocognitive differences between affective and instrumental offenders [4,49-51]. A study using the stop-signal task to assess differences in inhibition in violent and non-violent offenders [20], shows violent offenders performing worse on this task, which led the authors to conclude that violent offenders have a reduced inhibition compared to non-violent offenders. The present study suggests that a further differentiation can be made within a group of violent defendants, with affective defendants having more difficulty with response inhibition than instrumental defendants.

Contrary to our expectations, no difference between offender groups was found on the SCWT. The overall score for defendants on the SCWT showed clinically significant deficits compared to the normal population, suggesting that interference control is a problem for both types of defendants. These findings are consistent with Hanlon [4], who found significantly poorer performances across different neurocognitive domains, except for inhibition as measured with the SCWT. In a study using the CWIT, a variation on the classic SCWT, researchers did find a relation between a poorer score on the CWIT and the severity of the violence committed in the past [52]. Although this suggests there might be a relation between inhibition as measured with the SCWT and violence, in our study, however, the SCWT was not able to differentiate between affective and instrumental defendants.

To our knowledge the BRIEF-A and the RNG were not used in prior research to assess inhibition in violent offenders or defendants. In this study we found a modest, but significant correlation between the BRIEF-A and the RNG Adjacency. This means there is a correlation between inhibition as observed by clinicians and the Adjacency score as measured by the RNG. However, the BRIEF-A, nor the RNG was able to differentiate between affective and instrumental violent offenders. A literature search came up with one study using the BRIEF-A to predict alcohol-related aggression [53]. This study showed that the Behavioural Regulation Index (BRI), that comprises component processes such as inhibition, emotional control, flexible thinking, and self-monitoring, turned out to be the best predictor. Its constituent subcomponents did not predict alcohol related aggression at all. Therefore, further research with the BRIEF-A should include these other components in order to compare both groups on the BRI.

The above results parallel those of prior studies and might be explained by different brain functions that underlie the performance of the different tasks [54,55]. Barkley [31] identified three interrelated processes of inhibition:

- (a) Inhibition of the initial prepotent response to an event;
- (b) Stopping of an ongoing response, which thereby permits a delay in the decision to respond, such as measured by the SSRT; and
- (c) The protection of this period of delay and the responses that occur within it from disruption by competing events and responses (interference control), as measured by the SCWT.

It appears that the two offender groups only differ in the time needed to inhibit an ongoing response (SSRT). This is in line with prior findings that different kinds of criminal behaviour may be related to different executive functions [56].

The low correlations between all measurements as presented in Table 1 also underline that different instruments to measure inhibition might be sensitive to different processes underlying inhibition.

Related to the above, although the instruments used in this study are focused on specific aspects of inhibition, other executive functions are needed to accomplish the tasks and could have interfered with the results. Therefore, we cannot exclude that a worse performance is due to broader executive problems. However, instruments that can distinguish between inhibition and other executive functions are less suitable for clinical practice.

The strength of this study is that it was aimed at identifying neurocognitive profiles for two subtypes of violent defendants, using standard neuropsychological measurements covering the distinct processes underlying inhibition. This led to a broader understanding of the relationship between inhibitory processes and violence.

The use of Meloy's [38] criteria to identify the two subtypes contributes to a more standardized classification of these subtypes. This distinction is theoretically important and broadly supported in the literature, but a limitation of this study is that the dichotomy may oversimplify highly complex behaviour [27]. Violence may typically contain elements of both instrumental and affective behaviour [57]. However, the outcomes of this study did not change when tests were run using a continuous scale.

Another limitation was the small sample size and large number of defendants who refused to cooperate, which influenced the statistical strength and restricted the number of variables that could be included in the analyses. Post hoc power analysis using the Gpower computer program [58] indicated a total sample of 184 people is needed to detect a large effect ($d = .5$) with a two-tailed Mann Whitney U test with 95% power. It is possible that more predictors would have been significant with a larger sample size although this irrevocably affects clinical relevance of the results.

Also, the specific population used in this study, which includes the most violent defendants with a broad range of severe psychopathology, might limit the possibility to generalize the research results. When replicating this study with larger samples, a recommendation would be to not only include more offenders or defendants but also normal controls to compare the subgroups of violent offenders to the control group. In addition, although inhibition plays a crucial and central part in all other EF, it might be interesting to include other measurements for EF to come to a better understanding of the results by controlling for other cognitive functions. Including a self-rating measure such as the BRIEF-A or the Barkley Deficits in Executive Functioning Scale (BDEFS) might contribute to a higher ecological validity [31,59].

CONCLUSION

In sum, our results provide modest evidence for the validity of neurocognitive subtyping of violent defendants, pleading against the straightforward concept of a homogeneous group. In addition, it follows that it is important to differentiate between the processes underlying inhibition to accurately identify risk factors and adjust risk management to individual needs and responsibility. The use of neuropsychological measurements can be of incremental value to this decision-making.

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