Do High-risk Prisoners Entering Treatment Have Clinically Impaired Cognitive Impulse Control?

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Moffitt's (1993) developmental theory suggests that offenders on the life-course persistent (LCP) trajectory inherit or acquire neuropsychological deficits that compromise impulse control, and ultimately contribute to criminality. Empirical tests of this notion with adult LCP offenders are rare; the expected degree of impairment and which mechanisms are unclear. This research adopted a neurocognitive framework that proposes three cognitive mechanisms of impulse control: decision-making, perceptual control, and motor impulse control. Participants were 77 adult males, predominantly LCP prisoners completed five assessment tasks during pre-treatment assessment. Overall, proportions of impairment were unexpectedly low within and across cognitive impulse control domains. The highest proportions of impairment were observed on tasks requiring cognitive flexibility and sustained attention, and only cognitive flexibility uniquely predicted estimated pre-treatment violence risk. Results suggest the need to disaggregate cognitive from personality and behavioural variants of impulsivity and to further investigate how impaired cognitive flexibility affects progress during and following treatment.

Key words: clinical impairment; cognitive impulse control; high-risk prisoners; life-course persistent offenders; treatment.

Living adaptively requires of us that we sometimes control urges to act on impulse, especially when those impulses are incompatible with longer term desires. A dieter's success will be threatened if frequent urges to eat chocolate cake are not inhibited; a romantic relationship may be fraught with conflict if frustration is not sometimes controlled. That is not to say that acting on impulse is always bad: It can be invigorating to live for the moment without concern for tomorrow. But chronic failure to inhibit immediate impulses can have harmful outcomes, including chronic antisocial and criminal behaviour. This study investigates the prevalence of cognitive deficits that may lead to such failures

in a sample of high-risk male prisoners with high levels of clinically identified impulsivity problems.

For criminal offenders, a stable, trait-like tendency to act on impulse – or impulsivity – can predict criminal risk (Andrews & Bonta, 2006; Wong & Gordon, 2006); considerable empirical evidence supports the relationship between impulsivity and antisocial behaviour in juvenile (e.g., Farrington, 1989; Luengo, Carrillo-de-la-Peña, Otero, & Romero, 1994; Moffitt, 1993; White et al., 1994) and adult populations (e.g., Craig, Browne, Beech, & Stringer, 2004; Douglas & Skeem, 2005; Prentky, Knight, Lee, & Cerce, 1995; Zamble & Quinsey, 1991). Accordingly, impulsivity

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items are included in criminal risk assessment measures (e.g., Violence Risk Scale; Wong & Gordon, 1998–2003), and de

creased impulsivity – in the form of enhancement of self-regulatory capacities – represents a common intervention target in offender rehabilitation programmes across the world (e.g., Hollin, 2013). But its popularity as a risk-related concept conceals confusion about what it is, how to assess it, and how it is theoretically related to crime.

Two influential theories give impulsivity a role in initiating and maintaining criminal risk across the lifespan. Gottfredson and Hirschi's (1990) general theory of crime posits that a lack of behavioural control – developed within the context of socialisation experiences where such control is not modelled or valued – is the primary explanation for deviant behaviour. Empirical tests of Gottfredson and Hirschi's theory consistently show low self-control to be a valid predictor of crime regardless of offenders' demographic and criminal history variables (see Pratt & Cullen, 2000, for a review).

But it is Moffitt's (1993) developmental taxonomy that provides a plausible causal mechanism for the impulsive behaviour of offenders, connecting impulsive antisocial behaviour to both temperament and cognitive processes. According to Moffitt, people who offend only during adolescence do so because it is developmentally normative. But early-onset, life-course persistent (LCP) offenders maintain criminal involvement across much of the lifespan because of inherited or acquired neuropsychological variability, which, although potentially modifiable through life experience, remains relatively stable over the life course (Delisi & Vaughan, 2011; Goldsmith et al., 1987; Moffitt, 1993; Rothbart, Ahadi, & Evans, 2000). For LCP offenders, neuropsychological dysfunction manifests in difficult temperament, which is outwardly expressed via disinhibited behaviour and an angry, irritable disposition (Moffitt, 1993). Therefore, for Moffitt, underpinning the disinhibitory component of

difficult temperament that expresses itself in impulsive behaviour are cognitive inhibitory deficits, sensation-seeking tendencies, and a high activity level (Moffitt, 1993).

Consistent with Moffitt's (1993) approach, the measurement of impulsivity includes self-report personality tools (e.g., Barratt Impulsiveness Scale, Version 11; Patton, Stanford, & Barratt, 1995), cognitive tasks (e.g., Wisconsin Card Sorting Test; Heaton, 1981; Heaton, Chelune, Talley, Kay, & Curtis, 1993), and behavioural ratings (e.g., Lifetime History of Impulsive Behaviour; Schmidt, Fallon, & Coccaro, 2004). But in a correctional setting, the assessment of impulsivity seldom includes cognitive tools. Instead, personality self-report data or behaviour that appear to indicate that offenders acted without forethought (e.g., criminal behaviour for which they were caught quickly) may serve as a basis for inferring the presence of cognitive deficits. However, this assumption may not be valid as correlations are often low or non-significant in comparisons of self-report, personality-based measures, and cognitive measures of impulsivity in offender and non-offender samples (e.g., Cyders & Coskunpinar, 2012; Enticott, Ogl-off, Bradshaw, & Fitzgerald, 2008; Glicksohn, Leshem, & Aharoni, 2006; Parker & Bagby, 1997; Reynolds, Ortengren, Richards, & de Wit, 2006). These disparities could be explained simply by variation in measurement modality, instrument unreliability and so on. But they may also indicate that Moffitt's theoretical proposition – that impulsive personality characteristics go hand in hand with impairments in the cognitive processes responsible for impulse control – is not supported, or at least perhaps not past early adulthood. However, we know of no direct empirical investigations of whether LCP offenders as defined by Moffitt's theory show underlying cognitive inhibitory deficits in adulthood (Farrington, 2011).

Within the cognitive domain, there are a variety of potentially relevant processes that have been investigated in offenders. Studies

have found offenders to be overly sensitive to reward (e.g., Broomhall, 2005; Cherek, Moeller, Dougherty, & Rhoades, 1997; Mitchell, Colledge, Leonard, & Blair, 2002; Yechiam et al., 2008), or to show pronounced impairments in attention-shifting (e.g., Bergvall, Wessely, Forsman, & Hansen, 2001; Dinn & Harris, 2000; Fishbein et al., 2009; Hancock, Tapscott, & Hoaken, 2010; Tuominen et al., 2014) and response disinhibition (e.g., Barkatani et al., 2008; Dolan & Park, 2002; Enticott, Ogloff, Bradshaw, & Daffern, 2007; Lapierre, Braun, & Hodgins, 1995; Swann et al., 2011). But other studies have found no impairments in adult offender populations (e.g., Hart, Forth, & Hare, 1990; Pham, Vanderstucken, Philippot, & Vanderlinden, 2003). It is difficult to know what to make of these findings, given a lack of clear theoretical rationale for which cognitive functions may be of most etiological relevance to impulse control, and to impulsive behaviour that is in turn associated with criminality (Nigg, 2000).

This study used Bechara's (2005) neuro-cognitive framework to guide the choice of a range of instruments to measure cognitive mechanisms of impulse control in an offender sample. Bechara (2005) suggested that there are three interacting cognitive processes that contribute to successful impulse control: (a) decision-making, (b) perceptual control, and (c) motor impulse control. According to Bechara (2005), in cognitively healthy people, advantageous decision-making – making choices with maximally beneficial short- and long-term outcomes – requires the ability to attach emotional meaning to reward and punishment experiences (i.e., positive and negative feelings, respectively), which then guides future decision-making. Perceptual impulse control allows flexible mental sorting between different action plans generated in the process of making decisions: focusing attention on some, and inhibiting focus on others. Finally, motor impulse control allows successful implementation of a selected action plan by inhibiting competing

behaviours. Within controlled experimental settings with patients with certain types of impairment, it is possible to dissociate impulse control into these separate abilities of decision-making, perceptual control, and motor impulse control (Bechara, 2005).

This research investigated cognitive functioning across all three components of Bechara's (2005) model in a sample of imprisoned, predominantly early-onset, life-course persistent (LCP) offenders with high levels of criminal risk. For many of these offenders, impulsivity had been identified as a significant risk factor during clinical intake assessments for an intensive psychological treatment programme.

Our first objective was to investigate whether these early-onset, LCP offenders showed broad or specific clinically significant impairments in the cognitive processes associated with impulse control. Clinical-level impairment was selected as the outcome criterion because it better captures the level of severity in impulsivity that is usually attributed to high-risk samples than would an investigation of minor fluctuations in performance that remain in the normal range (Silverberg & Millis, 2009). Furthermore, it is common for non-offenders to score below average on at least one neuropsychological test within a battery (Binder, Iverson, & Brooks, 2009).

Our second objective was to examine whether global ratings of clinically significant impulsivity based on an offender's behavioural history were related to underlying cognitive deficits, by comparing scores from the cognitive tests to clinician-rated impulsivity on the Violence Risk Scale (VRS; Wong & Gordon, 1998–2003). The criteria used to rate the VRS impulsivity item suggest that impairments in all three of Bechara's (2005) domains are likely to be related to VRS impulsivity-item ratings. Finally, if cognitive deficits underpin impulsive behaviour, and such behaviour in turn is a risk factor for criminal activity, then we expected to be able to predict dynamic risk for violence (from the VRS) from scores on the cognitive tests.

Method

Setting

Participants were recruited from four prison-based, low-medium-security high-risk special treatment units (HRSTUs) in New Zealand (see Polaschek & Kilgour, 2013). High-risk violent offenders voluntarily attend the therapy programme for up to 12 months once they are eligible for parole, but in practice the New Zealand Parole Board commonly recommends attendance to increase the imminence of release. HRSTU admission criteria require that male prisoners have high static risk scores (at least a 70% chance of returning to prison in the five years following release), in a low-medium- or minimum-security status, and enough time left on the prison sentence to complete the programme (Polaschek & Kilgour, 2013).

Participants

Ninety-one prisoners were invited to take part in this study, and 77 agreed to do so (85%). All were serving sentences for combinations of violent and non-violent offences.¹ Of these, 62 were currently imprisoned for a combination of violent and non-violent offences. The mean estimated risk of reconviction leading to re-imprisonment within five years was 69% ($SD = 18$). Participants were predominantly New Zealand Māori (52.3%) or New Zealand European (30.8%) with the remainder of the sample of Pasifika or Asian ethnicity. On average, participants were 32 years old ($SD = 9.20$; range = 19–59 years) with a mean full-scale IQ of 94.7 ($SD = 13.92$).

Materials

Based on Bechara's (2005) recommendations of assessment measures that most closely align with decision-making, perceptual control, and motor impulse control (e.g., Bechara, Noel, & Crone, 2006), five tasks were chosen. If a recommended measure was

unavailable, a reliable, well-validated alternative was chosen (Lezak, Howieson, Bigler, & Tranel, 2012). Decision-making was assessed by the Iowa Gambling Task (IGT; Bechara, 2007). Because the IGT was specifically designed to capture emotion-based decision-making proposed by Bechara as crucial for impulse control, we included only this task to assess functioning in the decision-making domain (Bechara, 2007). Perceptual impulse control was assessed based on the Delis-Kaplan Colour-Word Interference Test (CWIT; Delis, Kaplan, & Kramer, 2001) and the Comprehensive Trail-Making Test (CTMT; Reynolds, 2002). Motor impulse control was assessed by Conners' Continuous Performance Task (CPT-II; Conners, 2002) and the Stop Signal Task (SST; Verbruggen, Logan, & Stevens, 2008). The IGT, CPT, and SST were administered on a Dell PC Laptop (Latitude D800, PP02X; 15" screen size). The CTMT and CWIT were not computerised. The CTMT required line-drawing responses made in the assessment booklet, and the CWIT required verbal responses. Some of the task manuals specified a scoring threshold for deeming performance to be clinically impaired. For those that did not, the common neuropsychological convention of scores at least two standard deviations below the normative mean was used as the impairment threshold (Schretlen, Tester, Winicki, Pearlson, & Gordon, 2008).

Iowa Gambling Task (IGT): Computerised Version

As with real-world gambling, the ultimate aim of the IGT is to win as much money and avoid losing as much money as possible. An overall net win in the IGT requires learning which choices maximise beneficial short- and long-term outcomes, based on experiences of monetary reward and punishment. Participants are presented with one choice at a time from four card decks (A, B, C, D; 60 cards per deck). Every card selection results in a win; the winning amount is shown on screen

after the card selection. But for some trials, a loss is also shown on screen (e.g., 'YOU WIN \$50, but LOSE \$100').

The average win and loss amounts are different for each card deck. Overall, Decks A and B are disadvantageous because they yield high rewards but even larger losses, whereas Decks C and D are advantageous because they yield lower rewards than Decks A and B but even lower losses, resulting in an overall net gain (Bechara, 2007; Bechara, Damasio, Damasio, & Anderson, 1994).

Participants make 100 choices in total, in blocks of 20. IGT performance is primarily evaluated from total and block net scores. Total net scores are the net number of selections from advantageous decks (i.e., CD – AB) from the 100 card selections. Block net scores are the net number of selections from advantageous decks (CD – AB) for each block of 20 card selections. Higher total and block net scores represent more advantageous decision-making. Raw total and block net scores are converted to *t*-scores ($M = 50$, $SD = 10$). For all blocks, *t*-scores ≤ 39 represent clinically impaired decision-making.

Delis–Kaplan Colour–Word Interference Test (CWIT)

The CWIT assesses inhibition of dominant verbal responses, and the ability to shift flexibly from inhibiting some responses and emitting others. Two baseline conditions assess how quickly and accurately participants can name coloured patches and read colour words (e.g., red, blue, green). The inhibition condition presents colour words on a page (e.g., 'red') in an incongruent ink colour (e.g., green). Successful inhibition occurs when the respondent names the ink colour, thus refraining from making the over-learned response of reading the word itself.

The inhibition/switching condition combines inhibition and cognitive flexibility. As before, colour words are presented in incongruent ink colours, but with the addition of a

box around some words and not others. For colour words presented within a box, participants simply read the word; however, for colour words without a box, participants must switch to naming the incongruent ink colour instead.

Successful resolution of cognitive interference in the inhibition and inhibition/switching conditions is indicated by fast and accurate raw completion times. Raw completion times (measured in seconds) are converted to age-corrected scaled scores ($M = 10$, $SD = 3$). Higher scaled scores represent better inhibitory skills. Scaled scores ≤ 4 represent clinically impaired performance.

Comprehensive Trail Making Test (CTMT)

The CTMT has five timed trails assessing visual cue perception, mental flexibility, alternating attention, and behavioural inhibition. Each trail increases in difficulty by adding more levels of distraction (i.e., filler stimuli). For all trails, the respondent draws lines on the paper to connect Arabic numerals (e.g., '7') or number words (e.g., 'seven') as quickly and accurately as possible. For Trails 1 to 3 the numerals 1 to 25 are joined in sequence (i.e., the respondent sequentially draws a line from 1 to 2, from 2 to 3, and so on without skipping any numbers). Trails 4 and 5 are markedly more difficult. Trail 4 requires rapid shifting between perceptual sets because Arabic numerals and number words are alternated (e.g., 1–two–3–four). Trail 5 requires higher level shifting: The numbers 1 to 25 are alternately joined with their corresponding letter in the alphabet from A–L (e.g., 1–A–2–B–3–C). Trails are presented in numerical order, and simple trails must be passed before participants attempt complex trials. Raw completion times for each trail (measured in seconds) are converted to *t*-scores; higher *t*-scores represent faster and more accurate progression through each trail; *t*-scores < 35 represent clinically impaired performance.

Continuous Performance Test (CPT)

The CPT requires rapid evaluation of a stimulus to decide whether to make or withhold a motor response. Participants attend to a series of rapidly presented, white capital letters on a black computer screen (approximately 1 inch in size, bold face). The letters are presented individually, for 250 ms, at three different inter-stimulus intervals (1, 2, 4 s). Participants are instructed to respond to all letters of the alphabet except X by pressing the keyboard spacebar. But participants make no response when X appears. The task has six blocks, each comprising 20 trials at each of the three inter-stimulus intervals (360 trials).

Raw scores on the CPT are converted to age-corrected *t*-scores. An impulsive profile on the CPT is represented by high, abnormal *t*-scores for commission errors, low, normal *t*-scores for omission errors, and low or abnormally fast *t*-scores for hit reaction time (CPT manual; Conners, 2002, p. 29). Commission errors are responses to presentations of X; omission errors are failures to respond to any other letter, and hit reaction time is the time taken to respond to any letter other than X (Conners, 2002, p. 29). For commission and omission errors, clinical impairment is indicated by any *t*-scores above 55 ($t = 55-59$, mildly atypical; $t = 60-64$, moderately atypical; $t \geq 65$ = markedly atypical). For hit reaction time, clinical impairment is indicated by *t*-scores below 40 (i.e., atypically fast reaction times).

Stop Signal Task (SST)

The Stop Signal task is a two-choice reaction task that assesses the speed of inhibition of an already-initiated motor response (Logan, Schachar, & Tannock, 1997). A fixation point (a white cross in the centre of a black screen) is presented, followed by either a white square or a circle. As quickly as possible, participants press a left-hand response button (the 'z' key) when presented with a white square, or a right-hand response button (the '/' key) when presented with a white circle.

On 25% of the trials ('stop signal trials'), the shape is followed by a tone (750 Hz, 75 ms), signalling that participants should stop themselves from pressing the key. The delay between shape and tone (stop signal delay; SSD) is varied to establish the maximum length of delay at which participants can inhibit responding. The delay is initially set at 250 ms and then changes based on the staircase tracking procedure (Verbruggen et al., 2008, p. 481), in which the SSD is adjusted to achieve a probability of successful inhibition approximately 50% of the time. When inhibition is successful, the SSD increases by 50 ms, but if inhibition fails, the SSD decreases by 50 ms. Therefore, an SSD of 0 ms represents continually failed inhibition, whilst an SSD >250 ms represents successful inhibition. Longer SSDs reflects faster implementation of inhibitory control (Verbruggen et al., 2008). The stop signal reaction time (SSRT) is the primary outcome score: the estimated speed of inhibition. It is calculated by using the following equation:

$$\text{SSRT} = \text{Mean no signal reaction time} - \text{Mean SSD}^2$$

A SSRT between 200 and 250 ms is considered a normal range (F. Verbruggen, personal communication, May 19, 2009), but to further aid in the interpretation of SST results in this study, we recruited a sample of male first-year university psychology students to provide normative comparison data. Their mean speed of inhibition ($M_{\text{SSRT}} = 218.44$ ms, $SD = 30.30$) was consistent with Verbruggen's advice. Although students were significantly younger than the offender sample (offenders $M_{\text{age}} = 32$ years, $SD = 9$; students $M_{\text{age}} = 25$ years, $SD = 8$), $t(89) = 3.60$, $p < .01$, in young-to middle-adulthood SSRT is unlikely to be affected by age differences (e.g., IQ; Lijffijt, Kenemans, Verbaten, & van Engeland, 2005; Van de Laar, van den Wildenberg, van Boxtel, & van der Molen, 2011). Using the student normative comparison data, the threshold for clinical impairment

was a SSRT at least 2 standard deviations longer than the student mean (i.e., SSRT > 280 ms).

Violence Risk Scale (VRS)

The VRS is an actuarial violence risk assessment tool based on six static risk items and 20 dynamic risk items that are predictive of violent and non-violent recidivism (see Wong & Gordon, 2006). Each static and dynamic item is rated on a 4-point scale (0, 1, 2, or 3), with higher scores indicating that the item makes a greater contribution to that individual's violence risk (Wong & Gordon, 1998–2003). For the purposes of this study we focused only on pre-treatment scores for item D17: impulsivity. The VRS operationalises impulsivity as: 'spur of the moment occurrences in which the individual reacts without pausing to consider the costs or consequences of negative behaviour' and 'the individual tends not to consider relevant information before reacting' (VRS Manual; Wong & Gordon, 1998–2003, p. 64). If impulsivity is a 'characteristic of the individual's mode of behaviour', a maximum rating indicative of clinically significant impulsivity is warranted (VRS manual; Wong & Gordon, 1998–2003, p. 64).

Procedure

Treatment facilitators briefed treatment group members about the research, after which the first author took each offender who agreed to hear more about the research to a nearby interview room and informed him individually about the research. The independence of the research project from the Department of Corrections was emphasised, and offenders were reassured that their participation would have no bearing on their sentence or treatment within the unit. Offenders who declined participation returned immediately to their daily activities.

Those who provided written consent to take part then completed the IGT, CWIT,

CTMT, CPT, and Stop Signal tasks, administered in one of five pre-determined³ orders sequentially allocated to each participant. Before each new task, participants were given the standard administration instructions for that task. Data collection took approximately 90 min. On completion, participants were offered a small amount of confectionery as a token of appreciation for their time and effort, and then returned to their daily activities. Lastly, basic demographic, intelligence, and criminal risk-related information was obtained from the treatment unit database for all consenting participants.

Results

Table 1 displays raw scores, standardised scores (*t*-scores or scaled scores), and proportions of clinically impaired cognitive impulse control for each task. Where applicable, Table 1 also includes proportions of abnormal performance on more general indicators of cognitive functioning, particularly related to difficulty executing baseline skills and sustaining attention over time (see percentage removed). Proportions of clinical impairment were calculated against the standardised scores described earlier, with the exception of the Stop Signal task, for which raw SSRT was compared between offenders and non-offender, normative comparisons.

More specifically, for the Colour–Word Interference Test we judged respondents as clinically impaired in higher level cognitive inhibitory skills if they showed normal baseline abilities (colour naming and word reading) but impaired scaled scores (≤ 4) for inhibition or inhibition/switching conditions. For the Comprehensive Trail-Making Test, we judged respondents as clinically impaired in higher level inhibitory skills when performance on simple trails (Trails 1–3; visual cue perception) was normal but performance on complex trails (Trails 4–5) was clinically impaired. For the Continuous Performance Test, we differentiated proportions of clinically impaired impulsivity profiles from more

Table 1. Raw scores, standardised scores, and proportions of impairment.

Domain (task) outcome	Raw scores <i>M</i> (<i>SD</i>)	Standardised scores <i>M</i> (<i>SD</i>)	Clinically impaired impulsivity (%)	Removed prior to analysis (%)	Total impaired overall (%)
<i>Decision-making (IGT)</i>					
IGT net score	5.90 (24.76)	47.88 (8.27)	12.99	—	12.99
Block 1 net (Cards 1–20)	−0.81 (5.90)	54.56 (8.83)	2.60		
Block 2 net (Cards 21–40)	1.09 (6.91)	47.51 (8.53)	10.39		
Block 3 net (Cards 41–60)	2.75 (7.52)	48.64 (7.72)	11.69		
Block 4 net (Cards 61–80)	1.45 (7.93)	46.97 (7.85)	14.29		
Block 5 net (Cards 81–100)	1.40 (8.25)	46.61 (9.22)	19.48		
<i>Perceptual (CWIT)</i>					
Inhibition	57.56 (16.09)	9.04 (2.77)	1.35	2.70s ^c	28.37
Inhibition/switch	75.88 (20.94)	6.83 (3.38)	24.32		
<i>Perceptual (CTMT)</i>					
Trail 4	34.03 (14.70)	46.10 (11.83)	14.29	3.90 ^d	38.97
Trail 5	60.65 (22.63)	42.09 (9.93)	20.78		
<i>Motor (CPT)</i>					
Impulsive profile ^a hit reaction time (ms)	341.09 (68.08)	41.42 (12.79)			
Commission errors	17.91 (8.26)	54.69 (10.20)	25.68	20.27 ^e	45.95
Omission errors	7.05 (12.07)	63.40 (37.18)			
<i>Motor (SST)</i>					
Stop signal reaction time (ms)	226.20 (35.03)	—	7.69 ^b	18.46 ^f	26.15

Note: IGT = Iowa Gambling Task ($N = 77$); CWIT = Colour-Word Interference Test ($N = 74$); CTMT = Comprehensive Trail Making Test ($N = 77$); CPT = Continuous Performance Task ($N = 74$); SST = Stop Signal Task ($N = 65$).

^aAn impulsive profile on the CPT is operationalised as abnormally fast hit reaction time and an abnormally high rate of errors of commission with a relatively lower rate of omission errors; ^bproportion of impairment as compared to student norms: $M_{SSRT} = 218.44$ ms ($SD = 30.30$); ^cproportion of impairment on CWIT baseline conditions (colour naming and word reading); ^dproportion of impairment on CTMT baseline conditions (simple Trails 1–3); ^eproportion of sample with CPT sustained attention/vigilance impairment but not motor impulse control impairment; ^fproportion of invalid stop signal data because responses did not meet the threshold of successful inhibition approximately 50% of the time (Verbruggen et al., 2008).

general impairments in vigilance and sustained attention. On the Stop Signal Task, we differentiated proportions of clinically impaired motor impulse control from proportions of erratic responding whereby data did not meet the threshold of successful inhibition approximately 50% of the time from which to calculate stop signal reaction time (Verbruggen et al., 2008).

As Table 1 shows, proportions of cognitive impulse control impairment ranged from as low as 8% to no higher than 26%. Notably, 25/77 (32.47%) displayed no clinical impairment on any task. As Table 2

shows, offenders without clinically impaired performance were no different from the remainder of the sample with respect to age, IQ, or criminal risk. From the five assessment tasks, 30/77 (38.96%) displayed impairment on one task only, 21/77 (27.27%) displayed impairments on two tasks, and only one participant displayed impairments on three tasks. Importantly, impaired performance on two or three tasks was not necessarily within a single domain of cognitive impulse control.

Table 1 also shows that some offenders were not captured within impairment

Table 2. Comparison of demographic and criminal risk outcomes for prisoners with and without cognitive impulse control impairments.

Demographic and criminal risk outcomes	Cognitive impulse control impairment		<i>t(df)</i>	<i>d</i>	95% CI
	Yes <i>M (SD)</i>	No <i>M (SD)</i>			
Age (years)	34.71 (12.53)	36.76 (9.99)	0.72 (75)	0.18	[-3.66, 7.76]
IQ	97.83 (14.98)	92.83 (13.08)	1.40 (62)	0.36	[-2.12, 12.14]
RoCRoI	0.70 (0.18)	0.65 (0.18)	1.16 (74)	0.28	[-0.14, 0.04]
VRS Static	13.45 (2.89)	13.00 (3.03)	0.53 (54)	0.15	[-2.13, 1.24]
VRS Dynamic	45.39 (7.26)	42.56 (8.46)	1.30 (54)	0.36	[-7.23, 1.55]
VRS total	56.48 (9.81)	52.27 (11.33)	1.63 (68)	0.40	[-9.38, 0.95]

Note: RoC*RoI = Risk of Conviction × Risk of Imprisonment. VRS = Violence Risk Scale; CI = confidence interval.

proportions for cognitive impulse control, but still performed abnormally due to more general cognitive impairments. On both perceptual impulse control tasks, approximately 3–4% of the sample had trouble successfully completing baseline requirements: colour naming and word reading on the Colour–Word Interference Test, or completing simple trails (1–3) on the Trail Making Test within a normal timeframe. For both motor impulse control tasks, approximately one fifth of the sample performed in a manner consistent with waning attention and increasingly erratic responding as the task progressed.

Decision-Making Impairment

Analysis of total net scores revealed that nearly half of the sample had negative scores; relatively more choices were made from disadvantageous card decks with high reward but even higher losses. However, as shown in Table 1, a much smaller proportion – only 13% – made sufficiently numerous disadvantageous choices to indicate clinically impaired ability to learn from previous mistakes.

Interestingly, despite mostly normal decision-making overall, the pattern of block net scores displayed in Table 1 showed a quadratic function over time – that is, advantageous scores increased from Block 1 (card selection 1–20) to Block 3 (card selections

41–60) but then decreased thereafter. Normal decision-making performance is indicated by a continuous positive learning curve as the game progresses (Bechara, 2007); by contrast, the quadratic pattern of block net scores suggests that participants initially learned which decks were advantageous, but then reverted back to disadvantageous choices in the final blocks, thus explaining increasing proportions of clinical impairment as the game progressed. One interpretation of this pattern is that once participants learned which card decks were advantageous, they deliberately reverted to making selections from riskier decks in the final blocks – a speculation we return to later.

Perceptual Impulse Control Impairment

Within the perceptual impulse control domain, only three participants were clinically impaired on both the Colour–Word Interference Test (CWIT) and the Comprehensive Trail-Making Task (CTMT). Yet proportions were relatively higher when performance on each task was analysed separately. For the CWIT, only one participant displayed clinically impaired inhibition relative to their baseline performance. However, 24% of participants displayed clinically impaired inhibition/switching abilities relative to their performance on either the baseline or inhibition-only conditions. Thus,

approximately one quarter of the sample demonstrated normal inhibition but were clinically impaired in cognitive flexibility, as assessed by the CWIT.

For the CTMT, on Trail 4, 14% performed within the mildly to moderately impaired or severely impaired range relative to simple trails. For Trail 5, 21% performed within the mildly to moderately impaired or severely impaired range relative to simple trails. Ten participants (13%) were clinically impaired on both Trails 4 and 5 relative to their performance on simple trails.

Motor Impulse Control Impairment

Within the motor impulse control domain, no participants were clinically impaired on both the CPT and Stop Signal tasks. Analysis of performance on the CPT alone showed that group-level averages were largely inconsistent with a clinically impulsive profile. That is, hit reaction times were faster than average but not abnormally so, commission errors were not high, and omission errors were relatively higher. However, 25% of participants' performance did fit an impulsive profile: atypically fast hit reaction times, a high number of commission errors, and relatively fewer omission errors.

For the Stop Signal task, the average stop signal reaction time for offenders displayed in Table 1 was within the range of normal performance and was not significantly different to the average SSRT of the normative, non-offender comparison sample, $t(89) = 0.99$, $p = .325$; $d = 0.24$. Based on the non-offender comparison sample parameters (SSRT $M = 218$ ms, $SD = 30$), a threshold for impaired performance of 2 standard deviations outside of these parameters identified only 7.69% of participants in the offender sample. Their average SSRT of 293 ms ($SD = 8.42$) was indicative of an abnormally slow inhibitory process.

General Summary: Patterns of Impairment

Impairment was lower than expected, and tended to be task-specific rather than consistent within, or across, all three cognitive impulse control domains. Decision-making, basic cognitive inhibitory functions within the perceptual impulse control domain, and basic motor inhibition on the Stop Signal Task were relatively intact. Tasks requiring advanced cognitive flexibility – the later stages of the CWIT and CTMT, and the attention shifting required to emit or withhold a motor response on the CPT – elicited the highest proportions of impairment: between 20 and 25% of the sample in each case. Moreover, approximately 20% of the sample displayed a pattern of impairment indicative of difficulty sustaining attention over time and maintaining provision of consistent, accurate responses as attention wanes.

Comparing Cognitive Impulse Control Performance and VRS Impulsivity

Pre-treatment, clinician-rated VRS ratings were available for 91% (70/77) of the sample. Performance outcomes from each cognitive impulse control task were compared between offenders with or without clinically significant impulsivity on the Violence Risk Scale (ratings of 2 or 3 vs. 0 or 1, respectively). Table 3 displays comparisons of standardised scores for each task with the exception of the Stop Signal Task, for which raw stop signal reaction time scores were compared.

Interestingly, particularly in light of the lower than expected proportions of impairment described earlier, the vast majority – 87% (61/70) – of the sample were judged to show current and historic evidence of clinically significant impulsivity, as assessed by a VRS score of 2 or 3. However, as shown in Table 3, offenders with clinically significant VRS impulsivity did not display significantly poorer cognitive impulse control on any assessment task than offenders

Table 3. Comparison of cognitive impulse control scores by pre-treatment, VRS impulsivity ratings.

	VRS clinical impulsivity		<i>t(df)</i>	<i>d</i>	95% CI
	Yes (<i>N</i> = 61) <i>M</i> (<i>SD</i>)	No (<i>N</i> = 9) <i>M</i> (<i>SD</i>)			
IGT total net score	47.94 (8.37)	49.88 (5.36)	0.64 (70)	0.28	[-8.01, 4.14]
CWIT inhibition	9.08 (2.68)	9.63 (3.02)	0.39 (67)	0.19	[-8.88, 5.99]
CWIT inhibition/switching	7.08 (3.47)	6.00 (2.88)	0.85 (66)	0.34	[-4.93, 12.15]
CTMT Trail 4	47.01 (11.90)	43.63 (11.40)	0.76 (70)	0.29	[-5.47, 12.26]
CTMT Trail 5	42.06 (10.28)	42.38 (9.50)	0.08 (70)	0.03	[-7.95, 7.32]
<i>CPT impulsive profile</i>					
Hit RT (ms)	39.24 (10.29)	36.55 (10.92)	0.69 (62)	0.25	[-5.14, 10.52]
Commission errors	55.40 (9.98)	56.72 (9.99)	0.35 (62)	0.13	[-8.86, 6.22]
Stop signal RT (ms)	223.97 (35.08)	229.57 (34.05)	0.37 (59)	0.16	[-35.70, 24.51]

Note: VRS = Violence Risk Scale; IGT = Iowa Gambling Task; CWIT = Colour-Word Interference Test; CTMT = Comprehensive Trail Making Test; CPT = Continuous Performance Task; RT = reaction time; CI = confidence interval; MS = Milliseconds.

without clinically significant VRS impulsivity. And those who showed impairment on any task also had equivalent mean impulsivity item scores to those who did not ($M_s = 2.3$ vs. 2.4), $t(68) = 0.63$, $p = .53$. Examination of VRS total scores for those with and without any clinical impairments showed no mean differences: impaired $M = 56.5$, $SD = 9.8$; non-impaired $M = 52.3$, $SD = 11.3$, $t(68) = 1.6$, $p = .13$.

Finally, we took the best three univariate predictors of current dynamic violence risk (VRS dynamic scores) and combined them in a multiple regression to examine whether in combination they could account for a significant amount of variance in pre-treatment violence risk. We selected stop signal reaction time, IGT net total, and CWIT inhibition/switching ($r_s = -.23$, $-.22$, $-.25$, respectively). They were not significantly correlated with each other. Together they accounted for 18% of the variance in VRS dynamic scores (adjusted $R^2 = 13\%$); $F(3, 49) = 3.5$, $p = .021$. However, of the three variables, only CWIT inhibition/switching made a significant independent contribution ($\beta = -.33$, $p = .02$).

Discussion

This study did reveal high clinician ratings of behavioural impulsivity, but overall rates of cognitive deficits were low. Although about two thirds of the sample produced one clinically significant score in completing the five chosen tasks, few demonstrated more than one. And in all cases, where there was a significant score on one task in the domain, the other was normal. By inference, most offenders' scores on most tasks were not clinically impaired. Consistent with a number of previous offender studies, tasks that taxed cognitive flexibility – a function within the perceptual impulse control domain – elicited the highest rates of impairment (20 to 25%; Bergvall et al., 2001; Broomhall, 2005; Dolan & Park, 2002; Fishbein et al., 2009; Hancock et al., 2010; Tuominen et al., 2014). However, the preponderance of performances in the clinically normal range was unexpected, especially given the rates reported in studies using less stringent criteria for identifying deficits (e.g., Tuominen et al., 2014). For example, this sample showed mainly normal performance on the Iowa Gambling Task, whereas an Australian sample recently

showed relatively poor performance (Hughes, Dolan, Trueblood, & Stout, 2015).

But normality of cognitive functioning should not be overstated given other patterns of cognitive impairment observed, particularly on both tests of motor impulse control: the Continuous Performance and Stop Signal Tasks. In addition to behavioural inhibition, these tasks heavily tax vigilance and sustained attention. We found that for approximately one fifth of the sample, opportunities to demonstrate higher level behavioural inhibitory skills were never reached because more basic task requirements, like remaining oriented to the task long enough to provide consistent, accurate responses, were substantially compromised. Anecdotal observations made during testing supported the tendency for some participants to become increasingly distractible as the tasks progressed. For example, numerous participants tried to engage in conversation while simultaneously completing the task. Given that these participants were being assessed for an intensive cognitive-behavioural treatment programme, identifying offenders who fit within this profile of general attention deficits is crucial given the detrimental affect of attention deficits on engagement and progress in treatment (Fishbein et al., 2009; Tuominen et al., 2014).

More general impairments aside, why were rates of cognitive-impulse-control-specific impairment processes relatively low in comparison to rates of behaviour hypothesised to result from these deficits? One possibility is the stringent criterion used. Perhaps relative rather than absolute levels of performance should be examined, as has been the case in other studies (e.g., Fishbein et al., 2009). However, a more interesting possibility is that some offenders never had cognitive deficits in the first place, or that they may be 'growing out' of cognitive deficits that were present earlier in life, either because of maturational brain processes (e.g., development in frontal lobes) similar to those seen more generally, or because of a change in the contingencies for criminal behaviour. For LCP

offenders, the development of cognitive inhibitory functions may be delayed, but not indefinitely impaired, perhaps through biological maturation of the relevant brain structures involved in impulse control (see Romine & Reynolds, 2005, for a review; Steinberg et al., 2008; Vaidya, Litzman, Markon, & Watson, 2010). Alongside biological development, mostly normal cognitive impulse control could also be accounted for by learning-based factors. For example, cognitive inhibitory skills may lie dormant in adulthood or develop unusually slowly until the environment requires, motivates, or positively reinforces the use of such skills (Denney, 1984). By adulthood, high-risk LCP prisoners have learned – perhaps from years of experiencing legal punishment for uncontrolled behaviour – that impulse control is important, thus prompting the need to practise, and successfully implement, these skills. If cognitive processes associated with impulse control are functioning in the normal range at this point, does that mean Moffitt's (1993) theory is wrong?

Despite many challenges arising from early development, snares, and the phenomena of cumulative and contemporaneous continuity, it appears from longitudinal cohort research that most chronic offenders eventually desist from crime and develop the ability to function adequately in the community (Farrington et al., 2006; Laub & Sampson, 2003). But Moffitt's (1993) theory is oriented toward explaining the development of chronic criminality *into* adulthood. It is not intended to explain the development in later adulthood out of that plight. Therefore it is entirely plausible that this sample of offenders showed impaired cognitive function associated with impulsive behaviour early in their adult lives, and some or most no longer do.

However, if the frontal regions that facilitate impulse control mature to a reasonably functional level in adulthood, and LCP offenders have the cognitive capacity to strengthen impulse control when their social

environment promotes it, why were the majority of offenders in the present study judged still to have a clinically problematic level of behavioural impulsivity as assessed by the VRS, and why was VRS impulsivity unrelated to cognitive impulse control performance?

One explanation relates simply to the unreliability of measuring behavioural impulsivity using a single 4-point scale, and the very truncated range of scores even within that scale, which severely limits variance. And the VRS item score for impulsivity, although potentially dynamic, captures the full range of historical behaviour by that offender, meaning that more recent improvements in self-control may not greatly reduce the score. Thirdly, examination of the evidence for the VRS ratings made by treating clinicians shows that affective dysregulation is commonly associated with the impulsive behaviour used to make the rating, and we collected the cognitive deficit data under relatively neutral affective conditions. Strong affect can have a substantial temporary effect on cognitive regulatory processes that would not be detected in a more neutral state (e.g., Knapp & Clark, 1991; Tice, Bratslavsky, & Baumeister, 2001).

Another possible explanation for the cognition/behaviour discrepancy is that although cognitive maturation may have occurred, the temperament that Moffitt (1993) described as going hand in hand with cognitive deficits in childhood remains relatively unchanged. Then evidence of more recent 'impulsive' behaviour may actually be a result of an enduring temperamental preference for risky, thrilling, behaviour. A stable personality preference for risky behaviour has been demonstrated in a number of studies of criminal offenders and is recognised as part of the temperamental antisocial personality pattern identified as one of the 'big four' risk factors for crime, by Andrews and Bonta (2006). Although personality factors were not measured in this study, risk taking was supported by performance during the Iowa Gambling

Task. As we noted, the pattern of results across blocks suggested that participants learned which decks to choose from to maximise profits. But as the game progressed, on average, they reverted back to the high-risk decks, thus explaining why proportions of clinical impairment then increased across successive blocks. Anecdotal observations made during the task supported this notion: Participants reported as they played that they later chose to gamble with the risky decks because it was simply a more entertaining strategy to adopt. It is worth noting too that there are no significant consequences to behaving this way in a research study: a point that was no doubt recognised by participants.

One positive relationship between cognitive performance and criminal behaviour was found. The Delis–Kaplan Colour–Word Interference Test was a significant predictor of dynamic violence risk (VRS). Given the number of comparisons, this result could be spurious. However, it suggests that it would be worthwhile comparing cognitive performance with indices of criminal risk as a whole, rather than less behaviourally meaningful characteristics such as index of offence type (Tuominen et al., 2014).

Limitations and Future Research Directions

The design of this study did not support examination of links between cognitive deficits and either real-life impulsive behaviour or criminal propensity more generally, with the exception of estimated dynamic risk for violence. Research that assesses the relevant cognitive processes alongside relevant behavioural data in more ecologically valid settings would be very useful, including experimental designs using analogues for antisocial behaviour, and research that experimentally alters the assessment context via state-based manipulation of factors known to affect impulse control, such as physiological arousal (e.g., Eysenck, 1993; Revelle, Anderson, & Humphreys, 1987), positive mood (e.g., Bohner, Chaiken, & Hunyadi, 1994; De Vries,

Holland, & Witteman, 2008), negative emotion (e.g., Knapp & Clark, 1991; Tice et al., 2001), and cognitive resource depletion (e.g., Muraven & Baumeister, 2000; Muraven, Baumeister, & Tice, 1999). Assessment of cognition could also be conducted in more socially complex, unsettled testing environments. Given more pronounced difficulty with cognitive flexibility in this sample, less structured testing environments with more distractions could be especially helpful in obtaining a more realistic view of impulse control for high-risk offenders who typically live chaotic lifestyles (e.g., Sung & Richter, 2006). Such research may find increased rates of clinically dysfunctional impairment only in specific state or context. It would also be beneficial to explore further which cognitive domains are most important, and whether they are associated with different patterns of problematic behaviour.

Moffitt's (1993) theory suggested that cognitive deficits and a disinhibited temperament go hand in hand in the development of life-course persistent offending. This study speculates that for some LCP offenders in adulthood cognitive control may have developed while the personality traits associated with this early temperament remain, including risk taking, sensation seeking, and high activity level sub-components of disinhibition. Measuring personality traits alongside cognition would be worthwhile in future research.

We did find that a small subset of high-risk, LCP offenders showed some form of impaired cognitive functioning, consistent with Moffitt's (1993) theory of impulsivity within the context of LCP offender development. Our findings suggest that the most relevant cognitive impairment for offenders is cognitive inflexibility: difficulty in prioritising some thoughts and inhibiting others before translating thoughts to behaviour (Bechara et al., 2006). Additional research on this group is warranted, and disentangling the mechanisms underlying the predictive relationship between cognitive inflexibility and changes in criminal risk is a logical next step.

In particular, we aim to examine links between pre-treatment cognitive inflexibility and capacity for positive behavioural change during, but also beyond, the treatment setting. For example, when offenders are faced with challenges like release from prison and reintegration to the community, arguably the ability to mentally prioritise pro-social goals when they are in competition with ingrained, antisocial ways of thinking and behaving all within a new social environment would rely heavily on intact cognitive flexibility.

Conclusions

We applied a neurocognitive framework that breaks down the conceptualisation and assessment of cognitive mechanisms of impulse control into three types, which were tested using five cognitive tasks. The results showed that for most offenders, most tasks showed no cognitive impairment. However, impaired cognitive flexibility was found in about a quarter of the sample, and was correlated with overall dynamic risk for violence. Our findings raise questions about whether Moffitt's (1993) description of cognitive deficits in LCP offenders is correct in this sample, and suggests that assessment and treatment that acknowledges the distinctiveness of both personality-based and cognitive factors is important.

Acknowledgements

We would like to acknowledge the support of the New Zealand Department of Corrections staff and offenders in completing this research, and Gina Grimshaw (Victoria University of Wellington).

Disclosure Statement

No potential conflict of interest was reported by the authors.

Notes

1. For 15 the index offence was a violent sexual assault on an adult victim.

2. The mean stop signal delay at which approximately 50% of trials are inhibited. A threshold of 50% inhibition is the point at which performance data are reliable enough to estimate SSRT from.
3. That is, tasks were administered in one of five pre-determined orders (not fully randomised) but participants were sequentially allocated to one of the orders to randomise order effects.

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