

RESEARCH ARTICLE

Examining the propensity and nature of criminal risk behaviours in frontotemporal dementia syndromes and Alzheimer's disease

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Abstract

INTRODUCTION: Some people with dementia develop changes in behaviour and cognition that may lead to interactions with police or the legal system. However, large, prospective case-control studies examining these behaviours are lacking.

METHODS: One hundred and forty-four people with dementia and 53 controls completed the Misdemeanours and Transgressions Screener.

RESULTS: Criminal risk behaviours were reported in: 65.6% of behavioural-variant frontotemporal dementia, 46.2% of right-lateralised semantic dementia, and 27.0% of Alzheimer's disease patients. In 19.1% of patients these behaviours led to contact with police or authority figures. Compared to controls, people with dementia showed higher rates of physical assault ($p = 0.024$), financial/professional recklessness ($p = 0.009$), and inappropriate behaviours ($p = 0.052$).

DISCUSSION: Criminal risk behaviours are common across dementia subtypes and may be one of the first clinical signs of frontotemporal dementia. Further research to understand how to balance risk minimisation with an individual's liberties as well as the inappropriate criminalisation of people with dementia is needed.

KEYWORDS

Alzheimer's disease, antisocial behaviour, criminal behaviour, frontotemporal dementia, law, legal, misdemeanours, right temporal variant frontotemporal dementia, semantic dementia, transgressions

Highlights

- The Misdemeanours and Transgressions Screener is a new tool to assess criminal risk behaviours.
- Forty-seven percent of patients with dementia show criminal risk behaviour after dementia onset.
- Behaviours included verbal abuse, traffic violations, physical assault.
- New onset of criminal risk behaviours >50 years is a clinical sign for frontotemporal dementia.

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1 | BACKGROUND

Changes in behaviour are one of the earliest and can be the most prominent symptoms in people with dementia. Because of their insidious nature, these changes are often downplayed until a serious incident occurs. People with dementia may experience reduced judgment, impaired reasoning ability, and increased disinhibition, which can lead to situations involving contact with police and allegations of criminal offending, such as physical and verbal aggression, theft, traffic violations, and inappropriate sexual behaviour.¹⁻³ Of relevance here, these changed behaviours place individuals at risk of interactions with police or security guards, which may lead to being “manhandled,” detained, arrested, charged, and prosecuted for offenses.^{4,5} Other potentially coercive responses may include being transported to emergency departments and involuntary admission to mental health units. These situations and outcomes are highly distressing for people with dementia and their families and place an unnecessary and inappropriate burden on police and the criminal justice and health systems.

Retrospective case reviews⁵⁻⁸ have suggested that criminal risk behaviours are more common in behavioural-variant frontotemporal dementia (bvFTD) than other dementia subtypes, although the actual prevalence is likely underestimated, due to the reliance on clinical records in which information on criminal behaviour and instances of police contact may not be comprehensively captured. To date, a few small studies have interviewed caregivers,^{1,9} but findings are difficult to replicate across centers due to the lack of consistent measurement approach. Thus, while there has been a degree of interest in this phenomenon for many years, large, prospective studies with validated measures are lacking, and to date no study has included a healthy older control group for comparison.

This study aimed to systematically investigate the prevalence and nature of criminal risk behaviour using a novel, purposefully designed measure—the Misdemeanours and Transgressions Screener (MATS). We hypothesized that criminal risk behaviours would be more common in frontotemporal dementia (FTD) syndromes than in Alzheimer’s disease (AD). Our second aim was to examine predictors of criminal risk behaviour (i.e., demographic and disease variables). Finally, we aimed to establish the validity of the MATS for assessing criminal risk behaviours in dementia.

2 | METHODS

2.1 | Participants

One hundred and ninety-seven participants were consecutively recruited from FRONTIER, the Frontotemporal Dementia Research clinic in Sydney, between 2017 and 2022. Participants with dementia were diagnosed by a multidisciplinary team according to current consensus diagnostic criteria, with the group including 64 people with bvFTD, (42 probable, 22 possible),¹⁰ 30 left-lateralised semantic dementia (SD-left)¹¹, 13 right-lateralised SD (SD-right),¹²⁻¹⁴ and

RESEARCH IN CONTEXT

- 1. Systematic review:** The authors reviewed the literature using traditional (e.g., PubMed) sources. While several case studies of serious criminal risk behaviours have been published, prospective studies using purposely designed tools are lacking, and studies have not compared the rate or prevalence of criminal risk behaviours to healthy older controls.
- 2. Interpretation:** Data from the Misdemeanours and Transgressions Screener show more severe criminal risk behaviours in frontotemporal dementia syndromes (i.e., behavioural-variant and right-lateralised semantic dementia) than Alzheimer’s disease and left-lateralised semantic dementia.
- 3. Future directions:** Examination of the psychosocial, cognitive, and neurobiological factors which predispose an individual to criminal risk behaviours may help in early diagnosis of dementia and management of these behaviours. Public education as well as targeted liaison with legal professionals and the police force is important to ensure that people with dementia can be diverted out of the legal system and into appropriate medical care.

37 AD,¹⁵ who were compared to 53 healthy controls. Individuals with atypical presentations (e.g., for whom there was a question of a primary psychiatric disorder) were excluded. Disease severity was indicated by disease duration (years since symptom onset) and the Clinical Dementia Rating Scale for Frontotemporal Lobar Degeneration (CDR-FTLD) sum of boxes.¹⁶

Controls were recruited from the community via local community clubs (e.g., lawn bowls, golf clubs), community activities for older adults (e.g., social clubs for retirees), websites, and word of mouth. All controls scored > 88/100 on the Addenbrooke’s Cognitive Examination III (ACE-III). Controls were screened for pre-existing medical conditions and had similar demographics as the people with dementia (i.e., age, sex, education). In addition to participants meeting relevant diagnostic criteria based on their neurological assessment, neuropsychological performance, and brain magnetic resonance imaging scan, a sufficient level of English proficiency was also required for all participants.

Informed consent was obtained in accordance with the Declaration of Helsinki. Ethics approval was granted by the South Eastern Sydney Local Health District and University of Sydney ethics committees.

2.2 | Misdemeanours and Transgressions Screener

The rate and nature of criminal risk behaviour was determined using the MATS (see [Supplementary Material](#) in supporting information). The MATS was developed by FK, CK, and JRH. First, the literature was

screened for any case studies or retrospective studies that reported criminal risk behaviours in dementia (e.g., Kim et al.,² Liljegren et al.,⁸ Diehl-Schmid et al.,⁹ and Mendez¹⁷). Reported behaviours were compiled and additional criminal risk behaviours reported in our clinic were added to the list. These were then categorised into 10 broad domains: (1) traffic violations (e.g., speeding, driving without a license), (2) stealing (e.g., stolen money, stolen car), (3) avoiding payments, (4) verbal abuse, (5) physical assault (another person or animal), (6) inappropriate behaviours (e.g., inappropriate sexual advances, hugged or kissed a stranger), (7) public indecency (e.g., urinated in public, masturbated in public), (8) property trespassing or damage, (9) illegal drug use or supply, (10) financial or professional recklessness (e.g., behaved unethically at work, developed a gambling problem). This questionnaire was completed by an informant (e.g., spouse, child, sibling), who spends a minimum of 5 hours/week with the person with dementia (see [Supplementary Material](#)). First, any history of antisocial or unlawful behaviour prior to the onset of their current condition was screened for. Then, the presence of criminal risk behaviours across the 10 domains was established. When an item was endorsed, the informant was probed for further details about the incident (e.g., the nature of the incident and when it occurred). Finally, a question about whether the behaviour led to involvement of the police or authority figures (e.g., security guards), what the person's attitude to that situation was, and what the outcome of this interaction with the criminal justice system was included. Informants completed the MATS prior to their in-person appointment. During their appointment, the MATS responses were reviewed with the caregiver and the research assistant (MD, CK) and any possible misunderstanding or misinterpretation was discussed. Controls completed a modified self-report version reporting behaviour in the past 5 years (see [Supplementary Material](#)).

2.3 | Neuropsychological assessment

Participants underwent a detailed cognitive neuropsychological assessment, and an informant was interviewed to establish symptom onset and presence of behavioural changes. The Neuropsychiatric Inventory (NPI¹⁸) was used to assess convergent validity. In addition, measures of inhibitory control (Hayling Sentence Completion task¹⁹) and emotion processing (Facial Affect Selection Test^{20,21}) were used to assess convergent validity. Divergent validity was established via measures of global cognitive function (ACE-III²²) and visuo-constructional skills (Rey Complex Figure²³).

2.4 | Data reduction and statistical analysis

The following scores on the MATS were calculated: (1) MATS-Yes response (i.e., if any of the 10 domains were endorsed the participant had a score of 1, if all MATS domains were not endorsed the participant was given a score of 0); (2) MATS total domains endorsed (i.e., a score/10 denoting the total number of domains endorsed). To account for the severity of the behaviours reported on the MATS,

each behaviour was assigned a Median Sentence Rank (MSR). The MSR is the offence seriousness ranking used by the Bureau of Crime Statistics and Research and is based on penalties issued by courts in New South Wales, Australia (https://www.bocsar.nsw.gov.au/Pages/bocsar_publication/Pub_Summary/CJB/cjb142-Measuring-offence-seriousness.aspx). The MSR rank uses a lower number to denote the most serious (i.e., murder has a lower MSR than speeding). Here we reversed the ranks so that a lower score indicated less severe criminal risk behaviours. These values were used to compute (3) MATS total MSR adjusted score (i.e., sum of all behaviours endorsed on the MATS x MSR reverse rank). The following items do not have an MSR and were therefore all given a rank of 1: given away large sums of money to strangers; donated large sums of money; developed a gambling problem; behaved unethically at work; touched, hugged, or kissed a stranger; approached children they did not know; approached strangers they did not know; falling for scams; excessive or reckless spending; poor investment decisions; financial errors (e.g., errors in paying bills).

Groups were compared using analysis of variance with Sidak correction for post hoc comparisons, or when assumptions were violated, the non-parametric equivalent was used (i.e., Kruskal–Wallis, Dunn's correction). A logistic regression analysis was conducted to determine demographic and disease variables that predicted the presence of criminal risk behaviours in people with dementia. A second logistic regression was conducted to examine whether NPI subscales (frequency x severity) predicted the presence of criminal risk behaviours in people with dementia. Divergent and convergent validity was examined using Pearson correlations between MATS scores and scores on the NPI, the Hayling Sentence Completion Test, the Facial Affect Selection Test, ACE-III, and the Rey Complex Figure.

3 | RESULTS

Demographics are reported in Table 1. No difference was observed between groups in age ($F[4,196] = 1.034$; $p = 0.391$), or years of education ($F[4,196] = 2.036$; $p = 0.078$), although sex distribution differed ($\chi^2 = 14.063$, $p = 0.007$), with the bvFTD group having a higher male:female ratio than the control group. Disease duration ($F[3,135] = .645$, $p = 0.597$) and the CDR-FTLD sum of boxes ($F[3,117] = 1.267$, $p = 0.289$) did not differ between groups.

3.1 | Misdemeanours and Transgressions Screener

No difference in reports of history of antisocial or unlawful behaviour in early life was observed between groups ($\chi^2 = 4.681$, $p = 0.322$), with 13/144 people with dementia and 3/52 controls endorsing this item. Examination of the types of criminal risk behaviours that were reported historically included the following in patients: Constantly in trouble at school and outside with police involvement as a juvenile, a single incident of drug-induced behaviour, a pollution conviction for inappropriate disposal of sewage waste, petty theft as a teenager and

TABLE 1 Demographics and clinical characteristics according to diagnostic group.

	bvFTD <i>n</i> = 64	SD-right <i>n</i> = 13	SD-left <i>n</i> = 30	AD <i>n</i> = 37	Controls <i>n</i> = 53
Sex (M:F)	51:13	6:7	17:13	23:14	26:27
Age (years)	65.29 ± 7.67	65.02 ± 6.52	67.60 ± 5.95	65.57 ± 7.75	67.34 ± 7.05
Education (years)	12.70 ± 3.38	13.46 ± 3.36	12.78 ± 3.41	13.23 ± 2.87	14.32 ± 2.99
Disease duration (years)	6.47 ± 4.61	7.47 ± 3.46	6.38 ± 4.00	5.67 ± 3.50	-
CDR-FTLD sum of boxes (max 24) ^a	7.69 ± 4.33	5.19 ± 3.17	6.05 ± 5.76	7.82 ± 4.97	-
History of criminal risk behaviours (yes:no; % yes)	9:55 14.1%	1:12 7.7%	1:29 3.3%	2:35 5.4%	3:49 5.8%
Current criminal risk behaviours (yes:no; % yes)	42:22 65.6%	6:7 46.2%	10:20 33.3%	10:27 27.0%	26:27 49.1%

Note: Unless noted, values are mean ± standard deviation.

Abbreviations: AD, Alzheimer's disease; bvFTD, behavioural-variant frontotemporal dementia; CDR-FTLD, Clinical Dementia Rating Scale for Frontotemporal Lobar Degeneration; SD-left, left-lateralised semantic dementia; SD-right, right-lateralised semantic dementia.

^aData available for 60 bvFTD, 8 SD-right, 20 SD-left, 30 AD.

speeding tickets in their 20s, student protest, driving under the influence of alcohol, road rage incident, fights on nights out in early 20s, speeding. In controls, the incidents were shoplifting, driving under the influence, and indecent exposure (swimming nude, public urination).

After disease onset, the rate of criminal risk behaviour significantly differed between groups ($\chi^2 = 17.114$, $p = 0.002$). Sixty-eight of 144 patients reported at least one criminal risk behaviour, while 26/53 controls reported a criminal risk behaviour in the last 5 years.

Importantly, of those participants who showed criminal risk behaviours, this had led to contact with the police or authority figures in 19.1% of patients. This was compared to 0% of controls reporting contact with police or authority figures, who self-reported innocuous incidents (e.g., forgetting to scan an item at a grocery store, or noticing they were speeding and then slowing down; $\chi^2 = 5.768$, $p = 0.016$). The reasons for contact with police and authority figures were varied and included allegations or reports of domestic violence, altercations with strangers, holding family members hostage, shoplifting, road rage, receiving stolen goods, absconding from residential care, and being missing/lost/wandering. These incidents had led to patients being apprehended, charges being placed (although in most cases they were dropped due to the dementia diagnosis), hospital admissions (including being scheduled in psychiatric wards), police warnings, domestic violence orders being issued, and being banned from public places (e.g., sports clubs, shopping centers). Qualitative data from free text responses indicated the patients' attitude included being unaware, unconcerned, or in denial, although instances of anger, agitation, and confusion were also reported.

3.2 | Profiles according to dementia subtype

The number of criminal risk behaviours according to diagnostic group is shown in the violin plots in Figure 1. The main effect of group was significant ($H[3] = 15.833$, $p = 0.001$), with the bvFTD group showing more criminal risk behaviours than the AD ($p < 0.001$), and SD-left ($p = 0.006$)

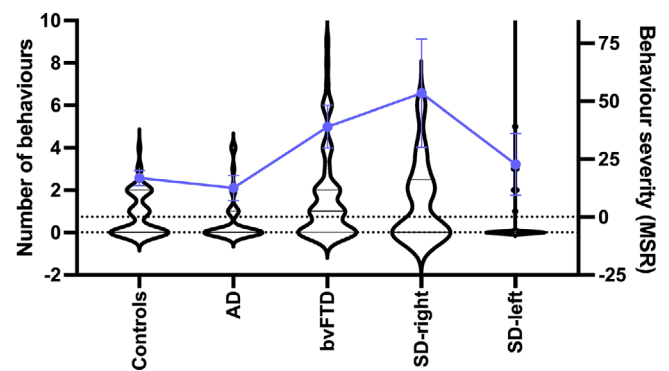


FIGURE 1 The violin plot shows the number of criminal risk behaviours endorsed on the Misdemeanours and Transgressions Screener. The blue line shows the mean score of behaviours adjusted for Median Sentence Ranking (MSR) as an index of severity. Greater separation between the number of behaviours and the MSR suggests more severe behaviours. AD, Alzheimer's disease; bvFTD, behavioural-variant frontotemporal dementia; SD-left, left-lateralised semantic dementia; SD-right, right-lateralised semantic dementia.

groups (Figure 1). Analysis of behaviour severity (MATS total MSR adjusted score, depicted by the blue line in Figure 1) also revealed a main effect of diagnostic group ($H[3] = 15.257$, $p = 0.002$), with the bvFTD group having a higher severity rating than the AD ($p = 0.001$) and SD-left ($p = 0.002$) groups, with a trend for SD-right to show more severe behaviours than SD-left ($p = 0.078$) and AD ($p = 0.078$) groups.

3.3 | Nature of criminal risk behaviours

The types of criminal risk behaviour in people with dementia and controls are shown in Figure 2. Comparisons between people with dementia and controls revealed more instances of physical assault ($\chi^2 = 5.123$, $p = 0.024$) and financial/professional recklessness ($\chi^2 = 6.830$, $p = 0.009$), with inappropriate behaviour approaching

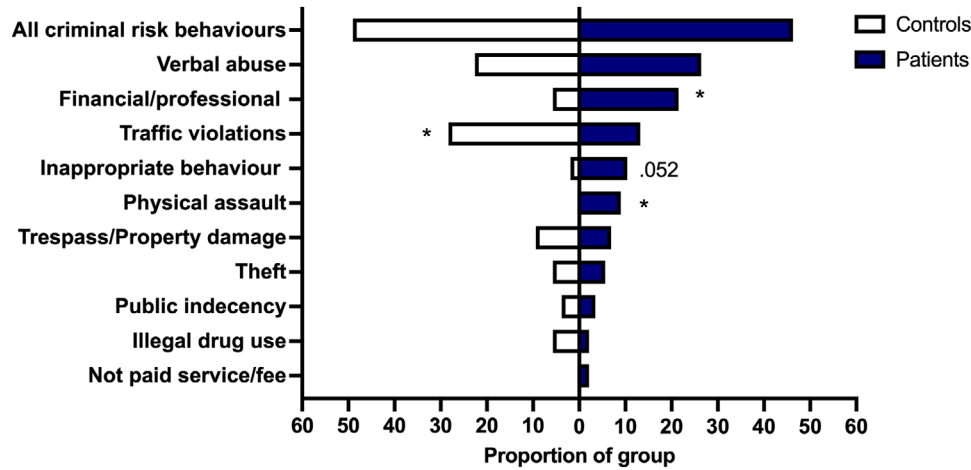


FIGURE 2 Types of criminal risk behaviours reported in people with dementia and controls. Bars represent the percentage of cases per criminal behaviour subtype.

TABLE 2 Types of criminal risk behaviours according to diagnosis.

	bvFTD	SD-right	SD-left	AD	Controls	Chi-square	<i>p</i>
Traffic violations	17.2	23.1	10.0	5.4	28.3	9.582	0.048
Theft	6.3	15.4	6.7	0.0	5.7	4.678	0.322
Not paid service/fee	1.6	15.4	0.0	0.0	0.0	18.513	<0.001
Verbal abuse	35.9	30.8	13.3	18.9	22.6	7.290	0.121
Physical abuse	10.9	7.7	10.0	5.4	0.0	6.373	0.173
Inappropriate behaviour	14.1	15.4	13.3	0.0	1.9	11.069	0.026
Public indecency	4.7	0.0	3.3	2.7	3.8	0.809	0.937
Trespass/property damage	9.4	0.0	6.7	5.4	9.4	1.898	0.755
Illegal drug use	4.7	0.0	0.0	0.0	5.7	4.324	0.364
Financial/professional	34.4	7.7	13.3	10.8	5.7	20.357	<0.001

Note: Values are percentage of cases who reported the behaviour per group.

Abbreviations: AD, Alzheimer's disease; bvFTD, behavioural variant frontotemporal dementia; SD-left, left-lateralised semantic dementia; SD-right, right-lateralised semantic dementia.

significance ($\chi^2 = 3.777$, $p = 0.052$). Controls were more likely to report traffic violations ($\chi^2 = 6.192$, $p = 0.013$) than patients. No other differences were seen between the groups.

The nature of criminal risk behaviours according to diagnosis is shown in Table 2 and examples of behaviours are shown in Table 3. Post hoc analyses showing groups with significantly elevated group proportions compared to the other groups are in bold.

3.4 | Predictors of criminal risk behaviours in people with dementia

Next, we conducted a logistic regression analysis to examine demographic factors which predicted the presence of criminal risk behaviours in people with dementia (i.e., excluding controls). The final model was significant ($\chi^2 = 26.216$, $p < 0.001$), and explained 23.4% (Nagelkerke R^2) variance in criminal risk behaviours and correctly classified 71.3% of cases. People with a diagnosis of bvFTD were

more than seven times more likely to show criminal risk behaviours (odds ratio [OR] = 7.327, $p < 0.001$) than the other dementia subtypes. Longer disease duration was also associated with more criminal risk behaviours (OR = 1.122, $p = 0.030$). Age, education, and sex, as well as diagnosis of another dementia syndrome were not significant predictors of the presence of criminal risk behaviours.

We also explored whether subscales of the NPI predicted the presence of criminal risk behaviours in people with dementia. The model was significant ($\chi^2 = 28.864$, $p = 0.004$), explaining 24.2% of variance (Nagelkerke R^2), and correctly classifying 66.7% of cases. The two subscales that were significant contributors to the model were the agitation/aggression subscale, which was associated with increased likelihood of criminal risk behaviours ($B = 0.366$, $p = 0.019$) and depression ($B = -0.434$, $p = 0.017$), which was associated with a decreased likelihood of criminal risk behaviours.

Finally, correlations in all participants combined were examined to establish convergent and divergent validity and are reported in Table 4. MATS scores were positively correlated with total scores on the NPI,

TABLE 3 Types of behaviours reported on the Misdemeanours and Transgressions Screener (MATS) in patients and controls.

	Patients	Controls
Verbal abuse	Using offensive language ($n = 34$) Threatened to physically assault another person ($n = 7$) Made inappropriate or offensive comments to strangers ($n = 12$) Argumentative ($n = 1$) Demanded money from people ($n = 1$)	Used offensive language ($n = 12$)
Financial/professional	Excessive spending ($n = 10$) Developed gambling problem ($n = 8$) Fallen for scams ($n = 5$) Donated large sums of money ($n = 5$) Behaved unethically at work ($n = 1$) Other: cancelling insurance policies, online spending and making impulsive large purchases ($> \$1000$ without the spouse's knowledge/consent)	Bad investment decisions ($n = 3$)
Traffic violations	Speeding ($n = 10$) Driven under the influence of alcohol ($n = 4$) Driven without a license ($n = 4$) Driven an unregistered vehicle ($n = 1$) Broken license restrictions ($n = 1$) Running a red light ($n = 3$) Driven in the emergency lane ($n = 1$) Not secured load ($n = 1$) Small accidents with car ($n = 1$)	Speeding ($n = 13$) Driven unregistered vehicle ($n = 1$) Used mobile phone while driving ($n = 1$)
Physical assault	Physical assault ($n = 1$) Intentionally hurt or were cruel to animals ($n = 4$) Barge people out of way ($n = 1$)	n/a
Inappropriate behaviour	Inappropriate sexual advances ($n = 3$) Touched, hugged, or kissed a stranger ($n = 5$) Approached children they did not know ($n = 6$) Been overly friendly with strangers (e.g., offering massages, talking to random strangers) ($n = 4$) Asked inappropriate questions (e.g., telling a screaming child to shut up, or asking questions about a person's virginity) ($n = 2$)	Complained about a neighbor's dog which had caused offense ($n = 1$)
Trespass/property damage	Trespassing (e.g., entering a neighbor's house to take property and leaving rubbish on neighbor's property) ($n = 8$)	Trespassing (e.g., entering onto private property on bushwalks to save time, or to pick up a ball that went over the fence) ($n = 4$) Property damage due to car accident ($n = 1$)
Theft	Shoplifting ($n = 5$) Taking money from another person ($n = 1$) Stealing from another person ($n = 3$) Giving items away from their workplace without payment ($n = 1$) Concealing withdrawals from a joint bank account ($n = 2$)	Taking small items from their workplace such as pens or failing to scan items at self-service supermarkets (e.g., a chili) ($n = 3$)
Public indecency	Public urination ($n = 4$) Undressing in public place ($n = 1$)	Public urination ($n = 2$)
Not paid service/fee	Not paid for entrance fees (e.g., to the cinema) ($n = 1$) Not paid for a restaurant bill ($n = 1$)	n/a
Drug use	Recreational drug use ($n = 3$)	Recreational drug use ($n = 3$)

Note: A single individual could have reported more than one type of incident.

Abbreviation: n , the number of times this was reported.

TABLE 4 Correlations between MATS responses and neuropsychological and behavioural assessments in all participants combined.

	NPI Total	Hayling Category B Errors	Facial Affect Selection Test Total-short	ACE-III Total	RCF-Copy
MATS Total number of behaviours	0.367***	-0.070	0.053	0.123	-0.004
MATS Behaviour Severity (MSR Total)	0.422***	-0.047	0.122	0.177*	-0.013

Note: Values are Pearson *r* values.

Abbreviations: ACE-III, Addenbrooke's Cognitive Examination III; MATS, Misdemeanours and Transgressions Screener; MSR, Median Sentence Ranking; NPI, Neuropsychiatric Inventory; RCF, Rey Complex Figure.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Data available: NPI: $n = 79$; Hayling Sentence Completion Test: $n = 102$; Facial Affect Selection Test: $n = 116$; ACE-III: $n = 157$; RCF: $n = 139$.

indicating that higher criminal risk behaviours were associated with higher neuropsychiatric symptoms. Correlations with neuropsychological test performance were not significant, except for a small positive association with ACE-III total score.

4 | DISCUSSION

This systematic, prospective study aimed to comprehensively examine the nature and prevalence of criminal risk behaviours in FTD and AD compared to healthy older controls, using a new, purposefully designed questionnaire. We found that criminal risk behaviours are remarkably common and were reported in almost half of our 144 participants with dementia. Importantly, of those who showed criminal risk behaviours, almost 20% of people with dementia had contact with police or authority figures. This was not seen in healthy older controls. People with dementia were more likely to have incidents of physical assault, financial/professional transgressions, and inappropriate behaviour (e.g., inappropriate sexual advances) than controls. These criminal risk behaviours were more common and more severe in bvFTD and SD-right. In the following we consider how our findings expand knowledge of the clinical profile of FTD, how this knowledge should be incorporated into clinical practice, and how these findings can inform responses to criminal risk behaviours in the community, especially when police contact or interactions with the legal system occur.

We found the highest prevalence of criminal risk behaviour in patients with bvFTD, which converges with the previous retrospective case review⁸ and caregiver interviews.^{1,9} Here, we also found that criminal risk behaviours are elevated in patients with SD-right, a group that has not been examined in studies of criminal risk behaviours previously. What predisposes bvFTD and SD-right patients toward criminal risk behaviours is unclear; however, both neurobiological and cognitive mechanisms are worth consideration. Adjacent literature underscores the potential role of the orbitofrontal cortex, ventromedial prefrontal cortex, and anterior temporal lobes.^{24,25} These brain regions overlap with the recognised patterns of atrophy in bvFTD and have been implicated in the manifestation of criminal risk behaviours due to their role in assigning emotional value to experiences, aspects of theory of mind including moral decision making, inhibition, interoceptive awareness, emotion perception, and regulation of emotions such as fear and

anger.²⁵ In addition, whether specific diagnostic features of bvFTD (e.g., loss of empathy, disinhibition)¹⁰ predict an individual toward criminal risk behaviours is an important consideration. Future studies are needed to more comprehensively assess the hypothesised relationship between criminal risk behaviours, patterns of neurodegeneration, as well as possible neurocognitive profiles including social cognition, executive functioning, and emotional experience.

The most common criminal risk behaviours were physical assault, inappropriate behaviours, and financial/professional recklessness, while traffic violations and verbal abuse were common in both people with dementia and healthy older controls. Notably, unlike previous studies,^{9,26} theft and indecent exposure were relatively uncommon. It has previously been proposed that the behavioural change in bvFTD is "antisocial" or "sociopathic" in nature,^{1,9,25,27} which implies a disregard for social rules or norms, and a violation of others' rights.²⁸ An alternative characterisation is that the more commonly observed criminal risk behaviours are "reactive" in nature, whereas the less common behaviours (e.g., not paying service/fee, illegal drug use, property damage) may require an additional "planning" or "proactive" dimension. This interpretation concurs with earlier work suggesting that criminal risk behaviours can result from two broad mechanisms: (1) disinhibition and (2) agitation/paranoia, with the former more common in frontotemporal dementia.²⁷ Interestingly, individual interviews suggest that patients are largely unperturbed by their actions and tend not to show remorse, shame, or a need to provide an explanation.⁹ This concurs with our findings in which patients were reportedly unaware, unconcerned, or in denial about their behaviour. Together, the evidence to date may suggest a lack of criminal intent or "guilty mind" in patients with dementia who show these types of criminal risk behaviours, and a reduced moral culpability which might well have relevance to how these people are dealt with in the criminal justice system. There is some evidence that police and the broader criminal justice system have some awareness of the significance of cognitive impairment on risk behaviours for people with intellectual disability; however, the extent of that awareness, and whether it extends to people with dementia, is a pressing issue and requires further investigation (e.g., Howard and Westmore²⁹). Where these behaviours result in contact with police and the criminal justice system, the responses may be anti-therapeutic for people with dementia. They may experience further stigma and harm when symptoms of illness are inappropriately criminalised.³⁰ Timely referral for health assessment should be a

priority to support access to care and services that promote the person's health, safety, and well-being.³¹

As can be seen this is an emerging area of research and there are likely to be multifactorial contributors that lead to the manifestation of criminal risk behaviours. While research has been limited by a lack of appropriate measures, the MATS appears to be a simple, valid assessment tool to comprehensively capture the range of criminal risk behaviours in dementia, although more comprehensive psychometric evaluation including construct validity is needed. Nevertheless, some limitations should be considered. Although we found a remarkably high prevalence of criminal risk behaviours, it is also plausible that variations in how carers and family members respond to these behaviours can impact their frequency. For example, some evidence suggests that some caregivers tend to monitor or supervise the person with dementia and intervene to prevent criminal risk behaviour occurring.³² Whether pre-morbid factors such as personality, demographics (e.g., socioeconomic status, sex), and history of trauma are unique contributors also warrants investigation, given their known role in the wider prison population, and potential differences among clinical syndromes.^{33,34} Our controls also reported risk behaviours that are common in the Australian population (e.g., verbal driver aggression) or other innocuous behaviours that did not result in contact with the police or authority figures. Previous studies have not included a control group and knowledge about "typical" behaviour in community-dwelling older adults is surprisingly difficult to access. Having a self-report version for controls and an informant-report version for the participants was a pragmatic methodological choice; however, it is a limitation of the current study. We therefore urge future studies to use the same questionnaire for patients and controls.

Finally, terming behaviours as criminal or offending in nature may vary across jurisdictions, depending on formal laws as well as community and police attitudes and tolerances. The MATS items that relate to theft, verbal and physical assault, public indecency, driving violations, property damage, and illicit drug possession/trade are acts that are formally unlawful across jurisdictions^{5,6,8,9} and would constitute breaches of local laws. Financially or professionally reckless behaviour were included in the MATS as they may be implicated in illegal conduct (e.g., allegations of fraud, stealing money to gamble).³⁵ The MATS item of inappropriately approaching others encompasses transgressions that create perceived or actual risks of harm to others. For example, an adult approaching a child they do not know is a feared behaviour in Australia, although such behaviour may be viewed with less suspicion in other countries. On a related note, the median sentence ranking used here is based on data from Australia. We are collaborating with international partners to translate the MATS. Establishing its validity in other jurisdictions will be essential to advance knowledge on behaviours in the context of dementia and the risk of criminal or other legal responses.

With respect to clinical management, criminal risk behaviour appears to be much more common than anticipated. One of the implications is that the emergence of criminal risk behaviour in an older adult

(e.g., >50 years old) without a history of criminal behaviour should be assessed for cognitive impairment and dementia. Communicating this finding with not only health, but also legal, professionals may help to identify people with bvFTD early and divert them from the criminal legal system and this aligns with recommendations that detainees over the age of 50 undergo a health assessment including cognitive assessment as routine procedure.³⁶ A second important implication is improving education for frontline workers such as police, security personnel, and other first responders as well as legal professionals. The literature on policing and dementia has largely focused on the risks of older people being victims of crime, rather than potential perpetrators. However, some research suggests that people over the age of 60 are as likely to be suspected perpetrators/disputants as they are to be alleged victims.³⁷ Some efforts have been made to examine police officers' knowledge about dementia,³⁸ and develop training on aging and dementia for police.³⁹ These types of initiatives are particularly important in the context of an aging population and increasing dementia prevalence.

Recommendations for how to manage these behaviours from a clinical perspective are limited, and how these behaviours may wax and wane with disease progression is also unclear. Routine assessment of criminal risk behaviour is an important first step (e.g., via the MATS), as in our experience these behaviours are often not reported by caregivers unless directly asked. It is also prudent to minimise potential safety concerns such as access to firearms and driving, particularly where criminal risk behaviours are identified, or if the person has a diagnosis of bvFTD or SD-right.⁴⁰ Beyond that, a need for balance between personal liberties and community safety should be front of mind. Working closely with family members, as well as frontline workers such as police to educate them on the issues at hand,³⁹ is essential. Future work that sheds light on the cognitive and neurobiological mechanisms will be important for the development of strategies to identify individuals who are likely to need great support, with the ultimate goal of preventing criminal risk behaviours before they occur.

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CONFLICT OF INTEREST STATEMENT

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CONSENT STATEMENT

Informed consent was obtained from all participants or their person responsible in accordance with the Declaration of Helsinki.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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