



## Neurobehavioural and cognitive function is linked to childhood trauma in homeless adults

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**Objectives.** To describe levels of traumatic childhood events in a sample of homeless individuals and to assess the contribution of traumatic events to neurobehavioural traits (measured with the Frontal Systems Behaviour Scale, FrSBe) and general cognitive function (IQ).

**Design.** A sample of 55 homeless adults was recruited from homeless services in the city of Sheffield, UK. All were interviewed to acquire substance misuse information, record experiences of childhood trauma, and assess cognitive and neurobehavioural traits.

**Methods.** Experiences of abuse and neglect were assessed with the Childhood Trauma Questionnaire. Participants also completed the Wechsler Abbreviated Scale of Intelligence and the FrSBe, which was completed with respect to current behaviour and conduct prior to homelessness.

**Results.** Around three-quarters of the sample scored in the clinically significant range for current neurobehavioural impairment. They also reported high levels of impairment when rating retrospectively for the period before they were homeless. The mean group IQ was below average at 88. Abuse or neglect during their upbringing was reported by 89% of the sample. Emotional abuse, emotional neglect, and physical neglect were all positively correlated with total FrSBe scores. Sexual abuse, emotional neglect, and physical neglect were all negatively correlated with IQ. The associations between trauma and IQ and neurobehavioural traits appear generally unrelated to the presence of substance misuse in the sample.

**Conclusion.** Our homeless sample displayed relatively low IQ with high levels of neurobehavioural impairment. Our evidence suggests that these neuropsychological factors may, in part, constitute a long-term consequence of childhood trauma.

Once associated primarily with the developing world, or with natural or man-made disasters, homelessness has now emerged as a major social concern in many developed

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countries (Toro, 2007). The problem of homelessness became a key issue in Europe and the USA in the 1980s, and it is likely that levels of homelessness will continue to increase worldwide. Homeless populations often display high levels of alcoholism, psychotic disorders, major depression, and personality disorders (Fazel, Khosla, Doll, & Geddes, 2008), yet often have little or no long-term contact with health services (van Laere, de Wit, & Klazinga, 2009). It was estimated in 1999 that within the European Union there were then around 2.7 million people who could be defined as homeless, i.e., either literally roofless, inappropriately housed, or living in crowded conditions, with around 1.8 million individuals dependent upon public and private services for the homeless (Avramov, 1999). It has been estimated that there are up to 380,000 homeless individuals in the UK, if homeless is defined to include those living in hostels, squats, sleeping on friends' floors, or in over-crowded accommodation. This reduces to about 800 if the definition is limited to those who are actually sleeping outside (Kenway & Palmer, 2003).

Factors that impact upon levels of homelessness obviously include those related to national stability, societal prosperity, availability of affordable housing, and national welfare provision (Berger & Tremblay, 1999). It has been argued that, in addition to these socio-structural issues, it is important to consider individual factors (Minnery & Greenhalgh, 2007). Studies from several Western countries report high rates of psychotic and depressive illness among homeless populations (Fazel *et al.*, 2008). Homeless individuals often report traumatic personal histories (Spence *et al.*, 2006), and may display a particularly negative outlook on their own past lives (Pluck *et al.*, 2008). Common pathways into homelessness include financial debts and domestic conflicts (van Laere *et al.*, 2009).

Several studies have described lower than expected cognitive abilities among homeless populations. One reported cognitive impairment in 80% of a sample of homeless shelter residents in Wisconsin, USA (Solliday-McRoy, Campbell, Melchert, Young, & Cisler, 2004). Another, found rates of cognitive impairment in 82% and suspected alcohol-related brain damage in 21% of shelter residents in Glasgow, Scotland (Gilchrist & Morrison, 2005).

IQ scores have been reported in several samples of homeless adults. A recent study in the UK reported an average full-scale IQ of 92 (Oakes & Davies, 2008). In one sample of homeless individuals in the USA, a group mean IQ of 83 was reported (Seidman *et al.*, 1997). Other researchers have published IQ scores around this level (Bremner, Duke, Nelson, Pantelis, & Barnes, 1996; Solliday-McRoy *et al.*, 2004). One study found that homelessness was associated with a drop in IQ from normal estimated premorbid levels to below average actual IQ, and that the level of IQ drop was correlated with duration of homelessness (Bremner *et al.*, 1996). This suggests that cognitive function declines as a consequence of homelessness. It has been reported that problem drug users are seven times more likely than non-users to become homeless (Kemp, Neale, & Robertson, 2006). However, it has also been observed that substance misuse tends to increase after individuals become homeless (Fountain, Howe, & Baker, 2002). Substance misuse may therefore potentially act to impair cognitive function prior to housing problems and also act as an exacerbating factor, once they have become homeless.

A further source of possible neuropsychological impairment is related to childhood trauma. Several reports have highlighted high levels of adverse childhood events among adult homeless populations (Spence, 2009; Spence *et al.*, 2006). Childhood traumas are associated with a range of neurodevelopmental and cognitive problems, particularly

those implicating executive functioning (De Bellis, 2005) and memory retrieval (Raes, Hermans, Williams, & Eelen, 2005).

It is therefore argued that the poor cognitive function of homeless people may be a consequence of events that occurred prior to homelessness, e.g., childhood trauma. A previous review has identified two main areas of concern regarding neuropsychological function among homeless populations; lower than average IQ and frontal lobe associated neuropsychological impairment (Spence, Stevens, & Parks, 2004). However, poor performance on a wide range of neuropsychological assessments has been reported, including immediate and delayed recall, sustained attention, information-processing speed, and visuospatial performance (Seidman *et al.*, 1997).

In a sample of homeless adults, we wished to examine the associations between childhood trauma and IQ and frontal lobe-related neurobehavioural traits as measured by the Frontal Systems Behaviour Scale (FrSBe; Grace & Malloy, 2001). We hypothesized that our homeless sample would demonstrate neurobehavioural and cognitive problems evinced by high FrSBe scores and low IQ and also high levels of childhood trauma. We further hypothesized that FrSBe scores would be raised even when rated considering pre-homeless behaviour and that current status FrSBe scores and IQ would be associated with childhood abuse and neglect. In addition, as we expected high levels of substance misuse within our homeless sample, we planned to examine the relationship between drug and alcohol use with neuropsychological performance.

## Methods

### *Participants*

A sample of homeless adults was recruited from various homeless agencies, including shelters and meals services in the city of Sheffield, UK. This was not a random sample of the homeless population of the city. This included the only homeless hostel in the city centre, which accommodates 50 individuals at any one time, the NHS Homeless Assessment and Support Team (HAST) which has around 50 referrals per year, the central meal and advice service provided by social services which has around 60 visits per day and the most popular church-based meal service, which has around 25 clients per evening. The only homeless service that was approached who declined to participate was a hostel in the suburban outskirts of the city. There were two main church-based meal services and one day centre that were not approached, as it was felt that the majority of the homeless individuals in the city centre would be using at least one of the services that were already cooperating with us.

Potential participants were recommended by staff at the homeless services, the service user consultant, or HAST staff. Study inclusion criteria were: currently homeless (lacking a secure tenancy and currently accessing services for the homeless), able to read and write and being currently at least 18 years of age. Only those who said that they would be non-intoxicated at the interview and appeared non-intoxicated when they attended for the interview were included. Participants also had to have been at least 16 years of age when they first became homeless. This criterion was chosen to focus the research on adult homelessness, as childhood homelessness involves other issues. Seventy individuals were initially considered, however only 55 fulfilled the inclusion criteria and attended for the interview.

## **Materials**

Assessments included the FrSBe (Grace & Malloy, 2001). This is based on a well-researched model of frontal-subcortical neuroanatomy (Alexander, DeLong, & Strick, 1986), and has the added benefit that it can be used retrospectively (Grace, Stout, & Malloy, 1999). The FrSBe can be used to give a total measure of neurobehavioural traits, and of the three common syndromes associated with prefrontal cortex dysfunction: 'apathy', 'disinhibition', and 'executive dysfunction' (Duffy & Campbell, 1994). The FrSBe is designed to be completed with respect to current status and also retrospectively. The construct validity of the FrSBe has been demonstrated by comparisons using individuals who have suffered brain lesions and healthy controls. It was found that the FrSBe could distinguish frontal-damaged patients as post- or pre-injury (retrospective) ratings, and between both post-injury frontal lobe patients and controls and post-injury frontal lobe patients and non-frontal lobe brain-injured patients (Grace *et al.*, 1999).

FrSBe scores are converted to *t* scores by reference to the normative sample of 436 White adult United States residents provided by the test manufacturer. They found that age, sex, and education were significantly related to FrSBe scores, and so derivation of *t* scores is stratified by these variables. To assess general cognitive function, the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999) was administered, this is a brief assessment of IQ that has been validated against the Wechsler Adult Intelligence Scale (Wechsler, 1997).

To measure substance misuse the Severity of Dependence Scale (Gossop *et al.*, 1995) was used. The validity and reliability of this brief scale have been established (Gossop, Best, Marsden, & Strang, 1997; Gossop *et al.*, 1995). In addition, the Alcohol Use Disorders Identification Test (AUDIT) was administered. This has been developed and validated over two decades by the World Health Organization (Saunders, Aasland, Babor, de la Fuente, & Grant, 1993).

Finally, all participants completed the Childhood Trauma Questionnaire (CTQ), which assesses five common forms of trauma experienced by children: emotional abuse, physical abuse, sexual abuse, emotional neglect, and physical neglect (Bernstein & Fink, 1998). This scale also contains a brief denial subscale which can indicate cases where there is probable minimization of trauma experienced as a child. Validity and reliability of this scale have been established in several different samples (Bernstein & Fink, 1998).

## **Procedure**

All participants were interviewed in a private office regarding demographic and homelessness variables. This included history of substance misuse and whether or not they had ever experienced a head injury that resulted in loss of consciousness. They completed the self-rating scales described above, and explanations of the terms were provided if required. All assessments, including the IQ test were administered by the same researcher. For the FrSBe, all participants were asked to complete this for how they were functioning currently, and for how they thought that they would have answered before they became homeless. The retrospective period was defined as the year before the first time they became homeless.

All participants provided informed consent and the research was approved by the local research ethics committee. All participants were paid a £30 participation fee and provided with pre-paid taxis to bring them to and from the interview location. The data reported in this study were part of a larger neuropsychological study of homelessness. The interviews were conducted between January 2005 and July 2006. The full assessment

took around 2.5 h. The majority of interviews were conducted in the mornings, as this was easier for some of the participants to remain non-intoxicated for the duration of the assessment.

### Statistical analysis

All analyses were performed with SPSS 14 (SPSS, 2006). Comparisons between FrSBe scores were performed with *t* tests, including one-sample, paired-sample, and independent-sample tests as appropriate. The relationships between FrSBe scores and childhood trauma and other variables were examined using correlation analyses. Parametric tests (and non-parametric equivalents) were used as appropriate. Qualitative descriptors are provided to describe the magnitude of correlations, i.e., small (.1-.299), medium (.3-.499), or large (.5+), these are taken from Cohen (1988). For the relationships between multiple variables and FrSBe total scores, partial correlations were used. These were chosen rather than regression analysis which requires that independent variables be uncorrelated (Ezekiel & Fox, 1959), in our sample different forms of childhood trauma were intercorrelated. Furthermore, it is recommended that minimum subject-to-variable ratio is 10 to 1 in multiple regression analyses (Halinski & Feldt, 1970), a ratio that we did not have.

### Results

Of the 55 homeless individuals, 10 had slept outdoors the previous evening, 19 in state provided temporary housing, 2 with friends, 1 in a squat, and the remainder in a hostel. Forty-four (80%) were male, the mean age was 34.3 (range = 18-53, *SD* = 9.6) and they had a mean of 10.7 (range = 7-16, *SD* = 1.5) years of education. The lifetime mean months homeless was 43.4 (*SD* = 50.3). The most common reason given for becoming homeless was substance abuse (25/55, 45%). Indeed, 48/55 (87%) described a period in the past year of daily use of at least one substance for a period spanning at least 2 weeks.

FrSBe *t* scores were calculated for each individual, to provide an indication of any deviation from the normal mean *t* score of 50. Whether considering current status or pre-homelessness, mean scores were >50 for all measures, (range = 68.7-78.5), mean scores are shown in Table 1. With one-sample *t* tests it was found that each neurobehavioural

**Table 1.** Mean (*SD*) for the *t* scores on the FrSBe scale rated both for current behaviour and rated retrospectively to before homelessness, also shown are the per cent of the sample that scored 65 or above (the clinically significant range)

FrSBe scale	Pre-homeless		Current	
	Mean <i>t</i> score	Percent scoring 65 +	Mean <i>t</i> score	Percent scoring 65 +
Apathy	70.8 (21.7)	58.2	71.8 (18.6)	72.7
Disinhibition	70.4 (16.4)	58.2	68.7 (18.9)	58.2
Executive dysfunction	75.8 (19.1)	70.9	74.6 (16.2)	74.5
Total	78.5 (21.1)	74.5	76.9 (19.9)	72.7

measure on the FrSBe was significantly raised, compared to the normative mean, among the homeless sample; in fact all  $p$  values were less than .001.

By definition of the scale authors, 'clinically significant' scores are  $\geq 1.5$  standard deviations above the normative mean, i.e., exhibiting a  $t$  score  $\geq 65$ . The proportion of individuals scoring  $\geq 65$  is also given in Table 1, irrespective of which scale or time point is examined, more than half of the homeless sample would be categorized as showing clinically significant neurobehavioural impairment. We also wished to examine whether homeless individuals reported that their behaviour had changed since becoming homeless. Comparing current and pre-homeless ratings, with repeated measures  $t$  tests, there were no significant differences. In addition, correlations were performed between pre-homeless and current ratings on the total FrSBe score and for the subscales. It was found that in all cases, pre-homeless and current scores were not significantly correlated.

Of the whole group of 55, 32 (58%) reported a lifetime head injury that had resulted in a period of unconsciousness. We compared those 32 with the 23 who did not report head injuries, using independent group  $t$  tests. No significant differences were found for either past or present apathy, disinhibition, executive, or total scores on the FrSBe.

Examining IQ, it was found that the mean was 88.1 ( $SD = 15.6$ ) which would put the sample as a whole in the low average range. A single sample  $t$  test revealed that as a group they scored significantly below the estimated population mean of 100 ( $t(54) = -5.76, p < .001$ ). It was found that there was no correlation between IQ and total FrSBe scores ( $r = -.206, p = .132$ ). IQ scores did not appear to be related to past history of head injury. The mean IQ for those with a past head injury was 89.2 ( $SD = 16.3$ ) which did not differ significantly from the mean IQ of those without a past head injury ( $M = 87.1, SD = 14.1$ ).

Considering the CTQ scores, it was found that 1 person scored 3/3 on the denial subscale and so their scores were excluded from further analyses. The remaining sample of 54 individuals reported high levels of all forms of trauma. For emotional abuse, 36/54 (66.7%) reported at least low to moderate levels of trauma and 14/54 (25.9%) severe to extreme levels. For physical abuse, equivalent proportions were 29/54 (53.7%) and 3/54 (24.1%); for sexual abuse, 15/54 (27.8%) and 10/54 (18.5%); for emotional neglect, 42/54 (77.8%) and 17/54 (31.5%); and for physical neglect, 33/54 (61.1%) and 15/54 (27.8%). Overall, 48/54 (88.9%) reported at least low to moderate trauma on at least one scale. As there were non-normal distributions of the CTQ subscales, non-parametric tests were employed where appropriate in further analyses.

To examine the influence of sex on severity of trauma, comparisons were made with Mann-Whitney  $U$  tests for scores on the five CTQ subscales. It was found that there was a significant difference for the severity of sexual abuse. Women reported significantly higher scores for sexual abuse ( $M = 16.4, SD = 8.3$ ) than men ( $M = 6.6, SD = 4.4$ ),  $U = 69.5, p < .001$ .

Correlations were performed between the five CTQ subscales and the total FrSBe score and IQ. The matrix of correlation coefficients is shown in Table 2. There were significant positive correlations between total FrSBe scores and emotional abuse, emotional neglect, and physical neglect. In all three cases, the direction of the correlation indicates that higher levels of trauma were associated with greater impairment. Sexual abuse, emotional neglect, and physical neglect were negatively associated with IQ score, indicating that higher severity of trauma was associated with lower IQ.

**Table 2.** Correlation coefficients (Spearman's rank order correlation) for associations between scores on the CTQ and the current status neurobehavioural and IQ measures

	IQ	Total FrSBe score
Emotional abuse	-.066	.424**
Physical abuse	.000	.057
Sexual abuse	-.427***	.243
Emotional neglect	-.383**	.347*
Physical neglect	-.314*	.292*

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

To assess the interrelationships between FrSBe scores, childhood trauma, and IQ, partial correlations were performed. Whilst controlling for IQ, the positive correlations between total FrSBe scores and emotional abuse ( $r = .439$ ,  $p = .001$ ) and emotional neglect ( $r = .308$ ,  $p = .025$ ) remained significant. However, the correlation between total FrSBe score and physical neglect, was found to be no longer significant whilst controlling for IQ in the partial correlation ( $r = .258$ ,  $p = .062$ ).

To assess the influence of substance misuse on the associations identified above, we performed partial correlations between the IQ and neurobehavioural measures and Severity of Dependence Scale and AUDIT scores. Of the sample of 55, 16 were at the time intravenous drug users. The most commonly abused substances in the past year were; cannabis which had been used by 40/55 (73%), heroin by 23/55 (42%), and crack cocaine by 29/55 (53%) of the sample. On the AUDIT, 22 individuals (40%) reported scores of 16 or more (indicative of high levels of alcohol problems). When controlling for both alcohol and drug abuse, we again detected significant relationships between the neuropsychological measures and childhood trauma. Emotional abuse was significantly correlated with total FrSBe scores,  $r = .483$ ,  $p < .001$ . Sexual abuse had a significant negative correlation with IQ,  $r = -.409$ ,  $p = .003$ . Emotional neglect was significantly negatively correlated with IQ ( $r = -.352$ ,  $p = .01$ ) and significantly positively correlated with total FrSBe scores ( $r = .337$ ,  $p = .015$ ). Physical neglect showed a significant negative correlation with IQ ( $r = .312$ ,  $p = .025$ ) and a significant positive correlation with the total FrSBe score ( $r = .308$ ,  $p = .026$ ).

## Discussion

As hypothesized, we have demonstrated significantly high levels of neurobehavioural problems and significantly low IQ's, and also high levels of childhood trauma among our homeless sample. We have also demonstrated that FrSBe scores are raised even when considering pre-homeless behaviour and that current status FrSBe scores and IQ are associated with childhood traumas. It is of particular interest that based on the FrSBe, the majority of the homeless sample would be classified as having clinically significant impairments. For the total FrSBe current status, 73% would be classified in this way. Our results are comparable to the findings obtained with conventional neuropsychological assessments. These have provided evidence of cognitive impairment in around 80% of homeless individuals (Gilchrist & Morrison, 2005; Solliday-McRoy *et al.*, 2004). In addition, we have found a mean group IQ of 88, which is in the low average range. This is slightly higher than, but generally consistent with, findings in previous research that

have revealed similar estimates, i.e., group mean IQs of 83 (Solliday-McRoy *et al.*, 2004) and 84 (Bremner *et al.*, 1996).

Homeless people are at high risk of being victims of violence (Padgett, Struening, Andrews, & Pittman, 1995) and so it is possible that a high prevalence of head injuries could account for the high FrSBe scores or low IQs reported here. Using a simple measure of whether or not the individuals reported ever having suffered a head injury that resulted in unconsciousness, we found no association with FrSBe or IQ scores. Nevertheless, a more detailed investigation of this issue, perhaps focusing on the presence of verifiable traumatic brain injuries in homeless samples may be worthy of further investigation.

As we encountered relatively low IQ scores, it is pertinent to consider how this may have affected the reliability of questionnaire-based data. We argue that low IQ is unlikely to have confounded the results due to problems with interpretation of the questions. We anticipated low IQ scores in many of the participants, and excluded those who were not sufficiently literate. In addition, all of the questionnaire assessments were designed to be comprehensible by the majority of the general population. However, it is possible that FrSBe *t* scores overestimate problems in the current sample due to a lower level of IQ or education in the homeless group relative to the normative sample. Conversion tables were used that stratified between those with 12 or less years of education and those with 13 or more years of education (as well as stratifying by sex and age). As our sample as a group had a relatively low number of years of education (mean = 10.7, range = 7-16), many may have received less education than members of the '12 years or less' normative strata. The publishers of the FrSBe do not report IQ data on their normative sample. However, as it is unclear how well the current homeless sample compares to the normative sample in terms of IQ and years of education, it remains possible that these factors may have inflated the FrSBe *t* scores.

A related issue is the level of insight that the individuals may have into their behaviour when completing the FrSBe. For example, it has been shown that there is a relationship between executive function problems and poor insight in people with serious mental illness (Mysore *et al.*, 2007). Although, the FrSBe was designed to be completed by individuals who have suffered brain injuries or have psychotic illnesses, we cannot rule out that some participants in our sample may have had limited insight into their behaviour and that this could influence the results. The FrSBe has a validated informant version that can be completed concerning an individual by a family member. This could circumvent potential problems of insight, and could be considered for future research. Though, contacting family members of homeless individuals would raise other pragmatic research issues.

It is easy to see how both IQ and the neurobehavioural traits measured by the FrSBe may be linked with homelessness. IQ is a predictor of earnings and is associated with economic and non-economic success at both the individual and national level (Rinderman, 2008). It could be argued that disturbances in behavioural regulation systems as measured by the FrSBe could impact negatively upon an individual's ability to maintain adequate housing in competitive capitalist societies. Indeed, empirical research has shown that scores on the FrSBe indicating prefrontal dysfunction in non-clinical samples are associated with high levels of personal debt (Spinella, Yang, & Lester, 2004) and also with low personal income and the inability to delay gratification (Spinella, Lester, & Yang, 2004).

These findings therefore suggest possible routes by which neurobehavioural traits as measured by the FrSBe could lead or contribute to homelessness. In addition, our

findings reveal for the first time, strong associations between childhood trauma and these neurobehavioural traits. This may indicate a rich interdisciplinary vein for future research linking the social, psychological, and biological realms.

Considering the relatively low IQ, one could argue that the problems encountered by some homeless people may have overlap with the problems of individuals with learning difficulties. Indeed, it is possible that homeless populations contain many individuals who may have learning difficulties but have not been detected by educational, health, and social agencies. Alternatively, considering the neurobehavioural traits reported here, it may be useful to examine issues from neuropsychological rehabilitation with some homeless individuals, if they appear to show strong frontal lobe-related behavioural traits.

We found that when the homeless individuals as a group rated their behaviour prior to homelessness with the FrSBe, this was also in the abnormal range and essentially the same as their current levels of impairment. However, there was no correlation between current and pre-homeless FrSBe scores. This indicates that although the sample as a group are scoring high at both ratings, as individuals they are reporting behaviour that varies between the two time points. This implies that the presence of neurobehavioural problems in this homeless sample is dynamic. An alternative explanation could be that individuals differ in their response to homelessness. Although the experience of homelessness may impair function in some people, for others, it may lead to improved psychological function if their previous housing situation had, for example, been particularly stressful or dangerous. Alternatively, the lack of correlation may reflect problems with the reliability of the FrSBe in this population. Longitudinal studies are therefore needed that can follow up homeless people over time to fully examine the effect of homelessness on behaviour and abilities.

As a group, the homeless sample reported high levels of traumatic childhood experiences; at least low to moderate levels of some form of trauma were reported by 88.9% of the group. Women reported significantly more severe sexual abuse than men. We have also shown that both IQ and FrSBe scores are related to severity of childhood traumatic experiences, several medium-sized correlation coefficients were reported, ranging from  $-.314$  for the correlation between IQ and physical neglect to  $-.427$  for the correlation between IQ and sexual abuse. The correlation between physical neglect and total FrSBe scores would be considered of a qualitatively small magnitude at  $.292$ . Although the pattern of correlations changed slightly, when IQ was controlled for, significant correlations remained between CTQ and FrSBe scores.

These findings could be used to argue against suggestions that impaired neuropsychological function in homeless adults is a consequence of the experience of homelessness itself (Bremner *et al.*, 1996). However, there is likely to be a complex interaction between homelessness and neuropsychological function involving both risk and maintaining factors. It is likely that childhood traumatic events are linked to neuropsychological performance through observable neurobiological influences. Non-human primate research has also shown that early maternal separation in rhesus monkeys is associated with cognitive impairment and reduced white matter volume in the prefrontal regions and also reductions in corpus callosum size (Sanchez, Hearn, Do, Rilling, & Herndon, 1998). This effect of neglect on neuroanatomy has also been described in humans; children with a history of interpersonal neglect have been shown to have reduced corpus callosum volumes (Teicher *et al.*, 2004). These alterations in human brain structure and consequent cognitive function are theorized to be driven

(to a large extent) by dysregulation of bio-psychological stress systems (Watts-English, Fortson, Gibler, Hooper, & De Bellis, 2006).

Although it appears that childhood traumas are associated with deficits in adult neurobehavioural functioning, and IQ scores, it should be acknowledged that child abuse and neglect rarely occur in isolation from other domestic problems, and there could be other mediating factors driving the associations. For example, one recent study of homeless mentally ill individuals reported numerous aspects of their childhoods as being suboptimal for development, including the observation that only 5% of clients had grown up with their father in the family (Spence, 2009). In addition, as we only included literate individuals, it is possible that we excluded some individuals from the most socially deprived backgrounds. It is certainly possible that we have sampled from those individuals who did not suffer the most extreme neurodevelopmental problems.

Previous research has tended to associate substance misuse with the neurobehavioural traits measured by the FrSBe (Verdejo-Garcia, Bechara, Recknor, & Perez-Garcia, 2006). For this reason, we examined the influence of drug and alcohol abuse on the association between childhood trauma and the neuropsychological measures. With partial correlations, controlling for the influence of alcohol and substance misuse, the associations between childhood trauma and IQ and neurobehavioural measures remained. Therefore, the presence of alcohol or substance misuse cannot explain the association between childhood trauma and neuropsychological variables that we have identified. Despite this, it must be acknowledged that there are likely other extraneous variables that could mediate the associations between performance and childhood trauma. For this reason, the reported correlations should be interpreted cautiously. Other factors such as socio-economic background and familial mental health issues may be important and should be considered in future research on the issue.

Indeed, a likely mediating factor between childhood trauma and neuropsychological function is mental health. It is well known that traumatic events in childhood are linked to serious mental health problems in adulthood (Crane & Duggan, 2009). In addition, problems such as mood disorder and psychotic illness are particularly associated with frontal-subcortical mediated neurobehavioural functions (Brown & Pluck, 2000). The current findings relate to the same neurobehavioural features. Future research, should address this issue, examining the interrelationships between childhood trauma, mental health, neurobehavioural, and cognitive function.

We acknowledge that there are some weaknesses to the current study. Part of the data was collected retrospectively, and so is not as reliable as data prospectively acquired. Also, as this was an exploratory investigation, we looked at correlations between several variables. This necessarily involves multiple comparisons, which may result in Type I errors, i.e., detecting associations which are purely coincidental. However, this issue could be resolved if the findings are replicated. It should also be noted that we did not investigate a truly random sample of the local homeless population. Of our sample, 18% had slept outdoors, 42% had slept in hostels, and 35% in temporary accommodation; this compares with national UK estimates for similarly defined homelessness of 9, 28, and 50%, respectively (Kenway & Palmer, 2003). Consequently, generalization of findings is limited due to the nature of our sample.

To conclude, we have demonstrated high levels of neurobehavioural traits, and low IQ, in a sample of homeless individuals. In addition, we have demonstrated high levels of reported childhood traumatic events in these same individuals and shown that they are significantly related to the cognitive and neurobehavioural problems displayed. These

findings highlight the long-term toxic consequences of child maltreatment, for those individuals affected and for the society to which they belong.

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