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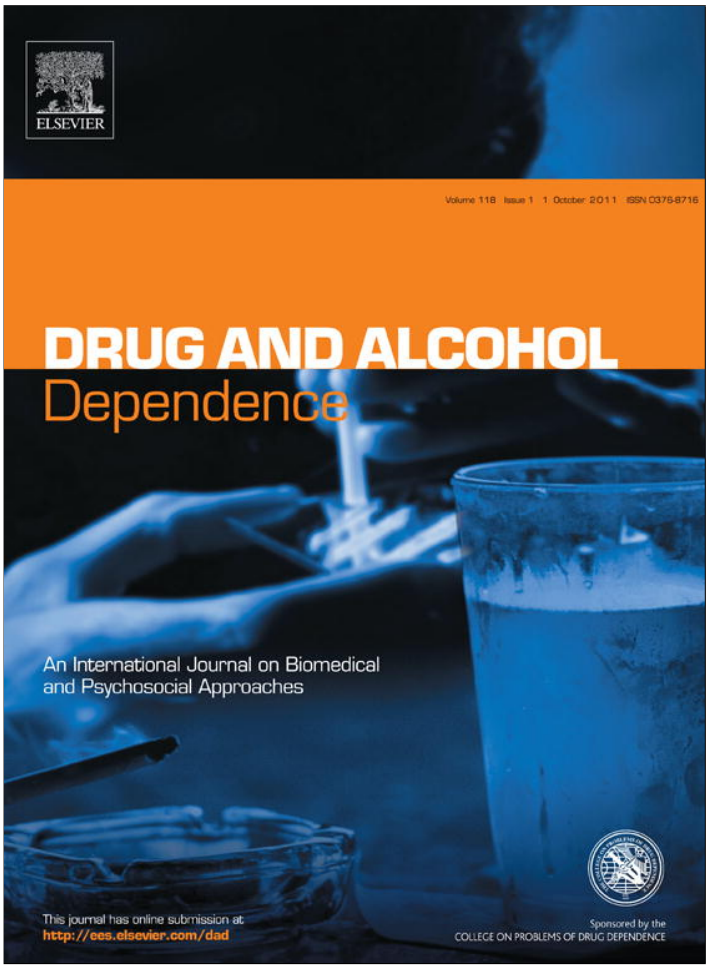

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Risky decision-making predicts short-term outcome of community but not residential treatment for opiate addiction. Implications for case management

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ABSTRACT

Background: Opiate addiction is associated with decision-making deficits and we previously showed that the extent of these impairments predicts aspects of treatment outcome. Here we aimed to establish whether measures of decision-making performance might be used to inform placement matching.
Methods: Two groups of opiate dependent individuals, one receiving treatment in a community setting ($n = 48$) and one in a residential setting ($n = 32$) were administered computerised tests of decision-making, impulsivity and planning shortly after the beginning of treatment, to be followed up three months into each programme.
Results: In the community sample, performance on the decision-making tasks at initial assessment predicted abstinence from illicit drugs at follow-up. In contrast, in the residential sample there was no relationship between decision-making and clinical outcome.
Conclusions: Intact decision-making processes appear to be necessary for upholding a resolve to avoid taking drugs in a community setting, but the importance of these mechanisms may be attenuated in a residential treatment setting. The results support the placement matching hypothesis, suggesting that individuals with more prominent decision-making deficits may particularly benefit from treatment in a residential setting and from the inclusion of aspects of cognitive rehabilitation in their treatment programme.

1. Introduction

Understanding the interaction between treatment, outcome and patient characteristics in addiction is considered crucial to identifying the key elements of helpful treatments and developing more effective treatment strategies (Finney et al., 1996; Curran and Drummond, 2005). Research focusing on this topic has identified a range of potential outcome predictors, but when transferred to the clinic these have not proven sufficiently robust, so far, to systematically inform treatment decisions at an individual level (Ghodse, 2010, p. 179). Recently, a number of novel measures of neuropsychological impairment have raised new hope that such robust outcome predictors may be achievable. Using these measures, studies have demonstrated an association between drug addiction and impairment of aspects of decision-making, impulsivity and delay discounting, both in terms of performance (Rogers et al., 1999; Bechara and Damasio, 2002; Clark et al., 2006; Kirby et al., 1999) and the associated brain activation (Bolla et al., 2003; Ersche et al., 2005; Paulus et al., 2005). Moreover, addictive individuals, who were more severely impaired on tests of decision-making and other prefrontal cortex-guided cognitive functions, were less likely to attain treatment objectives (Teichner et al., 2001; Bechara et al., 2001; Aharonovich et al., 2006; Passetti et al., 2008). Part of the appeal of these measures as outcome predictors is due to the face validity of the argument that neuropsychological impairment that is likely to lead to poor decision-making may influence clinical outcome.

These findings emphasise the importance of an individual's cognitive make up, but equally important for an understanding of addictive behaviour change is the complex interplay between treatment, cognitive factors and the environmental circumstances in which treatment takes place. Stress, ready availability of drugs, peer pressure and exposure to drug-related cues are all known factors that may contribute to relapse into drug use after a period of abstinence (McKay et al., 1995; Orford, 2001; Wang et al., 1999). Thus, since treatment in a residential setting may at least in part shelter

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from these (for example, patients are less likely to be offered drugs while in treatment in a residential, than in a community setting), the relationship between decision-making deficits and treatment outcome may differ across different settings. This is relevant to the present discussion, because one particular aspect of addiction treatment planning that would benefit from reliable outcome predictors is placement matching, i.e. the allocation of each individual to a particular treatment setting (SCAN, 2006).

There are substantial cost implications associated with choosing inpatient/residential rather than community/outpatient treatment. In the UK and in the USA, in the absence of evidence based criteria, placement matching has been usually guided by simple self-selection (Gossop et al., 2003) and by the principle of 'stepped care', which refers to the strategy of offering the least intensive level of care that meets treatment objectives (Mee-Lee and Shulman, 2003, pp. 453-465; SCAN, 2006, pp. 25–26; NICE, 2008, p. 16). In keeping with this principle, inpatient/residential treatment has tended to be reserved for individuals who have tried but have been unsuccessful in the community, or whose problems are too complex or too severe to be safely managed in the community.

Previously, we showed that performance on two computerised tests of decision-making, the Iowa Gambling Task (IGT) and the Cambridge Gamble Task (CGT), predicted short-term abstinence in a group of opiate dependent, poly-drug using individuals undergoing community drug treatment (Passetti et al., 2008). In the present study, we aimed to extend those initial findings by comparing two groups of opiate (poly-drug) users, one receiving treatment in a community and one in a residential setting. Our specific hypothesis was that the two settings would be associated with different strengths of the relationship between neurocognitive functioning and outcome. We reasoned that such a scenario would make neurocognitive methods relevant for guiding placement matching. If decision-making deficits were to co-vary with poor treatment outcome selectively in one setting, then it may be argued that, all other things being equal, individuals with preserved decision-making should be preferentially selected for treatment in that setting. Thus, measures of decision-making may potentially be used, together with a range of clinical measures, to inform the choice of the most appropriate setting for each individual.

2. Methods

2.1. Participants

Two cohorts of opiate dependent individuals took part in this study. A group of 55 participants were recruited from community drug treatment services in London (community sample), extending our previously reported group of 43 (Passetti et al., 2008). These were all individuals starting on a voluntary methadone- or buprenorphine-assisted detoxification programme. A second group of 33 participants were recruited from an inpatient facility in south London, en route to a residential rehabilitation programme (residential sample). Every patient admitted to either programme, who could be approached for screening and satisfied the inclusion criteria was offered to participate in the study. Nearly all agreed to take part in the study. Inclusion criteria were (i) age 18–55, (ii) opiate dependence syndrome as defined by DSM-IV criteria, (iii) no other current non-substance related DSM-IV Axis I diagnosis and no history of dementia, mental retardation, major depressive disorder or any non-substance related psychotic disorder. Exclusion criteria were: acute intoxication at the time of testing, being on a drug treatment order, inability to communicate in English and pregnancy. Use of other substances, besides opiates, was allowed and common in both settings (including: cocaine in 80/88, tobacco in 86/88, cannabis in 42/88, benzodiazepines in 28/88 and amphetamines in 3/88). Alcohol use was also common, although a third of participants in both samples were teetotal. The initial assessment consisted of a semi-structured interview based on an extended version of the Maudsley Assessment Protocol (MAP, Marsden et al., 1999), and including completion of the Brief Psychiatric Rating Scale (BPRS), the Beck's Depression Inventory (BDI) and the Young Mania Rating Scale (YMRS; Young et al., 1978). IQ was estimated using the Wechsler Test of Adult Reading (WTAR; Wechsler, 2001). The study was approved by the Multisite NHS Research Ethics Committee.

2.2. Treatment programmes

In the community, treatment programmes were similar across participating centres and included substitute opiate prescribing, weekly keyworking sessions, and access to psychology, psychiatry and social work, as required. Newly enrolled patients had a personalised care plan that was woven around the objectives of stabilization on opiate substitution treatment, cessation of illicit drug taking and gradual detoxification from prescribed opiates, and included actions for tackling drug-related problems such as homelessness and unemployment. Themes of relapse prevention, social skills training and vocational facilitation run through individual and group sessions. Urine drug testing was carried out at least weekly initially, then after the first few weeks randomly, at least monthly. Breath alcohol measures were collected daily for alcohol dependent individuals, and weekly or as clinically indicated for non-alcohol dependent individuals.

For the residential sample, treatment consisted of two phases. First they underwent assisted withdrawal from opiates and, where appropriate, from alcohol/benzodiazepines, in a hospital-based inpatient specialist addiction unit. During this phase, which lasted 29 ± 2 days (mean $\pm$ S.E.M., range 13–59), patients were required to participate in group work and they had access to individual and group psychotherapy. For the second phase of their treatment, which extended beyond the follow-up of this study, participants joined a residential programme of their choice at a variety of locations across the UK. These were either therapeutic communities or they were based on the 12-steps facilitation model. With differences in emphasis and theoretical approach, similar themes of relapse prevention, social skills training and vocational facilitation as those of the community treatment and treatment in the specialist addiction unit were incorporated in all residential programmes. Participants in residential treatment were under continuous supervision throughout, thus reducing the need for drug/alcohol testing, which was carried out at random or when clinically indicated.

2.3. Follow-up

In keeping with previous clinical research on outcome (see review in Gossop et al., 2003), we chose an early follow-up of 3-months after the start of treatment. For each treatment setting two groups were achieved at follow-up, Abstinent ('A') and Non-Abstinent ('NA'). To establish group membership we used a combination of face-to-face or telephone interview, and examination of paper or electronic clinical notes, which included urine drug screen results. All 'A' participants were interviewed in person to ascertain continued abstinence.

2.4. Outcome

We chose to use the most stringent measure of outcome, abstinence from all illicit drugs, using the customary term of 30-days prior to assessment (Marsden et al., 1999). Since the residential and community treatment programmes had different goals, this meant abstinence from all psychotropic substances in the former, and abstinence from all psychotropic substances except alcohol or prescribed opiate medication in the latter. Subdivision into abstinent and non-abstinent was clear-cut. In the community sample, most individuals in the 'A' group were abstinent well beyond the 30-days cut-off, as evidenced by self-report and urine drug screen tests; in contrast, most of those in the 'NA' group continued to take illicit drugs at least on a weekly basis throughout the time of the study (only three 'NA' individuals were illicit drug-free for more than one week, but less than two). In the residential sample, individuals in the 'A' group were still in residential programmes at the time of follow-up, where they were continuously monitored for abstinence from alcohol/drugs; in contrast, 'NA' individuals relapsed either at the end of assisted drug withdrawal, or within 1-2 weeks of joining their chosen residential programme, all subsequently re-presenting to drug services to recommence opiate substitution treatment.

At follow-up two participants were in prison and six had disengaged from the services without leaving a valid contact address. The demographics of the remaining 48 community and 32 residential treatment participants are presented in Table 1.

2.5. Neuropsychological testing

Neuropsychological testing took place as described previously (Passetti et al., 2008). In the residential sample, testing took place at least 3-days after admission (mean $\pm$ S.E.M., 'A' = 16.2 ± 3; 'NA' = 16.9 ± 2), at least 5-days after completion of benzodiazepine withdrawal and at least 48-h after a methadone dose reduction. A battery of decision-making (IGT and CGT), planning (Stockings of Cambridge, SOC), motor impulsivity (Go/No-go), reflection impulsivity (Information Sampling Task, IST) and delay discounting (DDT) tasks were administered in a quiet room. These tasks were chosen because they have all been previously shown to discriminate between individuals with and without an addictive disorder. Computerised tasks were administered using a laptop with mounted touch-sensitive monitor.

The IGT requires individuals to choose from four decks of cards, each characterised by a different reward-punishment profile. During the course of the task, healthy participants usually develop a preference for the two decks associated with the most conservative profile. In contrast, individuals with impairments of decision-making often continue to choose from the other two decks, which are associated with a 'risky' profile and overall lead to net loss. The main measure of performance

Table 1
Characteristics of the community and residential treatment sample.

	Community ($n = 48$)	Residential ($n = 32$)	Statistic*
Age (years)	37.3 (7.3)	35.8 (6.3)	0.956, $p = 0.342$
M:F	35:13	22:10	0.163, $p = 0.687$
Ethnicity (white:other)	12:36	4:28	1.875, $p = 0.171$
Verbal IQ ($n = 40, 27$)	99.6 (9.0)	97.8 (9.8)	0.772, $p = 0.443$
BPRS	28.3 (3.8)†	28.6 (3.2)††	0.330, $p = 0.742$
BDI	17.3 (10.1)	17.9 (9.3)	0.255, $p = 0.799$
YMRS	0.9 (1.6)	3.1 (2.0)	**5.260**, $p =$ **0.001**
Education (<GCSE)	46.8%	68.7%	**3.714**, $p =$ **0.054**
Homeless	47.9%	34.3%	1.441, $p = 0.230$
Parental occupation (unskilled)	47.9%†	28.9%	0.262, $p = 0.609$
MAP physical score	14.3 (6.2) ††	13.9 (7.1)	0.292, $p = 0.771$
MAP psychological score	13.3 (7.9) ††	15.3 (8.0)	1.135, $p = 0.260$
MAP network score	39.0 (21.4) ††	43.8 (20.1)	1.007, $p = 0.317$
Mean years of abuse	14.1 (8.9)	13.5 (6.0)	0.338, $p = 0.736$
Heroin daily amount (g)	0.85 (0.48)	0.87 (0.44)	0.226, $p = 0.822$
IV: smokers	32: 16	28: 4	**4.444**, $p =$ **0.035**
Mean methadone dose†††	46.0 (14.3)	40.3 (24.0)	1.208, $p = 0.233$
Cocaine dependent	43.7%	75.0%	**7.619**, $p =$ **0.006**
Alcohol dependent	14.6%	50.0%	**11.757**, $p =$ **0.001**

Mean (SD), ratios or percentages reported. MAP, Maudsley Assessment Protocol; BPRS, British Psychiatric Rating Scale; BDI, Beck's Depression Inventory. YMRS, Young Mania Rating Scale.

* Independent samples Student's *t* test or Pearson's Chi square. Statistically significant results in bold.

† Data missing for three participants.

†† Data missing for two participants.

††† In each group, the doses of six participants maintained on buprenorphine (dose range: 2–10 mg), were converted into methadone doses according to Mattick et al. (2003).

is the difference between the number of choices from the 'safe' minus the number of choices from the 'risky' decks ('net' score). A criterion net score of 10 has been suggested as suitable to classify subjects as 'impaired' or 'unimpaired' on this task (Bechara and Damasio, 2002).

The CGT requires individuals to choose between two mutually exclusive events differing in their probability. Subjects are presented with an array of ten boxes, some red and some blue, and are instructed that a token has been hidden at random inside one box. They first have to decide whether the token is hidden inside a red or blue box and then they have to decide on a bet, selecting from a series of amounts presented sequentially on the screen. The probability, explicitly represented by the box ratio, is varied across trials from 9:1 to 5:5. The main measures of performance are the percentage of times subjects bet on the most likely outcome, the deliberation time and the proportion of points bet. It is important to note that in this task choosing the least likely outcome is not associated with a premium in terms of the rewards to be won and thus the percentage of times subjects bet on the most likely outcome is an index of the quality of decision-making. Previous work using normative data has identified a decision-making score of 89.7% as a suitable cut off for defining 'impaired' performance on this task (Passetti et al., 2008).

The SOC task (Owen et al., 1990) requires subjects to match two arrangements of coloured balls by moving one of the two sets of balls on the screen. Since the balls have to be moved according to rules, moves have to be planned in advance in order to correctly solve each problem. The main measures of performance are the average number of moves taken to solve problems and the overall number of problems solved in the minimum number of moves ('perfect solutions').

The Go/No-go task consisted of a series of presentations of patterns appearing briefly on the screen, in response to which participants had to press a button, when they detected pre-specified Go stimuli; and withhold responding, at the appearance of an infrequent No-go stimulus (see Passetti et al., 2008, for references).

The IST measures one particular aspect of cognitive impulsivity, namely the extent to which relevant information is sampled prior to making a decision ('reflection impulsivity'). Subjects were presented with a grid of grey boxes, which they could open one by one, to reveal an underlying distribution of two colours. After opening as many boxes as they wanted, they had to decide which colour would be in the majority. The average number of boxes opened is a measure of reflection impulsivity (Clark et al., 2006).

The DDT required subjects to choose between larger delayed and smaller immediate rewards that were presented in a list of mutually exclusive alternatives. To enhance validity, subjects were told that one of the choice items would be selected at the end of the task and they would receive the reward they chose for this item, at the stated delay. Choices on the DDT were used to calculate for each participant a discounting rate parameter '*k*' (Kirby et al., 1999).

2.6. Statistical analysis

The first set of analyses compared community with residential treatment, while the second set of analyses compared the 'A' group with the 'NA' group. Student's *t*-test or repeated measures analysis of variance (ANOVA) was used for continuous variables and Pearson's Chi square test was used for categorical variables. Skewed data were subjected to arcsine, square root or logarithmic transformation as recommended by Howell (1997). The Greenhouse–Geisser Epsilon correction was used whenever appropriate. The final set of analyses looked at the degree to which neuropsychological performance predicted relapse. For these analyses we used logistic regression, with outcome at 3-months as the dependent measure and factors that differed between the two groups as covariates. These analyses were repeated using a cut-off score to define 'unimpaired' and 'impaired' performance on the decision-making tasks. Tarone's test of homogeneity of odds ratio was used to look at whether the odds differed significantly between the settings. Analyses were conducted using the SPSS 11.0 statistical package.

3. Results

3.1. Comparison of community versus residential cohorts

The differences between the community and residential samples are presented in Table 1. Compared to the community sample, participants in the residential sample were more likely to have left school with no qualification, to have a history of intravenous drug use and to have a concurrent diagnosis of alcohol or cocaine dependence. These differences are not surprising considering that residential treatment is generally reserved for the opiate dependent individuals with more severe and complex clinical problems (Gossop et al., 2003). As reported in Table 1, there was also a significant difference in YMRS scores. Inspection of raw data revealed this to be largely related to inpatient participants reporting problems with sleep in the ward dormitories and of limited clinical significance.

In terms of performance on the neurocognitive tasks, we found the expected relationships between aspects of task performance and different conditions in each task (e.g., different ratios of coloured boxes in the CGT, see Rogers et al., 1999; consecutive blocks in the IGT, see Bechara and Damasio, 2002; problem difficulty in the SOC, see Owen et al., 1990; reward size in the DDT, see Kirby et al., 1999, etc.), but there were no significant differences between treatment groups or group by condition interactions on any task measure. Table 2 reports a summary of the main measures for each task.

Table 2
Neurocognitive performance of the community and residential treatment sample.

	Community ($n = 48$)	Residential ($n = 32$)	Statistic*
CGT			
Decision-making	90 (11)	90 (11)	0.240, $p = 0.811$
Deliberation time	3215 (1140)	2776 (964)	1.796, $p = 0.076$
Risk taking	0.60 (0.13)	0.62 (0.10)	0.851, $p = 0.397$
Proportion impaired	0.375	0.344	0.081, $p = 0.776$
IGT			
Net score	0.7 (26.8)	−3.0 (34.4)	0.541, $p = 0.590$
Proportion impaired	0.667	0.625	0.147, $p = 0.702$
SOC			
Perfect solutions†	7.6 (2.1)	8.4 (2.0)	1.633, $p = 0.107$
Go/No-go			
P(FA) ††	0.15 (0.11)	0.20 (0.10)	1.658, $p = 0.102$
DDT			
ln(k)	−3.33 (1.38)	−3.19 (1.17)	0.466, $p = 0.643$
IST			
Information sampled††	8.0 (3.4)	7.3 (3.5)	0.774, $p = 0.442$

Mean (SD) or proportion of total reported. CGT, Cambridge Gamble Task; IGT, Iowa Gambling Task; SOC, Stockings Of Cambridge; DDT, Delay Discounting Task; IST, Information Sampling Task.

* Independent samples Student's t test or Pearson's Chi square.

† Data missing for 6 participants.

†† Data only available for 38 community and 30 residential participants.

3.2. Comparison of Abstinent ('A') versus Non-Abstinent ('NA') group

At follow-up, 12 individuals were classified as Abstinent ('A') in the community sample and 10 in the residential treatment sample (Pearson's Chi square = 0.376, $p = 0.540$). Compared to the 'NA' group, individuals in the 'A' group were less likely to be white (Chi square = 5.078, $p = 0.024$) and, if intravenous users, more likely to have shared injecting equipment (Chi square = 4.710, $p = 0.030$). There were no other differences between the groups in any demographic variables, drug histories, or psychological or physical health state.

In terms of performance on the neurocognitive tests, there were significant differences between the 'A' and 'NA' groups on the CGT, on the IGT and on the DDT. On the CGT, 'A' participants had higher decision making scores than 'NA' participants (Table 3; effect size = 0.576) and were more likely to be categorised as unimpaired (Table 3; odds ratio = 3.409, 95% CI = 1.025, 11.337). A repeated measures ANOVA of decision-making scores at different ratios of coloured boxes found that the 'A' group were more likely to choose the box colour in the majority ($F(1,78) = 5.183$, $p = 0.026$) across the range of ratios (no significant ratio × outcome interaction, $F(2,191) = 0.321$, $p = 0.768$; main effect of ratio, $F(2,191) = 19.703$, $p < 0.001$). This effect remained when co-varying for the pre-treatment factors that differentiated between the two settings (co-morbid alcohol or cocaine dependence, education and YMRS scores). There were no differences on decision latencies or betting behaviour on the CGT. On the IGT, 'A' participants were more likely to be categorised as unimpaired than 'NA' participants (Table 3; odds ratio = 3.150, 95% CI = 1.138, 8.716), but a repeated measures ANOVA of net scores by blocks did not detect a significant effect of group ($F(1,78) = 1.482$, $p = 0.227$). 'A' participants also had significantly lower discounting rates on the DDT than 'NA' participants (Table 3; effect size = 0.525).

3.3. Predictors of outcome

Logistic regression was used to predict outcome from factors that appeared to discriminate between 'A' and 'NA' participants, including performance on the neurocognitive tasks and race (white versus other). We did not enter the variable for sharing injecting equipment, because this only related to the subgroup of participants who were intravenous users. Setting was also included in the analysis. Both race (Wald Chi square = 6.509, $p = 0.011$) and performance on the CGT (Wald Chi square = 5.784, $p = 0.016$) were significant predictors of outcome, but setting, IGT performance and DDT scores were not (Wald Chi square = 0.972, $p = 0.324$; 2.858, $p = 0.091$; and 3.281, $p = 0.070$, respectively). Logistic regression found similar results whether raw scores or categorical measures of CGT performance were included in the analysis. To explore if the relationship between performance on the CGT and outcome was consistent over settings, a setting by CGT performance variable was entered. However, one of the parameters in the logistic regression could not be estimated on account of a cell containing a null value (in the community, none of the participants impaired on the CGT was abstinent at 3-months). Odds ratios computed setting a value of 0.5 for this cell found that in the community, but not in residential settings, the probability of achieving and maintaining abstinence was higher in individuals unimpaired on the CGT, than in individuals impaired on this task (Fig. 1). Odds ratios were 24.00 [95% CI = 1.32, 437.70], in the community (the wide CIs indicating the lack of precision in the estimate of the odds ratios due to the small numbers in some cells); and 1.87 [95% CI = 0.45, 7.69], in the residential setting. Testing for equality of odds ratios using the uncorrected data confirmed a significant difference between the two settings (Tarone's Chi square = 7.449, $p = 0.006$).

4. Discussion

According to the treatment matching hypothesis, the outcome of substance misuse treatment might be improved if we could select the most appropriate intervention for each individual, but accepted criteria for such a systematic matching are lacking (Ghodse, 2010, p. 179). The present results indicate that for community treatment the degree of decision-making impairment at the beginning of treatment might represent a robust predictor of at least one aspect of outcome, the achievement of early abstinence. In addition, we found that while intact decision-making increased the odds of achieving abstinence in the community, in residential treatment there was no relationship between these odds and performance on

Table 3
Neurocognitive performance of the of abstinent and non-abstinent groups.

	Non-Abstinent ($n = 58$)	Abstinent ($n = 22$)	Statistic*
CGT			
Decision-making	88 (12)	94 (6)	**2.488**, $p =$ **0.016**
Deliberation time	3052 (1059)	3007 (1188)	0.161, $p = 0.872$
Risk taking	0.62 (0.11)	0.60 (0.13)	0.816, $p = 0.417$
Proportion impaired	0.431	0.182	**4.287**, $p =$ **0.038**
IGT			
Net score	−3.3 (24.8)	5.8 (40.5)	0.986, $p = 0.333$
Proportion impaired	0.724	0.454	**5.096**, $p =$ **0.024**
SOC			
Perfect solutions†	7.9 (2.1)	8.0 (2.1)	0.171, $p = 0.865$
Go/No-go			
P(FA) ††	0.18 (0.11)	0.15 (0.11)	0.905, $p = 0.369$
DDT			
ln(k)	−3.11 (1.40)	−3.69 (0.81)	**2.302**, $p =$ **0.025**
IST			
Information sampled††	7.9 (3.6)	7.3 (3.1)	0.572, $p = 0.570$

Mean (SD) or proportion of total reported. CGT, Cambridge Gamble Task; IGT, Iowa Gambling Task; SOC, Stockings Of Cambridge; DDT, Delay Discounting Task; IST, Information Sampling Task.

* Independent samples Student's t test or Pearson's Chi square. Statistically significant results in bold.

† Data missing for 6 participants.

†† Data only available for 38 community and 30 residential participants.

a decision-making task. The results have important implications. They suggest that opiate dependent individuals with significant decision-making impairment are unlikely to achieve and maintain abstinence from illicit drugs within community treatment, but may instead benefit from residential treatment. They also suggest that measures of decision-making may be used, alongside other assessments, to guide placement matching. Previous literature on placement matching had suggested an interaction between setting, addiction severity and treatment outcome, such that individuals with higher severity would have better outcomes when treated in a residential rather than in a community programme (Tiet et al., 2007; Drummond, 2009). Our results mirror those of these previous studies, using an outcome predictor that is independent from measures of severity. An interesting result of our study was that in this sample (which excluded individuals with dual diagnosis) we found no differences in neurocognitive performance, across a range of measures, between the community and the inpatient/residential cohort. This suggests that the processes that had led to the selection of treatment intervention for the individuals included in the study did not already reflect differences in the aspects of cognitive function we investigated. Thus, these measurements do not appear to duplicate assessments that are already implicit in the evaluation of clinical variables, such as are used by treatment teams to guide case management.

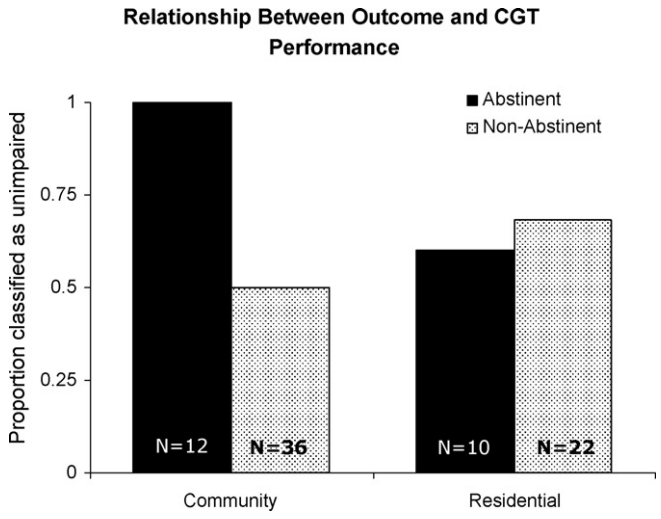

Fig. 1. In community treatment programmes, individuals with preserved decision-making as measured by performance on the Cambridge Gamble Task (CGT) were more likely to achieve and maintain abstinence. In residential treatment programmes there was no such relationship between outcome and CGT performance.

The main limitation of this study was some unavoidable differences between the residential and community groups. Firstly, individuals were not randomised to either group, each sample being determined by a combination of service referral and self-selection processes (analogous to the cohort of Gossop et al., 2003). As a result, in general, the residential group tended to include more complex and severe cases. Secondly, although all the community participants had a goal of ultimately becoming opiate-free, the speed of assisted withdrawal was much slower for these than for the residential sample. Thus, the community sample was on opiate substitute treatment throughout the follow-up period, while the residential sample was detoxified within a short time after enrolling in the study. However, the focus of the present study was not to compare the outcomes of two different treatment interventions, but to investigate the strength of the relationship between neurocognitive factors and outcome in two distinct settings, using a naturalistic sampling approach, chosen to match samples that would be encountered in real clinical contexts. Since there was no overlap between successful outcomes in the two settings (no one in the community sample achieved abstinence from all psychotropic substances, i.e., including opiate substitute prescription) and since outcome rates were similar in the two settings, it was appropriate to compare the subgroup of individuals who in each setting had the best outcome, relative to the rest of individuals in that setting. Furthermore, when we compared the CGT performance of groups defined by the factors that differentiated between community and residential sample (e.g., cocaine or alcohol dependence), decision-making scores were numerically lower in the group more prominently represented in the residential setting, suggesting that if anything these factors should accentuate, rather than attenuate, the relationship between performance and clinical outcome in this setting.

In the present study, although we excluded individuals who were on a drug treatment order from the courts, we did not mea-

sure each individual's motivation to achieve abstinence and this could have explained part of the variance. While the finding of a relationship between decision-making and outcome in the community sample despite no correction for motivation to change actually strengthens the significance of the finding, differences in motivation might have explained the lack of a similar relationship in the residential sample. However, previous research has found similar association of good outcome and preserved decision-making in studies involving individuals receiving inpatient/residential treatment and including no correction for motivation to change (Aharonovich et al., 2006; Bowden-Jones et al., 2005; Paulus et al., 2005). In addition, the predictive validity of current tools for the assessment of motivation in individuals undertaking addiction treatment has been questioned (West, 2005) and it is doubtful if the addition of any such tools might have significantly increased the measured strength of the relationship between measures of decision-making and outcome. Future studies will need to address this issue directly, perhaps using new, more carefully tailored tools for measuring motivation to change.

Of the neurocognitive measures employed in the present study, the decision-making score of the CGT was the best predictor of outcome. In comparison to the widely used IGT, which assesses decision-making between options with unknown outcome probabilities, the level of risk is explicit in the CGT, in the ratio of red to blue boxes. Thus, the effect on CGT choice behaviour implicates the ability to evaluate trade-offs between uncertain rewards and punishments as an important factor in newly abstinent drug users relapsing. This emphasis on probability processing is also distinct from the constructs underlying the DDT, which taps decision-making in the temporal domain. Indeed, while DDT and IGT performance measures were correlated in a cocaine-dependent group, neither measure was significantly correlated with CGT choice behaviour (Monterosso et al., 2001). However, the DDT also discriminated between abstinent and non abstinent individuals in the univariate comparisons. In fact, while the addition of a residential treatment arm diluted the relationship between CGT performance and clinical outcome, the relationship between DDT performance and clinical outcome was strengthened by the inclusion of this group (cf. present results with Passetti et al., 2008). Steeper rates of delay discounting may reflect a stable trait (Kirby, 2009), which might play a greater role in the development, rather than in the maintenance of addictive disorders (Dom et al., 2006).

On the basis of the preliminary findings of this study, we can only speculate about the mechanisms underlying the differences in the strength of the relationship between decision-making and outcome in community and inpatient/residential treatment. We have already acknowledged the differences between the two groups, both in terms of pre-treatment characteristics and in terms of the different challenges of treatment in the two settings. In addition, the intensity of intervention differed across settings, as was the definition of abstinence, which excluded prescribed opiate substitution treatment in the community sample. Any of these differences may have distorted the relationship between neurocognitive functioning and outcome, for example, by compensating for the effects of impairment in the group in the residential setting. Here we would like to point to another, alternative interpretation of the discrepancy between the community and residential samples, which emphasises a possible role of the setting *per se*. Compared to treatment in the community, treatment in a residential setting not only reduces exposure to many of the environmental pressures that may lead to relapse; it also provides containment for internal influences that may act as powerful triggers to relapse, such as dysphoria and anxiety (Marlatt and Gordon, 1980). Thus, it is possible that for individuals who were most likely to succumb to such triggers, the selection of residential setting might have compensated for impairments in top-down prefrontal processes. For these individuals with particularly poor decision-making, being in a residential setting might have greatly facilitated the achievement of abstinence, to the point that in a residential setting they would be as likely to abstain from illicit drugs as individuals with intact decision-making processes.

In summary, the present study demonstrated that opiate dependent individuals with significant decision-making impairment are unlikely to achieve and maintain abstinence from illicit drugs within community treatment, but may benefit from residential treatment. These are preliminary findings, but they have important clinical implications. At a time when a move towards cost containment in western healthcare systems is leading to a shift in resources towards treatment in community settings (Gossop et al., 2003; McKellar et al., 2004), they point to the importance of maintaining inpatient/residential treatment as part of the continuum of care. If replicated in a larger cohort, the results support the case for diverting individuals with decision-making impairments from community to residential treatment early on, provided they are motivated to achieve and maintain abstinence, and for including aspects of cognitive rehabilitation in their treatment programme.

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Contributors

FP, MK and MAS designed the study. FP wrote the protocol, collected and analysed the data and wrote the first draft of the manuscript. PD contributed to refinements of the initial protocol and the management of data collection. SW, LC, KC and MAM contributed to the interpretation and statistical analysis of the data. All authors contributed to and have approved the final manuscript.

Conflict of interest

LC and MAM consult for Cambridge Cognition plc, which distribute the Cambridge Gamble Task. All other authors declare that they have no conflicts of interest.

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