Stimulant psychosis: systematic review

CATHERINE CURRAN, NEETHA BYRAPPA and ANDREW McBRIDE

Background  Psychosis associated with stimulant use is an increasing problem, but there is little research evidence about the nature of the problem and its management.

Aims  To critically review the literature on stimulant psychosis and sensitisation.

Method  Systematic review of studies that have investigated stimulant use and psychosis in humans. The main outcome measures were increases in psychosis with stimulant use, and differences between stimulant users and non-users.

Results  Fifty-four studies met the inclusion criteria. Experimental studies show that a single dose of a stimulant drug can produce a brief increase in psychosis ratings (a ‘response’) in 50–70% of participants with schizophrenia and pre-existing acute psychotic symptoms, unaffected by the presence of antipsychotic medication. Those with schizophrenia who do not have acute psychotic symptoms respond, but less frequently (30%). There has been little research into the longer-term effects of use.

Conclusions  Compliance with antipsychotic medication by someone with schizophrenia will not prevent a relapse or worsening of psychotic symptoms if stimulants are used. Low-dose antipsychotic treatment may be beneficial in stimulant users, to prevent sensitisation.

Declarations of interest  None.

Stimulants have been used for many centuries but only latterly have there been reports of associated psychosis (Guttmann & Sargant, 1937), culminating in Connell’s monograph (Connell, 1958), which reviewed cases of ‘stimulant’ psychosis that resolved rapidly. In Japan, where there was an epidemic of injected amphetamine use, the duration of psychosis appeared to be prolonged and chronic (Koyama et al, 1991). The theory was proposed that repeated low doses of a stimulant lead to changes in the central nervous system (CNS) (Ellingwood & Kilbey, 1980), a form of ‘kindling’, which produces a psychotic illness similar to schizophrenia. Animal experiments seem to support such an effect (Post & Kopanda, 1976). Others dispute this theory of sensitisation (e.g. Brabbins & Poole, 1996). If sensitisation is occurring, then early treatment and retention of stimulant users in mental health care services would appear to be desirable to prevent chronic psychoses developing. There is a lack of good-quality evidence as to the effectiveness of this: a recent Cochrane review found no relevant trials (Srisurapanont et al, 2004).

The purpose of this study is to examine evidence for the theory of sensitisation. The hypothesis is that stimulant psychoses can be divided into a ‘toxic’ type of response and a chronic persisting response resulting from longer-term use of stimulants.

METHOD

We searched for experimental and observational studies in humans taking stimulants that investigated or described the development of psychotic symptoms. We did not include case series or cross-sectional studies, as these give little information as to the direction of effect or changes over time.

We performed electronic searches on Medline, PsyCIT and EMBASE psychiatry from the earliest dates available to 2001, using the search terms COCAINE, CRACK, AMPHETAMINE, METHYLAMPHETAMINE, METHAMPHETAMINE, METHAMPHETAMINE, AMPHETAMINE, DEXAMPETAMINE, METHYLPHENIDATE, PSYCHOACTIVE DRUGS, CNS STIMULANT DRUGS and DRUG-INDUCED PSYCHOSIS (for stimulants) and PSYCHOSIS, PSYCHOSES, SCHIZOPHRENIA and SCHIZO-AFFECTIVE (for psychoses). Where Medical Subject Headings (MeSH) terms were available, they were exploded and combined. Papers were checked for references to other relevant studies.

Identifying and evaluating the studies

Following the initial searches by C.C., all experimental case-control and longitudinal studies were independently appraised by C.C. and N.B. Any disagreements on whether a study should be included were resolved by reference to the criteria. Three methodologically distinct types of studies were identified, which were reviewed separately. Studies were included if they met the following criteria.

Experimental studies

Studies were included if:

(a) participants were given stimulants (cocaïne, amphetamines or methylphenidate); and
(b) participants were monitored for possible psychotic reactions; and
(c) circumstances of administration were controlled for dose, route and timings (if variable doses were given, this was related to dose per kilogram or dose according to physiological response or blood level); and
(d) psychosis or changes in psychosis were measured in a standardised fashion.

Longitudinal studies

Studies were included if:

(a) a cohort of substance users with or without psychosis, defined by operational criteria, was followed up for a defined period; and
(b) stimulant users were identified and differentiated from other substance users in the report.

Case-control studies

Studies were included if:
(a) individuals using stimulants with psychosis were compared with those using stimulants with no psychosis; or
(b) individuals with psychosis using stimulants were compared with control individuals with psychosis but with no history of drug use; or
(c) individuals using stimulants were compared with individuals using non-stimulant substances; and
(d) Stimulant users are identified and differentiated from other substance users in the report.

RESULTS
A total of 84 experimental or observational studies were identified by the search and cross-referencing strategies. Initial agreement on studies meeting the criteria in the review was present for 89% of the experimental studies, 82% of the longitudinal studies and 75% of the case-control studies. After discussion between the raters, it was agreed that 43 studies met the criteria and were thus included in the review.

Experimental studies
A total of 32 experimental studies were included (Table 1). Twenty-eight of these involved single doses of oral or intravenous (i.v.) dexamfetamine or methylphenidate given to individuals with schizophrenia, and 9 of these 28 studies included a control group. One of the remaining 4 studies included a heterogeneous group of individuals with psychosis and controls given two doses of dexamfetamine orally 48 hr apart (Strakowski et al., 1997). Two studies involved substance users (Cami et al., 2000; Farren et al., 2000). The final study (Casey et al., 1961) was a randomised controlled trial of 520 individuals with schizophrenia in which one group received dexamfetamine orally for 20 weeks. All studies used some form of standardised rating scale – most commonly the Brief Psychiatric Rating Scale (BPRS) – to measure changes resulting from stimulant use. A ‘response’ was considered to have occurred when changes were measured in the psychosis component of the various scales. The response to a single dose of stimulant, when present, was brief, seldom lasting more than a few hours.

The Strakowski et al. (1997) study looked for a response to repeated doses of stimulants. In the control group there was a greater response to the second dose of dexamfetamine than to the first. Participants with pre-existing psychosis showed no such enhanced response to a second dose.

The study by Casey et al. (1961) examined additional drug therapy in patients with schizophrenia, all of whom were taking antipsychotic medication regularly and had not responded to 200–600 mg of chlorpromazine taken daily for at least 2 months. One arm of the study examined the addition of dexamfetamine as an adjunctive treatment for schizophrenia. There was no benefit from the addition of dexamfetamine 60 mg daily compared with placebo, with worsening of ‘hostile belligerency, paranoid belligerency and thinking disturbance’.

For 26 studies it was possible to perform a statistical analysis of differences in psychotic response between controls, those with schizophrenia in remission and those with positive symptoms, using the definitions provided by the studies to determine the presence or absence of positive symptoms. There was a methodological difference between participants given i.v. dexamfetamine and those given oral dexamfetamine or i.v. methamphetamine (see Table 6): the doses of dexamfetamine used intravenously were lower and fixed, as opposed to being varied according to body weight (dexamfetamine 20 mg as opposed to 0.5 mg/kg methylphenidate).

Across the 26 studies, 51.4% of those with schizophrenia who had positive symptoms (n=149), 28.3% of those with schizophrenia in remission (n=69) and 10.2% of controls (n=9) had a temporary increase in positive symptoms, usually lasting for only a matter of hours. An analysis of the effects of the presence of positive symptoms v. absence of positive symptoms in participants with schizophrenia found a significant difference (χ²=46.3, d.f.=1, P<0.0001). We also examined modulating effects of antipsychotic drugs on the psychotic response. We did not detect a significant effect of antipsychotic medication in the response of participants with schizophrenia to a single dose of stimulant (χ²=0.06, d.f.=1, P=0.80); this was true whether the participants were defined as having positive symptoms or as being in remission (χ²=0.16, d.f.=1, P=0.68 for those with positive symptoms; χ²=0.36, d.f.=1, P=0.55 for those in remission).

Longitudinal studies
Seven longitudinal studies met the inclusion criteria (Table 2). Studies of this type were most commonly excluded because of the difficulty of separating stimulants from the other substances used. Two studies examined individuals prescribed stimulants: adults with narcolepsy (Pawluck et al., 1995) and children with attention-deficit hyperactivity disorder (Cherland & Fitzpatrick, 1999). Two of the 11 adults in the first study developed acute psychotic symptoms, as did 9 of the 192 children in the latter study. Two follow-up studies of cocaine users (Gawin & Kleber, 1986; Carroll et al., 1993) reported no case of chronic psychosis. Sato et al. (1983) studied amphetamine users who had previously had long-lasting psychotic episodes who reduced a stimulant after long periods of abstinence. These individuals were found to relapse after using a lower dose of amphetamine than they had used before first becoming psychotic. In one case the person’s relapse seemingly was due to stress, without drug use. The researchers also conducted a small, uncontrolled trial of haloperidol 3 mg daily in eight of these individuals, none of whom then relapsed following subsequent amphetamine use. Iwanami et al. (1994) studied individuals who presented with a psychotic illness in the presence of amphetamine use; they identified a small group whose psychotic symptoms persisted for several months after ceasing amphetamine use who were being prescribed antipsychotic treatment. This group did not meet criteria for DSM-III schizophrenia (American Psychiatric Association, 1980) but had definite psychotic symptoms.

Kwapil et al. (1996) reported a 10-year follow-up study of substance-using individuals and controls who scored highly on the Chapman Questionnaire ‘psychosis proneness’ section. This self-report questionnaire is designed to measure symptoms and traits reported to be characteristic of proneness to schizophrenia or psychosis. The study showed that psychosis was not predicted by earlier substance use, but the small number of stimulant users meant that the power of the study was insufficient for a meaningful analysis of any link between psychosis and stimulants.

Case-control studies
Most case-control studies identified by the search strategy were excluded because it
<table>
<thead>
<tr>
<th>Study</th>
<th>Study sample (n)</th>
<th>Substance and dosage</th>
<th>Increased/new positive symptoms</th>
<th>Decreased/no positive symptoms</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casey et al (1961)</td>
<td>Schizophrenia (520)</td>
<td>Dexamfetamine 60 mg orally, daily for 20 weeks</td>
<td>Yes</td>
<td>NR</td>
<td>All participants were in-patients</td>
</tr>
<tr>
<td>Strakowski et al (1997)</td>
<td>Psychosis (13) Controls (11)</td>
<td>Dexamfetamine 0.25 mg/kg orally × 2, 48 h apart</td>
<td>Yes</td>
<td>NR</td>
<td>Psychosis group did not show enhanced response with second dose; controls did. No recordings for individual patients</td>
</tr>
<tr>
<td>Angrist et al (1980)</td>
<td>Schizophrenia (21)</td>
<td>Dexamfetamine 0.5 mg/kg orally stat</td>
<td>Yes</td>
<td>Yes</td>
<td>High initial positive symptom score predicted high score after amphetamine</td>
</tr>
<tr>
<td>Angrist et al (1982)</td>
<td>Schizophrenia (26)</td>
<td>Dexamfetamine 0.5 mg/kg orally stat</td>
<td>Yes</td>
<td>Yes</td>
<td>Mean negative symptom score significantly decreased after amphetamine; positive symptom score showed a non-significant increase</td>
</tr>
<tr>
<td>Angrist et al (1985)</td>
<td>Schizophrenia (25)</td>
<td>Dexamfetamine 0.5 mg/kg orally stat</td>
<td>Yes</td>
<td>Yes</td>
<td>11 showed an increase in extrapyramidal symptoms including 3 who developed tardive dyskinesia</td>
</tr>
<tr>
<td>Pandurangi et al (1989)</td>
<td>Schizophrenia (19)</td>
<td>Dexamfetamine 30 mg orally stat</td>
<td>Yes</td>
<td>Yes</td>
<td>Worsening positive symptoms correlated with lack of enlargement of VBR and better response to treatment</td>
</tr>
<tr>
<td>Van Kammen et al (1982a)</td>
<td>Schizophrenia (45)</td>
<td>Dexamfetamine 20 mg infusion/placebo infusion</td>
<td>Yes</td>
<td>Yes</td>
<td>Pimozide-treated patients who worsened had higher psychosis ratings</td>
</tr>
<tr>
<td>Van Kammen et al (1982b)</td>
<td>Schizophrenia (82b)</td>
<td>Dexamfetamine 20 mg infusion</td>
<td>1. Yes (drug-free)</td>
<td>1. Yes</td>
<td>Pre-infusion psychosis ratings did not correlate with dexamfetamine-induced changes</td>
</tr>
<tr>
<td>Van Kammen &amp; Boronow (1988)</td>
<td>Schizophrenia (30)</td>
<td>Dexamfetamine 20 mg infusion prior to and following pimozide treatment for 6 weeks</td>
<td>Results as for Van Kammen et al (1982b)</td>
<td>2. Yes</td>
<td>Reduced negative symptoms on dexamfetamine correlated with reduced negative symptoms on pimozide</td>
</tr>
<tr>
<td>Wolkin et al (1994)</td>
<td>Schizophrenia (17)</td>
<td>Dexamfetamine 0.5 mg/kg orally</td>
<td>Yes</td>
<td>No</td>
<td>Effects no different in people with or without lifetime history of substance use</td>
</tr>
<tr>
<td>Sanfilipo et al (1996)</td>
<td>Schizophrenia (37)</td>
<td>Dexamfetamine 0.5 mg/kg orally</td>
<td>Yes</td>
<td>NR</td>
<td>Trend to lower negative symptoms in those with higher negative symptom score. No recordings for individual patients</td>
</tr>
<tr>
<td>Abi-Dargham et al (1998)</td>
<td>Schizophrenia (15) Controls (15)</td>
<td>Dexamfetamine 0.3 mg/kg i.v.</td>
<td>Yes (schizophrenia)</td>
<td>Yes (all others)</td>
<td>Worsening of positive symptoms associated with larger reduction in [123I]IBZM binding potential (increased dopamine transmission)</td>
</tr>
<tr>
<td>Cami et al (2000)</td>
<td>Substance users: ecstasy (14)</td>
<td>Dexamfetamine 40 mg orally</td>
<td>No</td>
<td>Yes (all)</td>
<td>Negative symptom measures reduced in both groups</td>
</tr>
<tr>
<td>Kirrane et al (2000)</td>
<td>Schizophrenia spectrum disorder (12) Other psychotic disorder (13)</td>
<td>Dexamfetamine 30 mg orally</td>
<td>No</td>
<td>Yes (all)</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Study sample (n)</td>
<td>Substance and dosage</td>
<td>Increased/new positive symptoms</td>
<td>Decreased/no positive symptoms</td>
<td>Comment</td>
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<tr>
<td>Janowsky et al (1973)</td>
<td>Schizophrenia, acutely ill (22)</td>
<td>Methylphenidate 0.5 mg/kg i.v. over 30s</td>
<td>Yes (all acutely ill schizophrenia group, mania group)</td>
<td>Yes (all others)</td>
<td>17 patients evaluated off antipsychotics. No evidence that antipsychotics alter the response in acutely ill patients</td>
</tr>
<tr>
<td>Janowsky et al (1977)</td>
<td>Schizophrenia (16)</td>
<td>Methylphenidate 0.5 mg/kg i.v.</td>
<td>Yes (both groups)</td>
<td>Yes (both groups)</td>
<td></td>
</tr>
<tr>
<td>Lieberman et al (1984)</td>
<td>Schizophrenia (6)</td>
<td>Methylphenidate 0.5 mg/kg i.v. over 2 h</td>
<td>Yes</td>
<td>Yes</td>
<td>All participants were out-patients</td>
</tr>
<tr>
<td>Lieberman et al (1987)</td>
<td>Schizophrenia (34)</td>
<td>Methylphenidate 0.5 mg/kg i.v. over 2 h</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Sharma et al (1991)</td>
<td>Schizophrenia (9)</td>
<td>Methylphenidate 0.5 mg/kg i.v.</td>
<td>Schizophrenia: Yes</td>
<td>Schizophrenia: Yes</td>
<td>Mean change in BPRS ratings greater in schizophrenia group; there was response in both schizophrenia and non-schizophrenia groups but also individuals in both groups who did not respond</td>
</tr>
<tr>
<td>Carpenter et al (1992)</td>
<td>Schizophrenia with history of hyperactivity (8)</td>
<td>Methylphenidate 0.3 mg/kg orally daily for 5 days</td>
<td>No</td>
<td>Yes</td>
<td>One patient withdrew owing to hypertension. No change in symptoms</td>
</tr>
<tr>
<td>Levy et al (1993)</td>
<td>Schizophrenia (13)</td>
<td>Methylphenidate 0.5 mg/kg i.v.</td>
<td>Yes (results presented as mean difference)</td>
<td>Yes (controls)</td>
<td>Thought disorder greater in schizophrenia group but not in controls. No recordings for individual patients</td>
</tr>
<tr>
<td>Lieberman et al (1993)</td>
<td>Schizophrenia (70)</td>
<td>Methylphenidate 0.5 mg/kg i.v.</td>
<td>Yes (59% schizophrenia)</td>
<td>Yes (controls)</td>
<td>Group with psychosis showed an increase in positive and negative symptoms</td>
</tr>
<tr>
<td>Koreen et al (1997)</td>
<td>Schizophrenia (32)</td>
<td>Methylphenidate 0.5 mg/kg i.v. or mCPP 0.1 mg/kg</td>
<td>No (mCPP)</td>
<td>NR (schizophrenia)</td>
<td>No recordings for individual patients</td>
</tr>
<tr>
<td>Szekse et al (1999)</td>
<td>Schizophrenia (11)</td>
<td>Methylphenidate 0.5 mg/kg i.v.</td>
<td>Yes (methylphenidate)</td>
<td>No (controls)</td>
<td>No recordings for individual patients</td>
</tr>
<tr>
<td>Farren et al (2000)</td>
<td>Cocaine users (8)</td>
<td>Cocaine intranasally 2 mg/kg 2 h after placebo or clozapine</td>
<td>Yes (paranoid symptoms)</td>
<td>NR</td>
<td>Clozapine reduced mean expected high; no attenuation of paranoid or craving scores. Cocaine levels increased by clozapine</td>
</tr>
</tbody>
</table>

BPRS, Brief Psychiatric Rating Scale; IBZM, iodobenzamide; mCPP, m-chloropiperazine; NR, not recorded; stat, immediately; VBR, ventricle to brain ratio; i.v., intravenously.
Table 2  Longitudinal studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Study sample</th>
<th>Follow-up</th>
<th>Findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pawluck et al (1995)</td>
<td>Adults with narcolepsy on methylphenidate (&gt; 100 mg/day)</td>
<td>5 years</td>
<td>2/11 psychotic symptoms</td>
<td>Both premorbid difficulties, former had paranoid ideas, latter family history of psychosis and head injury</td>
</tr>
<tr>
<td>Cherland &amp; Fitzpatrick (1991)</td>
<td>Children with ADHD on methylphenidate, pemoline or dextroamphetamine</td>
<td>5 years</td>
<td>9/192 developed mood-incongruent psychotic symptoms</td>
<td>Notes three symptom clusters: MPM toxic hallucinations (first doses), slower-developing paranoia mood-congruent psychotic symptoms</td>
</tr>
<tr>
<td>Gawin &amp; Kleber (1986)</td>
<td>Cocaine users in treatment programme</td>
<td>4–6 weeks</td>
<td>Screened with DIS, no reported case of psychosis</td>
<td>Looking for withdrawal symptoms</td>
</tr>
<tr>
<td>Carroll et al (1993)</td>
<td>Treatment-seeking cocaine users</td>
<td>1 year</td>
<td>No evidence of any chronic psychotic disorder</td>
<td>Most abstinent or markedly decreased use</td>
</tr>
<tr>
<td>Sato et al (1983)</td>
<td>Methamphetamine users with chronic psychosis</td>
<td>&gt; 1 month (variable within group)</td>
<td>16 patients reused MAP after long-term abstinence (up to 5 years) and relapsed with less MAP than previously, 4 with only one injection, 1 with none</td>
<td>Excluded if met DSM-III criteria for schizophrenia</td>
</tr>
<tr>
<td>Iwanami et al (1994)</td>
<td>Methamphetamine users with psychosis</td>
<td>&gt; 1 month (variable within group)</td>
<td>Two groups, symptoms lasting for: 1 week after abstinence (transient group, n = 54), 3 months after abstinence (persistent group, n = 17)</td>
<td>All given antipsychotics, Abstinence ensured</td>
</tr>
<tr>
<td>Kwapił (1996)</td>
<td>High scores on Chapman Questionnaire (‘psychosis-prone’) using substances</td>
<td>10 years</td>
<td>Psychosis-prone group used more stimulants than controls</td>
<td>Persistent group more likely to have non-auditory non-visual hallucinations</td>
</tr>
</tbody>
</table>

ADHD, attention-deficit hyperactivity disorder; DIS, Diagnostic Interview Schedule; MAP, methamphetamine; MPH, methylphenidate.

Table 3  Case–control studies of stimulant users: with v. without psychosis

<table>
<thead>
<tr>
<th>Study</th>
<th>Cases (n)</th>
<th>Controls (n)</th>
<th>Significant differences (cases v. controls)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brady et al (1991)</td>
<td>Cocaine users with psychosis (29)</td>
<td>Cocaine users, no psychosis (26)</td>
<td>Greater duration and amount of use prior to admission in psychosis group; greater proportion of males in psychosis group</td>
<td>72% reported psychosis occurring with increased frequency, greater speed of onset and with smaller amounts of cocaine over time</td>
</tr>
<tr>
<td>Satel &amp; Edell (1991)</td>
<td>Cocaine users with paranoia (10)</td>
<td>Cocaine users without paranoia (10)</td>
<td>‘Psychosis proneness’ score on the Perceptual Aberration Scale and Magic Ideation Scale positively correlated with paranoia</td>
<td>Unable to determine direction or causality of relationship</td>
</tr>
<tr>
<td>Bartlett et al (1997)</td>
<td>Cocaine users with paranoia (22)</td>
<td>Non-paranoid users (18), Sensitised users’ (11)</td>
<td>Greater duration of cocaine use in sensitised group</td>
<td>Sensitisation linked to other psychotic features of cocaine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-sensitised users (7)</td>
<td>Reduced dose escalation in sensitised group</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Increased referentiality and unease in sensitised group</td>
<td></td>
</tr>
<tr>
<td>Manschreck et al (1988)</td>
<td>Psychosis &gt; 24 h, cocaine users (31)</td>
<td>Cocaine users, non-psychotic (28)</td>
<td>Past psychiatric history, violence and total drug use all greater in cases</td>
<td>Freebase cocaine used; psychosis present in 29% of cocaine-using patients hospitalised in 1 year</td>
</tr>
</tbody>
</table>

I. Users whose paranoia had worsened over time.
was impossible to separate stimulant use from other drug use known to be associated with psychotic states, such as cannabis.

Four studies compared cocaine users with psychosis with users with no psychosis (Table 3). Heavier cocaine use was shown among participants with psychosis compared with controls in three studies (Manschreck et al, 1988; Brady et al, 1991; Bartlett et al, 1997). In two studies it was reported that the psychotic episodes worsened over time (Brady et al, 1991; Bartlett et al, 1997). Five studies compared individuals with schizophrenia or another psychotic illness who had been using stimulants with matched groups who had not been using stimulants (Table 4). These studies showed a lower age of onset of psychosis in the stimulant-user group, fewer negative symptoms and more paranoid themes. First-rank symptoms were noted to be fewer and hallucinatory experiences more common. Seibyl et al (1993) showed that most of the people misusing drugs in their study had begun their cocaine use after psychosis had developed.

Two studies compared people misusing stimulants with those misusing other drugs (Table 5). Graf et al (1977) showed an increase in the psychotic profile on the
Minnesota Multiphasic Personality Inventory at discharge in people using stimulants rather than other drugs, and Dalmau et al (1999) showed a significant difference in the rates of psychosis between patients formerly using amphetamines and those using opiates in a study of residents of a drug rehabilitation unit.

**DISCUSSION**

The studies reviewed here provide useful evidence about the effect of stimulant use on people with pre-existing psychotic illness, but more limited evidence about the phenomenon of sensitisation.

The expectation that antipsychotic medication might block the action of stimulants and prevent deterioration in psychotic illnesses on exposure is not borne out by these studies. The presence of positive symptoms of schizophrenia (as distinct from being in remission) appears to make an individual more likely to experience a worsening of psychotic symptoms in response to a single dose of a stimulant drug.

There is clear evidence from these studies that, irrespective of the individual's mental state, a large enough dose of a stimulant drug can produce a brief psychotic reaction, usually lasting only hours and being self-limiting in the majority of individuals. The differences between i.v. dexamfetamine, oral dexamfetamine and i.v. methamphetamine in participants with active symptoms are probably due to the lower doses used in the i.v. dexamfetamine condition – usually a maximum of 20 mg. Evidence for sensitisation is found in only two studies. Strakowski et al (1997) showed that when two doses of a stimulant were given to volunteers free from psychosis, the second dose produced a greater psychotic response as measured by the BPRS – a 'sensitised' response. Stimulant users in the study by Brady et al (1991) reported psychotic symptoms occurring with lower doses over time.

The difference between patients who were substance users in the study by Dalmau et al (1999), where psychosis rates were noted to be greater among in-patients who used cannabis or stimulants rather than opiates, is interesting. Sensitisation is a possible contributing factor, but not the only one. The results might have been confounded by differences in rates of admission to the unit. It is possible, for example, that those with opiate problems were admitted more frequently for in-patient detoxification, whereas stimulant users (in whom the withdrawal syndrome is less severe) might have been given out-patient treatment. The proportion presenting with psychosis as in-patients would therefore be greater for those using stimulants rather than opiates.

The difficulties of researching the longer-term effects of stimulants are seen in the two Japanese studies (Sato et al, 1983; Iwamani et al, 1994). The widespread use of high-dose injected methamphetamine led to hospital admissions of individuals with chronic psychosis that persisted after substance use had ceased. Many patients in these studies could have been given a DSM-IV diagnosis of schizophrenia or other psychotic illness (American Psychiatric Association, 1994) but were classed as having methamphetamine psychosis.

The small open-label trial of haloperidol (Sato et al, 1983) merits attention, if only because of the paucity of other evidence and the relationship of its results to animal studies. Eight of the cohort of stimulant users with chronic psychoses who had relapsed following stimulant use were prescribed small doses of haloperidol (3 mg daily) following recovery and were observed for further relapse. These participants did not relapse, even if they returned to stimulant use; however, participants who were not given haloperidol relapsed into a psychotic state lasting days to weeks after using stimulants. The results could lead us to postulate that where people are unable to abstain from stimulant use despite repeated psychotic episodes, small doses of regular antipsychotic medication administered once the episode has settled might reduce or prevent sensitisation in the future.

Human experimental studies investigating sensitisation are unlikely because of ethical considerations, but a number of animal experiments have been carried out. Stimulant-induced stereotyped behaviour in small mammals and possible hallucinatory experiences in primates have been used as a model for schizophrenia in humans. In animals, the response to chronic amphetamine use has been divided into two phases. In the 'initiation' phase of these experiments animals are 'sensitised' by small regular doses of stimulants, insufficient to cause a 'psychotic' reaction on their own. The 'expression' phase occurs if the animals are either stressed or given a single dose of a stimulant. In the first phase, sensitisation has been shown to be blocked by antipsychotic drugs, whereas the psychotic reaction in the expression phase is not always blocked (Lieberman et al, 1990). Castner & Goldman-Rakic (1999) investigated rhesus monkeys, which were given intermittent, escalating low doses of amphetamine over a 12-week period, followed by an acute challenge with low-dose amphetamine (0.4–0.46 mg/kg). Enhanced responses (hallucinatory-like behaviours, static posturing and motor stereotypies) were noted in response to a low-dose amphetamine challenge 5 days after withdrawal and up to 28 months later. The monkeys also showed an increase in responses 'independent of stimuli', possibly indicating hallucinations, in the absence of additional drug challenges. Antipsychotic drugs were not used.

Meng et al (1998) performed a similar experiment on rats, but also pre-treated one group of rats with high-dose haloperidol (0.5 mg/kg) or clozapine (20 mg/kg), withholding the 'sensitising' phase of amphetamines. This group showed an enhanced response to amphetamine challenge in a similar way to those sensitised with amphetamines. Rats that had been given low-dose antipsychotic treatment (haloperidol 0.1 mg/kg or clozapine 4 mg/kg) alongside regular amphetamine administration did not show an enhanced effect, suggesting that they were not sensitised, in a similar way to the humans in the study by Sato et al (1983). The sensitisation following high-dose antipsychotic treatment is presumably related to dopamine receptor upregulation, which occurs in these circumstances, increasing the vulnerability of the brain to stimulants once the antipsychotic treatment is stopped.

Evidence against sensitisation occurring can be found. Seibyl et al (1993) noted that for the majority of participants stimulant use began after the onset of psychotic illness, again weakening the case for a causative role for stimulants. We identified only two studies that looked specifically at the therapeutic use of methylphenidate and psychosis (Pawluck et al, 1995; Cherland & Fitzpatrick, 1999), but many studies have established the safety of this agent, although not specifically reporting or examining for psychosis (e.g. Efron et al, 1997). Illicit use of methylphenidate, however, tends to follow a different pattern, with binges and escalation of dose occurring.

The lack of evidence in this area of psychiatry causes problems for clinicians who
must plan management without a solid evidence base for a group of patients whose management is challenging. Using the data from these studies, we can say clearly that use of stimulants leads to a brief psychotic reaction, usually only hours in length, that is more pronounced in people who already have active symptoms of psychosis and is seemingly unaffected by antipsychotic medication. With regard to the hypothesis that stimulant use can produce chronic psychosis, supportive evidence is present in studies of humans but is of lower quality, although supported by experimental animal studies.

In the absence of better evidence, treatment of stimulant-induced psychosis should probably involve efforts to encourage abstinence from stimulants and medication with antipsychotics until the acute symptoms settle. This should be followed by regular low doses of antipsychotics in those who have experienced more than one episode of psychosis. Given that the evidence (however poor) points to sensitisation occurring, it is important that people using stimulants should be assertively managed in an attempt to prevent long-term chronic psychosis.

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