

# Chapter 3: Effects of Amphetamine-Type Stimulants

## 3.1 Effects for users

The action of amphetamine-type stimulants in the brain elevates levels of the monoamine neurotransmitters dopamine, serotonin (5-HT) and noradrenaline (Rothman & Baumann, 2003). Dopamine is involved in the regulation of movement; cognitive processes related to attention, working memory and motivational behaviour; and is the primary neurotransmitter involved in reward pathways (Tzschenke, 2001). Serotonin has a role in a variety of physiological processes, and in complex behaviours such as mood, appetite, sleep, cognition, perception, motor activity, temperature regulation, pain control, sexual behaviour and hormone secretion (Kema et al., 2000). Noradrenaline is responsible for mediating cardiovascular effects, arousal, concentration, attention, learning and memory (Ressler & Nemeroff, 1999).

As noted, ATS include both meth/amphetamine and MDMA or ecstasy. The difference between these groups of drugs is that MDMA primarily inhibits serotonin reuptake and stimulates serotonin release, while methamphetamine has the same effects on dopamine (Clemens et al., 2007; Dean 2004). The differential release of neurotransmitters by MDMA and methamphetamine results in relatively unique subjective effects produced by each drug. While MDMA is more likely to produce euphoria, mild hallucinations and feelings of closeness to others, methamphetamine is more likely to enhance confidence, energy and sexual stimulation (Clemens et al., 2007; Dean 2004).

The effects of ATS include the sought after effects, and negative short-term and long term consequences. Both the intended and the adverse consequences will depend on the amount taken, purity, physiological factors such as age and general health, individual tolerance to the drug and the context in which the intoxicating effects are experienced.

The sought after effects of meth/amphetamine include a sense of wellbeing, euphoria, mood elevation, increased libido, alertness, reduced fatigue, increased concentration, diminished appetite, enhanced reflexes, and a perceived increase in confidence, energy, and physical strength (AIDS Council of New South Wales (ACON), 2006; Dean, 2004). At relatively low doses, performance of simple motor and cognitive tasks can improve (although performance may deteriorate after larger doses or after regular use) (e.g., Brauer & de Wit, 1997; Rogers et al., 1999). The immediate sought after effects of ecstasy are similar and include a subjective sense of closeness to other people, enhanced sociability, positive mood states, including a sense of wellbeing and euphoria, and changed perceptions, in particular sharpened sensory perception (AIDS Council of New South Wales (ACON), 2006; Dean 2004; Tancer & Johanson, 2001). For ecstasy, the balance of positive to negative effects shifts after a relatively short period of repeated use, possibly acting as a disincentive to frequent use (e.g., Peroutka et al., 1988).

As with the sought after effects, the adverse effects of ATS are dose and frequency related (i.e., their likelihood and intensity increase with increasing dose and increasing use). The short-term adverse effects of meth/amphetamine include: restlessness, irritation,

anxiety, agitation, tremor, teeth grinding, insomnia, confusion, increased heart rate and irregular heart beat, abdominal pain, sweating, dilated pupils, fatigue, and parasitosis (picking and scratching skin) (ACON, 2006; Dean 2004). The short-term adverse effects of ecstasy include racing thoughts, depersonalisation, panic attacks, tremor, muscle cramps, increased heart rate, decreased capacity to cope with changing ambient temperature (which may result in hypo- or hyperthermia), hyperactivity, insomnia and impairment of sexual functioning (Cohen 1998; Dean 2004; Peroutka et al., 1988).

The sought after effects and adverse effects were discussed during consultations. In addition to 'rush' or euphoric experiences, it was noted that ATS are sometimes used to enhance sexual performance and for weight loss. It was also noted that some people might use ATS as self-medication to alleviate distress and anxiety. However, these latter symptoms may in fact become exacerbated following use and during 'come down', which can then result in further use and instigate a binge-crash cycle. It was noted that following 2 to 5 days after abstinence many regular users would experience a lack of energy and enthusiasm, reduced concentration, poor motivation, irritability and possibly anger. Long-term effects mentioned by participants in the consultations included poor diet and nutrition, kidney and heart problems, and high stress levels.

### 3.2 Negative cognitive and psychological effects

There is a range of short-term adverse consequences of ATS use. Some of the more serious mental health consequences of meth/amphetamine use are sleep disorders, psychosis, paranoid hallucination, agitation, confusion, severe panic, anxiety and depression (Dean, 2004). Many studies have documented reduced mood and feelings of anxiety in the few days following MDMA use (Curran, 2000). Other common side effects in the few days following ecstasy use include insomnia, drowsiness, depression and difficulty concentrating (Morgan, 2000). More limited research is available on the long-term adverse consequences, but it appears that long term users report lack of sleep, severe fatigue, reduced resistance to disease, psychological problems (panic attack, paranoia, hallucinations etc), mood swings and violence (Allen & Tresidder, 2003).

It is difficult to monitor the trends in harms associated with ecstasy use by using routine data sources, as many of these do not differentiate ecstasy from other ATS. While the relative lack of specific long-term research on the effects of ecstasy means it is less conclusive and more contentious, it is generally accepted that, particularly at high doses, some problems will result, including memory and cognition problems, and depression. As stated by Hammersley and colleagues (2002):

There is considerable ignorance coupled to considerable apprehension about the long-term effects of Ecstasy. It is ironic that the very area that users are most concerned about is also the very area that medical, or other, science is least able to help with information" (p.156).

## Cognitive deficits

Despite grounds to be concerned about the cognitive impact of long term ecstasy use, definitive evidence is lacking (Turner & Parrot, 2000). Studies of MDMA users, particularly heavy users, report poorer function on cognitive tests involving working memory and executive function. In a recent review of the literature, Parrott (2006) stated that objective deficits in working memory, attention, frontal-executive function and episodic memory tasks had been found in heavy ecstasy users. Other studies have found deficits in tests of logical reasoning and serial addition (McCann et al., 1999; Parrott et al., 1998). From a review of the literature, Morgan (2000) found evidence of selective impairment of episodic memory, working memory and attention. Such cognitive effects may be long-lasting. For example, Thomasius and colleagues (2006) found that verbal memory deficits in ex-ecstasy users did not improve even after 2.5 years of abstinence.

Neurocognitive deficits have been found in samples of amphetamine users. Research in Western Australia, with a sample of dependent amphetamine users attending an outpatient clinic, assessed a range of cognitive abilities including information processing speed, attention, learning, memory and executive functions (Collins, Dyer & Fox, unpublished). The study found that, relative to published normative data, all the amphetamine users exhibited some form of deficit on the cognitive skills evaluated and performed significantly below expectations according to a measure of pre-morbid intelligence (Collins, Dyer & Fox, unpublished).

With regards to methamphetamine use, research shows that long-term exposure can result in pronounced neuropsychological deficits, with the most consistent and profound impairments observed in working memory, attention and executive function (Barr et al., 2006). Research to date has demonstrated specific deficits associated with prolonged methamphetamine use in tasks of auditory discrimination, auditory vigilance (London et al., 2005), working memory and word recall (Chang et al., 2005; Thompson et al., 2004). Attentional deficits have also been observed and may be related to decreased cognitive inhibition (Salo et al., 2002), and attending to irrelevant task information (Nordahl et al., 2003). Finally, as demonstrated by performance on the Stroop Interference Task, methamphetamine use can have adverse effects on domains of executive function, including abstract reasoning, planning and behavioural flexibility (Kalechstein et al., 2003).

It is important to note that research with ATS users is often confounded by polydrug use in these samples and the possibility of pre-existing psychological problems that make it difficult to draw strong conclusions. In particular, caution is recommended in interpreting data pertaining to long-term cognitive effects of ecstasy use, as use of this drug is most often seen in the context of polydrug use and the role of concomitant cannabis use in any cognitive impairment is yet to be adequately addressed (Croft et al., 2001).

## Depression and anxiety

Symptoms associated with both depression and anxiety have been linked with ATS use. For example, from a review of the literature, Morgan (2000) concluded that there was growing evidence that chronic, heavy, recreational use of ecstasy is associated with sleep disorders, depressed mood, persistent elevation of anxiety, impulsiveness and hostility. Furthermore, the relationship between depressive/anxious symptomatology and ATS use

may be stronger than the link with psychosis. For example, a recent study in Victoria found that up to 85% of amphetamine users may suffer from depression and/or anxiety compared to 7% who showed psychotic conditions (Nutting et al., unpublished).

Both the 2004 National Drug Strategy Household Survey (NDSHS) and the 2006 Ecstasy and Related Drugs Reporting System (EDRS) included the Kessler Psychological Distress Scale (K10; Kessler et al., 2002) to measure the level and severity of symptoms of depression and anxiety among survey participants. It is important to counsel caution in comparing the findings because criteria for drug use and diagnostic cut-off scores differed between the surveys. In the NDSHS, those who had used the drug at least once in the previous month had the following K10 scores: for meth/amphetamine, 36% were low risk, 33% medium risk, 21% high risk and 10% very high for psychological distress; for ecstasy, 44% were low risk, 34% medium risk, 16% high risk and 6% very high risk for psychological distress (Australian Institute of Health and Welfare, 2005a); among the 2006 EDRS sample, who completed the K10, just over half (55%) scored in the medium risk range, followed by low risk (38%) and high risk (7%) (Dunn et al., 2007).

As already noted, investigating psychiatric problems associated with ecstasy is difficult due to high rates of polydrug use among those presenting with psychiatric symptoms and the possibility of pre-existing problems. To date, most research has investigated the proposed link between MDMA use and depression due to the common influence on serotonin levels in the brain. Sumnall and Cole (2005) conducted a meta-analysis of 25 studies investigating depressive symptomatology in 'recreational ecstasy users'. A small association between ecstasy use and depressive symptomatology was found, but considered unlikely to be clinically relevant. The authors also highlighted their observation that drug histories were often poorly reported and polydrug use was mostly not controlled. A study by Roiser and Sahakain (2004) compared current and ex-ecstasy users with polydrug users who had never used MDMA and found no significant differences between the groups.

A recent study by Guillot and Greenway (2006) found no significant differences in depressive symptomatology on the Beck Depression Inventory-II (BDI-II; Beck et al., 1996) between heavy ecstasy users and ecstasy naïve college students. In addition, most ecstasy users who were diagnosed with a psychiatric disorder reported that the diagnosis preceded their use of the drug. A study by Soar, Turner and Parrott (2006) also considered premorbid psychiatric history in relation to the degree of self-reported problems attributed to ecstasy use. It was found that 'problematic ecstasy users' scored significantly higher than 'nonproblematic ecstasy users' on somatisation, depression, anxiety and negative psychobiology. 'Problematic ecstasy users' also reported significantly higher levels of use, and personal and family psychiatric histories.

From their review of the literature on psychiatric sequelae attributed to ecstasy use, Gowing and colleagues (2001) concluded that:

Overall, these reports indicate a clear association between ecstasy use and subsequent short-term mood changes. More severe psychiatric sequelae, including depression, panic disorders, psychoses and anxiety, may occur but probably only in those individuals made vulnerable by personal or family history of psychiatric disturbance, by stress or by concurrent use of other drugs (p.34).

Thus, the exact nature of the relationship is complex and more research is needed to determine the causal pathways between mental health problems and ATS use. Specifically, mental health problems may pre-date and exist independently of ATS use, ATS use may contribute to the onset of mental health problems, or there may be a common and shared cause (Baker & Dawe, 2005).

Psychological problems have also been identified in samples of injecting drug users (IDU). Among the sample for the 2006 Illicit Drug Reporting System (IDRS), the majority reported methamphetamine as the drug most often injected in the last month (33%) and the last drug injected (30%) (O'Brien et al., 2007). While mental health problems were not analysed according to the primary drug used, 38% of the total sample reported experiencing a mental health problem other than drug dependence in the last six months. The most commonly reported problem was depression (27%) followed by anxiety (14%).

## Psychosis

One of the possible consequences of ATS use, in particular methamphetamine, is the causal role in inducing a psychotic state. This association has been widely publicised in both the media and in academic research. Research has comprised of human experiments (in the 1970's that involved giving participants doses of methamphetamine in order to induce psychotic symptoms), animal experiments, case reports, surveys of drug users, and imaging studies (to detect neurological structural changes). Despite efforts to explicate the nature of the association between methamphetamine use and psychosis, in general it has been concluded that it remains unknown how acute or enduring the status of psychosis is (Kingswell, 2007).

Heavy users of ATS typically use less regularly than opiate users and 'binge' over a period of a few days and nights, often followed by the use of drugs such as benzodiazepines or other sedatives to 'come down' (Darke et al., 2000). Such bingeing can induce a temporary psychosis identical in symptoms to an episode of paranoid schizophrenia, and this psychosis can be reliably induced in people with no history of, or predisposition towards, mental illness (Darke et al., 2000). ATS use can also severely exacerbate psychotic symptoms in those already experiencing a psychotic state of some form (World Health Organisation, 1997).

A presentation at a recent Australian conference reported that those at greatest risk of methamphetamine-induced psychosis had a predisposition to mental illness, consumed the drug at higher doses, preferred injecting or smoking the drug and had an earlier age of initiation (Heffernan, 2006). Research conducted by Chen and colleagues (2003) compared pre-morbid characteristics and psychiatric co-morbidity among 445 methamphetamine users with and without a lifetime diagnosis of methamphetamine psychosis. Results were that those with the diagnosis were younger at first methamphetamine use, used larger amounts of methamphetamine, had significantly higher scores on the Premorbid Schizoid and Schizotypal Traits questionnaire (Foerster et al., 1991), and higher rates of major depressive disorder, alcohol dependence and antisocial personality disorder.

Research into the association between amphetamine use and psychosis has been conducted both in Australia and internationally. A cross-cultural study conducted by

Srisurapanot and colleagues (2003) sampled methamphetamine-induced psychotic inpatients in Australia, Japan, Philippines and Thailand. This research found that persecutory delusion was the most common lifetime psychotic symptom, followed by auditory hallucinations, strange or unusual beliefs and thought reading. Auditory hallucinations were the most common current symptom, followed by strange or unusual beliefs, and visual hallucinations.

Another international study, sponsored by the World Health Organisation (WHO), involved data collection at four centres in the Asia-Pacific region – Australia, Japan, Philippines and Thailand (Ali et al., 2006). Very few similarities were found across the sites regarding extent, patterns and routes of methamphetamine administration. Australian participants were reported as the most experienced drug users in terms of lifetime number of drugs used and the age of onset for methamphetamine use. Australian and Japanese methamphetamine users predominantly injected the drug, while those from the Philippines and Thailand almost exclusively smoked the drug. While Australian participants had the highest prevalence of morbid depression, symptoms of psychosis were comparable between countries, with delusions being the most commonly experienced symptom. While very few participants in other countries reported past psychological treatment (aside from methamphetamine-induced psychosis), over 60% of the Australian sample had received some form of treatment.

A recent study conducted in Sydney concluded that the prevalence of psychosis among a sample of current methamphetamine users was 11 times higher than among the general population of Australia (McKetin et al., 2006a). Among the 309 methamphetamine users interviewed, 13% screened positive for psychosis, and 23% had experienced a clinically significant symptom of suspiciousness, unusual thought content or hallucinations in the past year. Those defined as dependent methamphetamine users were three times more likely to have experienced psychotic symptoms than their non-dependent counterparts, even after adjusting for history of schizophrenia and other psychotic disorders.

One of the primary issues raised during consultations concerned the psychotic symptoms induced by methamphetamine use, including associated acts of aggressive and violent behaviour. In addition to the contributing factor of increased purity of more recent formulations of meth/amphetamine, it was suggested that some consumers may be predisposed to violence and psychosis. This was in reference to the observation that while some regular users do not exhibit these behaviours, an occasional user may experience a psychotic episode.

### 3.3 Dependence and adverse outcomes

ATS users can become dependent and ATS dependence is associated with a range of physical and mental health problems. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM; American Psychiatric Association, 2000), dependence is characterised by experience of at least three of the following symptoms:

- tolerance, which is defined as either a need to use larger amounts of the substance to achieve desired effect, or decreased effect with continued use of the same amount;
- withdrawal;

- increased dosage and duration of the substance use;
- unsuccessful attempts to cut down or control substance use;
- increased time spent to obtain the substance, use the drug or come down from the drug;
- giving up social, occupational and recreational activities because of substance use; and
- continued substance use despite awareness of its negative consequences (e.g., physical or psychological problems).

It has been estimated that the number of regular methamphetamine users in Australia is 102,600 and of these, 72,700 have been estimated to be methamphetamine dependent (McKetin et al., 2005). It has been suggested that the newer crystalline form of methamphetamine may lead to greater dependence compared to other forms. This issue was recently investigated in a sample of 309 regular methamphetamine users in Sydney (McKetin, Kelly & McLaren, 2006). Using the Severity of Dependence Scale, this study found that participants who had used crystal methamphetamine in the past year were significantly more likely to be dependent on methamphetamine compared to those who had only taken other forms of methamphetamine during this time. Furthermore, methamphetamine dependence was found to be associated with injecting or smoking as methods of use, using more than weekly, and a history of use over 5 years. Even after adjusting for these patterns of use, crystal methamphetamine use remained significantly associated with methamphetamine dependence.

A study by Kalechstein and colleagues (2003) produced the first findings to demonstrate that methamphetamine dependence is associated with impairments across a range of neurocognitive domains. Methamphetamine dependent users abstinent for 5 to 14 days performed significantly worse than controls on neurocognitive measures sensitive to attention/psychomotor speed, verbal learning and memory, and executive systems measures sensitive to fluency. These differences were not attributable to demographics, estimated premorbid IQ, and level of self-reported depression. Research investigating the methamphetamine market in Sydney found that dependence on methamphetamine was the key predictor of poor physical and mental health among users (McKetin, McLaren & Kelly, 2005).

Other recent research has added to the understanding of the relationship of meth/amphetamine dependence to adverse outcomes. For example, Dyer and Cruickshank (2005) explored the psychological profile among 218 admissions to an inpatient methamphetamine detoxification program. It was found that approximately 46% of methamphetamine-dependent inpatients had been previously diagnosed for a psychological health problem, with approximately 30% requiring admission to a psychiatric hospital. In a second study the Beck Depression Inventory II (BDI-II; Beck et al., 1996) was administered to 367 outpatients receiving treatment for methamphetamine or heroin dependence. The mean total BDI-II score was reported to be in the moderate range. It was found that methamphetamine-dependent patients' total BDI-II score was similar to that of psychiatric outpatients with clinical depression, but significantly greater than psychiatric outpatients with anxiety disorders.

Psychiatric problems appear to occur predominantly among dependent methamphetamine users, rather than among those who take the drug infrequently. To further illustrate this, a recent Australian conference was presented with research conducted with a large community sample of amphetamine users in Queensland (Conroy, 2006). It was noted that 42% of those who were amphetamine dependent, compared to 21% of non-dependent amphetamine users, had recently experienced moderate to severe mental health disability. Overall, dependent users had higher levels of depression and anxiety, more easily lost their temper and had poor relationships.

Based on their own research and a review of the literature, McKetin and Mattick (1997) concluded that:

Dependence on amphetamine has been associated with poor psychological health, especially in younger individuals who frequently use large amounts of amphetamine.... Psychological problems reported by amphetamine users included feeling scattered, vague, distracted and problems with concentration that impeded work performance or study....The results of this study show that severely dependent amphetamine users suffer from poor memory and concentration, performing from half to one standard deviation worse on WMS-R indices than less dependent amphetamine users. This study also found preliminary evidence that a history of heavy amphetamine use, particularly injecting more than 3-4 days per week, was associated with impairment of visual memory tasks (pp.235, 240).

### 3.4 Negative physical health effects

ATS use in the short term can lead to increases in heart rate, hypertension, irregular body temperature and rates of breathing, constriction of blood vessels and cardiac arrhythmia (Lineberry & Bostwick, 2006; Maxwell, 2005). Short- and long-term ATS use can impact on the cardiovascular system (increasing heart rate, increasing blood pressure, cause arrhythmia and palpitations) sometimes resulting in cardio and/or cerebrovascular crises, such as myocardial infarction or stroke, aneurysm and hemorrhage (e.g., Buxton & McConachie 2000; Hung et al., 2003). Acute coronary syndrome is common in patients hospitalised for chest pain after methamphetamine use (Turnipseed et al., 2003).

ATS can impact on the ability to regulate body temperature in a changing environment, contributing to hyperthermia, and metabolic disturbances are not uncommon (see Gowing et al., 2002). Methamphetamine induces dose-dependent brain hyperthermia that precedes, and is greater than, overall body hyperthermia, suggesting methamphetamine-induced neuronal activation is a contributing source of that hyperthermia (Brown et al., 2003). ATS suppress the appetite, and can be associated with weight loss and general poor nutrition. Less common problems include renal and hepatic problems (see Allen & Tresidder, 2003; Gowing et al., 2002; Maxwell, 2005). Maxwell (2005) also reported that many longer-term ATS users experience a range of health problems that adversely affect their general well being. Such problems include: poor dental hygiene including damaged and discoloured teeth from dry mouth, heavy sugar intake and tooth grinding; appearing older than chronological age; and skin lesions – excoriations and ulcers from parasitosis.

As indicated earlier, evidence suggests that ATS impact on cognition and this may be

associated with particular neurological consequences, which sometimes may endure even after abstinence (e.g., Davidson et al., 2001). It is postulated that long-term deficits could result from the capacity of MDMA and methamphetamine respectively to exhaust serotonergic and dopaminergic neurons (Clemens et al., 2007). These can include short and long-term consequences such as hyperactivity, confusion, agitation, low mood, lethargy, and anhedonia (see Baker, Lee & Jenner, 2004).

## Toxicity and overdose

As reviewed in Dean (2004), toxic central effects of amphetamine use include psychosis, hyperthermia, seizures, and rhabdomyolysis (an acute, potentially fatal disease that destroys skeletal muscle), while cardiovascular toxicity includes ventricular arrhythmias, acute myocardial infarction and cardiomyopathis. Neurotoxicity refers to neurological changes that persist after cessation of use, and evidence suggests that chronic methamphetamine use leads to dopamine depletion and possibly also changes in serotonergic function (Davidson et al., 2001).

There is also evidence that MDMA can produce neurotoxic effects in some users. From a review of the literature, Morgan (2000) found several cognitive and psychological effects from ecstasy use (outlined above) and suggested a likelihood that some of these problems are caused by ecstasy-induced neurotoxicity. Morgan (2000) found support for this from preclinical evidence of MDMA-induced neurotoxicity and behavioural deficits, evidence of depleted serotonin in heavy ecstasy users, and by dose-response relationships between the extent of exposure to ecstasy and the severity of impairments. Boot and colleagues (2000) suggested that those ecstasy users most at risk of neurotoxicity are those who consume two or more ecstasy tablets at a time, use the drug fortnightly or more, inject MDMA, and use for more than 24 hours.

Severe MDMA overdoses are associated with intense sympathomimetic responses, active hallucinations, and thermoregulatory, neurologic, cardiovascular, hepatic and electrolyte disturbances (Gowing et al., 2002). Neurological symptoms include agitation, hallucinations, seizures, coma, and acute and chronic psychiatric symptoms (Kalant, 2001). To date, there are few studies that support the notion that MDMA causes neuronal cell death but rather, it appears to damage only the terminal regions of 5-HT neurons (Baumann et al., 2007). In general, there is considerably more evidence of long-term damage following chronic use of methamphetamine (Pubill et al., 2003).

ATS overdose can occur and is associated with circulatory collapse, cerebral hemorrhage and myocardial infarction (World Health Organisation, 1997). The most recent EDRS reported that 21% of the national sample had ever overdosed on ecstasy or related drugs (Dunn et al., 2007). Overdose was defined as 'passed out or fallen into a coma'. The majority reported recently overdosing on ecstasy (36%), while 3% each reported overdosing on crystal methamphetamine and base. Data from the Australian Institute of Health and Welfare (AIHW) report the number of inpatient hospital admissions per million persons among persons aged 15 to 54 with a principal diagnosis relating to amphetamine. These figures have fluctuated during the six-year period from 1999/2000 to 2004/05. The latest figures show a decrease from 180 per million persons in 2003/04 to 156 per million persons in 2004/05 (Australian Institute of Health and Welfare, 2005b).

In 2005, there was a total of 68 drug induced deaths in which methamphetamine was mentioned among those aged 15 to 54 years, compared to 75 in 2004 (Degenhardt & Roxburgh, 2007). Of these deaths, methamphetamine was found to be the underlying cause in 26 cases in 2005 compared to 17 in 2004. Deaths from ecstasy consumption have variously involved persons with pre-existing cardiac conditions (World Health Organisation, 1997), hyperthermia, and ingestion of excessive amounts of water (Darke et al., 2000). Deaths following MDMA use are frequently the consequence of a serotonin syndrome and/or of sympathomimetic overstimulation, both of which are exacerbated by environmentally caused overheating (Schifano, 2003).

A study conducted by Schifano and colleagues (2003) investigated the number of ecstasy-related deaths occurring in England and Wales between August 1996 and April 2002 recorded in the National Programme on Substance Abuse Deaths database. A total of 202 ecstasy-related deaths were recorded and showed a steady increase in the number of deaths each year. Of these, ecstasy was implicated as the sole drug causing death in only 17% of cases, with a variety of other drugs (mostly alcohol, cocaine, amphetamine and opiates) being identified. Toxicology results revealed MDMA accounted for 86% of cases, MDA for 13% of cases, and single deaths were associated with MDEA and PMA. An analysis of ecstasy-related deaths in Australia during 2000-2004 using data from the National Coronial Information System (NCIS) found 112 such deaths (Fowler et al., in press). Ecstasy was deemed to be the primary contributory factor in just under half of these cases, and the sole drug present in only six of these deaths (Fowler et al., in press).

### Negative effects of specific routes of administration

Some effects are associated with specific routes of administration, as detailed at the National Leadership Forum on Ice (Ministerial Council of Drug Strategy Joint Communiqué, 2007). Nasal use by snorting has a delayed effect of approximately five minutes subsequent to dose. There is a potential risk for Hepatitis C to be passed on from tiny, often invisible amounts of blood on shared snorting equipment. Oral use of crystal methamphetamine by swallowing can cause irritation as crystal particles travel to the stomach. Anal and vaginal use, known as 'shelving' and 'shafting', can damage the lining of the anus or vagina and increase the chances of HIV and Hepatitis C transmission. In addition to the typical health and medical effects associated with smoking including addiction, smoking equipment can cause burns to mouth or gums, and Hepatitis C can be transmitted if equipment is shared. In addition to smoking, injecting is the route of administration most associated with dependence, and the latter mode of administration poses risks of contracting blood borne viruses, and repeated injection in the same spot can lead to vein inflammation, scarring, abscesses, blood clots and vein collapse.

There is a paucity of research investigating transitions to injecting from other routes of administration. Those studies that have investigated this area have mostly recruited heroin users (e.g., Gossop et al., 1988; Neaigus et al., 2001; Parker et al., 1988). A paper by Strang and colleagues (1992) identified the pertinent issues, including variations of route of administration by time and place; influence of availability of drug paraphernalia; influence of context; and the association between changes in route of one drug and changes in route of other drugs.

One study that investigated transitions to injecting among amphetamine users was conducted by Darke and colleagues (1994). A sample of 301 regular amphetamine users was interviewed and two thirds reported injecting the drug in the previous six months. A transition to regular amphetamine injecting from other routes of administration was reported by 40% of participants, with males twice as likely to report such a transition. The main reasons provided were 'liking the rush' from injecting, and a perception that it was both more economical and a healthier way to use.

The 2006 EDRS reported that 20% of the national sample of regular ecstasy users (REU) had ever injected any drug and of these, 69% had injected in the previous six months (Dunn et al., 2007). Those who reported lifetime injecting first injected at a median age of 18 years and had been injecting for a median of eight years. Amphetamine ('speed') was the most common drug first injected (48%) and ever injected (84%). Crystal methamphetamine was reported as the most common drug injected in the previous six months (72%) and the most common drug last injected (35%).

Among the 2006 EDRS sample, lifetime injectors compared to non-injectors were significantly more likely to be older, male, have fewer years of education, have a prison history, be unemployed, be in drug treatment, and be less likely to identify as heterosexual. With regards to initiation into injecting, 43% of injectors reported doing so for the first time while under the influence of other drugs; most commonly alcohol and cannabis.

### 3.5 Negative behavioural and social effects

Several adverse effects can arise from behaviours associated with ATS use. Sexual risk taking, driving while impaired and polydrug use have been associated with both meth/amphetamine and ecstasy use, while aggressive and violent behaviours are more often associated with methamphetamine use. Riley and colleagues (2001) identified the main risks for young people who use ecstasy as polydrug use (85%), driving while intoxicated (35%) and unprotected sex (30%).

#### Polydrug use

Meth/amphetamine and ecstasy users are frequently described as 'polydrug users', referring to frequent use of other drugs. Sometimes other drugs are used separately to ATS, sometimes simultaneously (e.g., alcohol) and sometimes to manage some of the adverse effects of ATS use (e.g., drugs used to manage the 'crash'). The 2004 NDSHS found that across all reported drugs, recent ATS users had substantially higher rates of polydrug use than non-ATS users, including three times the rate of smoking and almost ten times the use of cannabis (Australian Institute of Health and Welfare, 2005a). It was reported that 87% had consumed alcohol, 68% had used cannabis and 49% had used MDMA with methamphetamine on at least one occasion. Thirty eight percent reported alcohol use as a substitute when methamphetamine was not available, while 24% nominated MDMA as the next most common substitute. With regards to MDMA users, the 2004 survey noted that 83% had consumed alcohol with MDMA on at least one occasion, 57% had used cannabis with MDMA and 39% had used methamphetamine with MDMA. Alcohol was nominated by 42% as the preferred substitute when MDMA was not available, followed by 24% nominating methamphetamine as their next most common substitute.

The most recent EDRS survey found that among REU, 99% reported lifetime use of alcohol and 96% reported use of alcohol in the previous six months (Dunn et al., 2007). Similarly, 98% reported lifetime cannabis use and 83% reported cannabis use in the previous six months. More than three-fifths of the sample reported lifetime 'speed', crystal methamphetamine, cocaine and LSD use; more than one-third reported recent use of crystal methamphetamine, base and cocaine. Of the total sample, 93% reported usually using other drugs with ecstasy and 80% to 'come down' from ecstasy. Alcohol was the most common drug reportedly used with ecstasy (75%), followed by tobacco (64%) and cannabis (45%). Cannabis was the most commonly reported drug used during 'come down' (70%), followed by tobacco (64%) and alcohol (41%). Rates of methamphetamine use with ecstasy were low, with speed the most common (27%), and less than 10% reported using a form of methamphetamine during 'come down'.

Focus group discussions among ecstasy users have also found that combining ecstasy use with alcohol was the most commonly reported risk behaviour (Shewan et al., 2000). In addition, other drugs, most notably cannabis, LSD and amphetamine, were also reportedly used over the course of a typical evening. As already noted, combined alcohol and amphetamine use is relatively common, with up to 60% of those meeting diagnostic criteria for an amphetamine use disorder also meeting criteria for an alcohol use disorder (Burns & Teesson, 2002). Furr and colleagues (2000) found an association between alcohol intoxication and methamphetamine smoking, and suggested that heavy drinkers may use amphetamine to counteract the performance deficits caused by alcohol consumption. Reports of concurrent use of cannabis and benzodiazepines have also been commonly found among amphetamine users (Baker et al., 2004).

Methamphetamine and ecstasy are increasingly used in combination, yet little is known of the effects of this combination. Clemens and colleagues (2004) recently conducted research with rats to investigate the behavioural, thermal and neurotoxic effects of MDMA and methamphetamine when given alone or in combined low doses. The researchers concluded that these drugs used in combination may have greater adverse acute effects, including acute head-weaving (moving head from side to side) and hyperthermia, and long-term effects, including decreased social interaction, increased emergence anxiety and dopamine depletion, than equivalent doses of either drug alone. In a subsequent article summarising the research to date, Clemens and colleagues (2007) reported that animal models suggest: a tendency for more compulsive use of methamphetamine over MDMA; unique pro-social effects of MDMA; modulation by high temperatures in the rewarding effects of both drugs; functional and emotional impairments associated with both drugs; and likely synergistic adverse effects when used in combination.

Polydrug use was one of the themes that emerged from the consultations. The impact of polydrug use, particularly alcohol use in conjunction with ATS, was raised as a potential contributor to ATS related aggression and violence. At one of the consultations it was noted that polydrug use was prevalent in rural and remote communities, in particular the use of illicit drugs with alcohol. There was consensus and considerable concern that polydrug use had a significant impact on treatment outcomes. Polydrug use could also contribute to shifts in patterns of drug use. For example, a number of participants expressed concern that attempts to manage ATS problems might 'shift the problem to use of other drugs'. A written

submission from the Australian Drug Foundation (ADF) highlighted the development of new forms of drugs in response to effective law enforcement measures that would require:

a quick response, early warning information system to circulate information to those who need it most; the users and frontline health and emergency staff.

## Driving risk

Drug driving is generally accepted as:

driving under the influence of alcohol or any other drug to the extent that one is unable to demonstrate appropriate control over a motor vehicle (Davey et al., 2005, p.62).

Brookhuis and colleagues (2004) used an advanced driving simulator to assess acute effects of MDMA on simulated driving behaviour and heart rate. Regular ecstasy users completed test rides in the driving simulator shortly after use of MDMA (prior to attending a rave) and were tested again after attending the rave while under the influence of MDMA and several other drugs. Participants were also tested when sober at a comparable time of night. Driving performance, as assessed by lateral and longitudinal vehicle control, was not greatly affected after MDMA use (prior to the rave), but showed deterioration after multiple drug use. The authors suggested that the most alarming result was the decreased perception of risk taking after both MDMA and other drug use with regards to unsafe driving and accident involvement.

As reviewed by Sheridan and colleagues (2006), injury associated with methamphetamine use is most commonly related to driving and violence. A number of Australian studies were reviewed including a 10-year multi-centre study conducted by Drummer and colleagues (2003). This research, of drugs in drivers killed in Australia, found that 4.1% of the 3398 cases had stimulants in their blood. Furthermore, while only 3.4% of car drivers tested positive, 23% of truck drivers tested positive to stimulants.

The National Drug Law Enforcement Research Fund (NDLERF) recently funded a large-scale prospective study of the incidence and severity of drug- and alcohol-related trauma in South Australia, including driving-related trauma (Griggs et al., 2007). Samples were taken from trauma patients presenting to the Royal Adelaide Hospital Trauma Service or Emergency Department. Across the two hospital groups, motor vehicle crashes were the leading cause of presentation to the hospital following trauma, accounting for 70.2% of presentations. Among these, 38.4% were positive for alcohol or other drugs. Meth/amphetamine was found in 6.9% of injured car drivers.

Of police detainees who self reported driving during the 12 months prior to detention, 55% stated they had driven following the use of illicit drugs, with 30% reporting driving after the use of meth/amphetamine (Mouzos et al., 2006). Of these, 58% had used cannabis and 50% had used amphetamine and driven at least once a week after using the drug. An increase in the incidence of drug driving was associated with a decrease in the incidence of drink driving. Many reported uncertainty about the legality of drug driving (52% were unlicensed), were generally unconcerned about driving, and were not deterred from driving through fear of detection. Just under a quarter (22%) believed amphetamine had a positive effect on driving compared to 15% for cannabis and 7% for heroin (see Table 3.1). Nicholas (2003) suggests that meth/amphetamine users may be attracted to police pursuits for the

same reasons they use the drugs - a desire for excitement and risk-taking behaviour and raised levels of aggression.

**Table 3.1: Perceptions of adult police detainees of the effects of drug use on their driving**

	Worse		Better		Same as normal	
	n	%	n	%	n	%
Alcohol only	72	62	12	10	32	28
Cannabis	37	44	15	18	32	38
Cocaine	3	50	0	0	3	50
Heroin	14	61	1	4	8	35
Amphetamine/methamphetamine	39	49	20	25	20	25
Benzodiazepines	20	83	1	4	3	13
Alcohol and any of these drugs	51	65	11	14	16	21

Source: AIC, DUMA collection 2006

The 2004 NDSHS found that of Australians aged 14 years and over who had used illicit drugs in the past 12 months, one in four (23%) had driven a motor vehicle after they had used illicit drugs (Australian Institute of Health and Welfare, 2005a). This was more common for males than females. In contrast, one in six persons (16.1%) had driven a motor vehicle after they had consumed alcohol (translating to 2.2 million people, consisting of approximately 1.5 million males and 0.7 million females).

The 2006 EDRS reported that of those who had driven a car in the previous six months, 77% had driven within one hour of taking an illicit drug on at least one occasion (Dunn et al., 2007). Of these, 78% reported driving after taking ecstasy, 34% after amphetamine ('speed'), 26% after crystal methamphetamine, and 15% after base methamphetamine. Participants who had driven a car in the preceding six months were asked to indicate how impaired a person's driving ability would be under the influence of various drugs. For ecstasy, the majority indicated that driving under the influence of ecstasy would carry a 'moderate risk' (42%) or 'high risk' (31%). For methamphetamine, the majority indicated that driving under the influence of methamphetamine would carry a 'low risk' (36%) or 'moderate risk' (26%).

The 2006 IDRS also enquired about driving risk behaviour and of those who had driven recently, 78% reported driving after taking an illicit drug (O'Brien et al., 2007). Among this group, 30% reported driving after taking speed, 23% after crystal methamphetamine and 14% after base.

Several jurisdictions have now introduced random roadside drug testing and comments were made in reference to this during consultations. Specifically, this was noted as providing an opportunity to deter drug impaired driving and for ATS early interventions. ATS are among the most common drugs identified in road-side drug testing and it is likely that many people thus identified (e.g., youth out late at night, transport industry staff) might not otherwise come into contact with health and community services.

## Sexual behaviour

ATS, and particularly methamphetamine, have been linked with increased libido and decreased disinhibition. Among those in the 2006 EDRS who reported engaging in penetrative sex, the majority (85%) reported using drugs during sex in the previous six months (Dunn et al., 2007). Among this sample, 83% reported using ecstasy, 18% reported speed use and 16% reported use of crystal methamphetamine on these occasions. Use of protective barriers during sex when combined with drug use was similar to protective use in general, and more common with casual (50%) than regular (19%) partners.

Molitor and colleagues (1999) compared the sexual risk behaviour among a sample of injecting methamphetamine users to injecting drug users never using methamphetamine. Results indicated that male methamphetamine injectors had more sex partners and participated in more acts of anal intercourse with casual partners and vaginal intercourse with regular and casual partners than their counterparts. Female methamphetamine injectors engaged in more acts of vaginal intercourse with regular partners than their counterparts. Furthermore, male methamphetamine injectors reported trading sex for money or drugs, and were less likely to use condoms than their counterparts. Lastly, methamphetamine use also correlated with using shared needles or syringes and not always disinfecting needles or syringes.

Heterosexual ATS users have been reported to engage in more risky sexual behaviours including multiple sexual partners, anonymous partners and unprotected sex (Lineberry & Bostwick, 2006). In a study exploring sexual risk behaviours among a sample of 139 HIV-negative, heterosexual methamphetamine users, participants reported using condoms for vaginal sex about one third of the time (Semple et al., 2004). In contrast, condoms were used for anal sex about one quarter of the time, and 7% of the time for oral sex. A United States study examining the sexual behaviours of 1011 males found 15.6% reported recent or past methamphetamine use (Krawczyk et al., 2006). Recent methamphetamine users were more likely to have casual or anonymous female sex partners, multiple partners, partners who injected drugs, and received drugs or money for sex with a male or female partner. However, while there is evidence for a link between methamphetamine dependence and unprotected sex, McKetin and colleagues (2005) argued that this may be due to the associated lifestyle of these persons rather than due directly to the pharmacological effects of methamphetamine.

There is proportionally more research into sexual risk behaviour and methamphetamine use among homosexual populations. Research in the United States suggests that methamphetamine use is endemic to urban gay and bisexual men (Halkitis et al., 2001). Research also consistently shows an association between methamphetamine use and HIV infection, likely to be a result of the high-risk sexual behaviours in conjunction with the drug use (Reback, 1997; Worth & Rawstorne, 2005). In Australia, figures from the Sydney Gay Community Periodic Survey 1996-2005 reported that 20% of gay men in Sydney had used crystal methamphetamine in the previous six months (Hull, Rawstorne et al., 2006a). In Queensland, Melbourne and Perth, the rate among gay men is reportedly lower, at between 12-16% (Hull, Brown et al., 2005; Hull, Prestage et al., 2006; Hull, Rawstorne et al., 2006b).

Shoptaw and Reback (2007) reviewed the available literature on the epidemiology of methamphetamine use in men who have sex with men (MSM), methamphetamine use and risk behaviours for sexually transmitted infections and potential interventions to prevent and respond to these risks. It was found that methamphetamine use was highly prevalent in MSM and there were strong associations observed between methamphetamine use and HIV-related sexual transmission behaviours. Behavioural treatments, from brief interventions to intensive out-patient treatments, produced sustained reductions in methamphetamine use and concomitant sexual risk behaviours among methamphetamine-dependent MSM.

While more research has been conducted into methamphetamine use among homosexual populations, few studies have directly compared methamphetamine users according to sexual orientation. A study conducted in Sydney compared homosexual/bisexual male and female regular ecstasy users with their heterosexual counterparts to determine whether patterns of drug use or risk differed across these groups (Degenhardt, 2005). It was found that self-reported risk behaviours such as unprotected sex and needle sharing (among injectors) did not differ according to sexuality. However, homosexual/bisexual men and women were significantly more likely than heterosexual men and women to report a greater number of sexual partners and higher rates of injecting drug use.

Increased risk-taking behaviours related to ATS use were raised as an issue during consultations. Particular mention was made of sexual health and concerns raised over the transmission of sexually transmitted infections (STIs).

### Aggression and violence

Most research linking ATS drugs with aggressive and violent behaviour has focused on its association with methamphetamine. The impact of methamphetamine use on neurochemical brain systems is thought to underlie the relationship with aggression. A recent study by Sekine and colleagues (2006) found that chronic methamphetamine users had higher levels of aggression than non-drug using controls and decreased levels of serotonin in areas of the brain involved in the regulation of aggression. However, serotonin depletion is more often documented in relation to ecstasy use than methamphetamine and little evidence has been found for a relationship between ecstasy use and aggression. Methamphetamine is more often implicated in regulation of dopamine and in this regard, may relate to aggressive behaviour via the 'fight-or flight' response of the sympathetic nervous system (Haller, Makara & Kruk, 1998).

Several studies have found high levels of aggressive behaviour among regular methamphetamine users (Hall et al., 1996; Sommers & Baskin, 2006; Wright & Klee, 2001; Zweben et al., 2004). The 2006 IDRS (O'Brien et al., 2007) asked participants about drug-related aggression. Verbal aggression following the use of alcohol/other drugs was reported by 33% of the sample and physical aggression by 13%. For both of these behaviours, various formulations of methamphetamine were by far the most common drugs reported as being consumed prior to aggression. For those who had been verbally aggressive, 46% reported taking a form of methamphetamine and for those who had been physically aggressive, 49% reported taking a form of methamphetamine.

Police detainees charged with violent offences were not more likely to test positive to methamphetamine than those charged with other forms of offending (Smith, forthcoming). However, heavy or dependent ATS users were more likely to have a history of violent offending. The number of times ATS dependent users were charged with a violent offence in the past 12 months was higher than those detainees not dependent on ATS. Furthermore, it was found that violent detainees dependent on ATS had greater contact with the criminal justice system through arrest or imprisonment than other violent detainees. More specifically, of all violent offenders, aggravated robbery offenders were most likely to report ATS dependence, were more likely to indicate that all of their offending was drug related, and were most likely to have spent time in prison in the past 12 months.

A significant difficulty in disentangling the links between meth/amphetamine and violent crime is polydrug use. In attempting to disentangle polydrug use and violent crime, analysis of the drug using histories of incarcerated male offenders found that those who were regular users of both heroin and amphetamine had the highest likelihood of involvement in violent crime, followed by those who were regular amphetamine users, and then regular heroin users (Makkai & Payne, 2003, see Table 3.2). Those who were not regular users of either drug had much lower probabilities of involvement in violent crime and lower frequency of offending.

**Table 3.2: Violent offending histories for regular amphetamine and heroin users, adult male prisoners (%)**

	Regular amphetamine user only	Regular heroin user only	Regular amphetamine and heroin users	Non-regular user of any drug
Violent offence history				
Ever committed any violent offence	81	76	81	65
Ever regularly committed a violent offence	26	29	36	17
Ever regularly committed two or more violent offences	9	8	12	2
Frequency of violent offending (column per cent)				
More than one day per week	5	9	8	2
One day per week	5	4	5	2
About monthly	4	9	14	4
Less than once a month	34	29	20	35
None in the past six months	22	20	22	24
Never in my life	29	29	31	35
(Total)	(100)	(100)	(100)	(100)

Source: Australian Institute of Criminology, DUCO Male Survey, 2001

It has also been speculated that the relationship between violent behaviour and methamphetamine use is related to psychosis. Recent studies in Sydney found that methamphetamine users reported experiencing overt hostility during psychosis (McKetin, McLaren & Kelly, 2005), and in another study, half those who experienced psychotic symptoms in the past year reported feeling hostile or aggressive at the time, and one quarter exhibited overt hostile behaviour (McKetin et al., 2006a).

McKetin and colleagues (2006b) reviewed the existing literature and concluded that it is not clear whether violent behaviour among chronic methamphetamine users can be attributed directly to methamphetamine use or to co-occurring factors, such as concomitant alcohol use, psychiatric status and lifestyle factors. The authors found that research was limited by a failure to distinguish between economically motivated violent crime and assaults, and lack of controls for personality and lifestyle factors. However, the authors stated that while there is currently insufficient evidence to indicate a direct causal relationship between methamphetamine use and violence, the evidence for this relationship appears strongest in the context of methamphetamine-induced psychosis.

### 3.6 Effects on family and community

ATS use also has considerable implications and consequences for the families and friends of users, and the wider community. The social and behavioural effects outlined above (e.g., driving risks, spread of STIs, aggression and violent behaviour) significantly impact at both an individual and community level. Family relationships are affected both in regards to the impact on parents of an ATS user (see Chapter 4; 'Prevention and Harm Reduction') and on children exposed to parental ATS use. Children are affected by ATS use during pregnancy and by the impact of growing up in an environment where people are using drugs. Backyard manufacture of ATS is an issue that affects both children and community members through exposure to laboratories and associated chemicals. These factors are discussed below in relation to existing research.

The detrimental effect of ATS on relationships was highlighted throughout the consultation process. The impact of ATS use on peer relationships was identified as an area to target in prevention programs. It was suggested that a heavy ATS use can result in a 'loss of mateship'. The detrimental impact on relationships was also mentioned in relation to consumers' alienation from their family and friends. Within Indigenous communities, it was suggested that a great sense of shame is experienced over ATS use and there can be a loss of cultural identity and connection. Paradoxically, while many might use ATS in social settings, adverse impact on people's social and family relationships can be a significant factor in treatment seeking.

#### ATS use during pregnancy

The 2004 NDSHS found that women who were pregnant and/or breastfeeding in the previous 12 months were less likely to consume alcohol (47%) and any illicit drug (6%) than those not pregnant and/or breastfeeding (85% and 17% respectively) (Australian Institute of Health and Welfare, 2005a). Births in mothers with opioid, stimulant or cannabis diagnoses are linked to several negative birth outcomes (e.g., low birth weight). A recent study of over

400,000 linked birth records from 1998 to 2002 (Burns et al., 2006) found 1,974 mothers had an opioid diagnosis, 552 a stimulant diagnosis and 2,172 a cannabis diagnosis (Table 3.3). Births in mothers with these drug-related diagnoses were more likely in women who were younger (particularly in the cannabis group), who were not married, who were Australian-born, and who were Indigenous. Mothers with a drug-related diagnosis were also more likely to be without private health insurance.

**Table 3.3: Maternal demographic characteristics of pregnancies to mothers with and without a drug-related diagnosis code, 1998–2002 (%)**

	Worse		Better		Same as normal	
	n	%	n	%	n	%
Alcohol only	72	62	12	10	32	28
Cannabis	37	44	15	18	32	38
Cocaine	3	50	0	0	3	50
Heroin	14	61	1	4	8	35
Amphetamine/methamphetamine	39	49	20	25	20	25
Benzodiazepines	20	83	1	4	3	13
Alcohol and any of these drugs	51	65	11	14	16	21

Source: AIC, DUMA collection 2006

Other studies have found that fetal exposure to methamphetamine can lead to multiple prenatal complications, such as intraventricular hemorrhage, fetal growth restriction, increased risk of preterm labour, placental abruption, decreased birth weight, cardiac defects, cleft palate, and behavioural effects in neonates (National Institute on Drug Abuse, 1998; Plessinger, 1998; Smith et al., 2003). Methamphetamine exposure throughout gestation has been associated with decreased growth in infants exposed only for the first two trimesters. They were found to be significantly smaller for gestational age compared with the unexposed group (Smith et al., 2003). Neurotoxic effects include neurochemical alterations in areas of the brain associated with learning, leading to cognitive impairment, behavioural deficits, increased motor activity, and enhanced conditioned avoidance responses.

However, as reviewed in Dean and McGuire (2004), a number of other studies have failed to demonstrate a relationship between malformations and amphetamine exposure. Taking into consideration the entire body of research reviewed, the authors concluded that the use of amphetamine in regular low doses poses little teratogenic risk. However, further research is required to address the possibility of cardiac malformations and whether dependent or binge patterns of amphetamine use may confer a greater risk to the foetus. With regards MDMA use during pregnancy, Dean and McGuire (2004) found insufficient evidence to make firm conclusions about the potential teratogenicity of MDMA.

## Parental ATS use

In addition to the potential adverse effects of maternal drug use during pregnancy (outlined above in respect to ATS), research has found that rates of behavioural and emotional problems are more prevalent among children of illicit drug users, particularly oppositional-defiant and non-compliant behaviours (e.g., Smith, 1993; Willens et al., 1995). In a study conducted by Patton (2003), reports from service providers indicated a range of problematic and dysfunctional behaviours in children raised in families where illicit drugs were used:

fear of abandonment; separation anxiety; fear of losing their carer; fear of being left alone; self-blame for their parent's departure; collecting food and hoarding it; overeating; intense fear of sirens and the police; inappropriate sexualised behaviour; sleeping difficulties; aggression (p.8).

The impact of parental use has been illustrated by research conducted by the Department for Community Development (DCD) in WA (Leek, Seneque & Ward, 2004) found that in cases involving children:

- Drug and alcohol use contributed to 57% of cases studied;
- Drug and alcohol use was the second most common contributing factor for an application to DCD following neglect;
- Where a single main reason could be identified, drug and alcohol use was the main reason in 23% of cases;
- 44% of respondents to care and protection applications were drug and alcohol users; and
- Of those known to be AOD users, 42% were using psychostimulants and 54% were polydrug users.

The 'Nobody's Clients Project' conducted by Odyssey House in Victoria reported on the experiences of 48 primary school aged children whose parents had accessed treatment for drug dependence (Gruenert et al., 2004). It was reported that:

- By age 7, on average, children had moved house over five times and attended two schools;
- The majority of primary caregivers of the children were unemployed and relied on government payments;
- Over 50% of parents reported that their children had been negatively affected by their drug use and 70% that their child's exposure to active drug use was 'distressing';
- Child protection services were actively involved with 41% of the cases and had past involvement with 67% of the cases; and
- 24% of the children obtained scores in the clinically abnormal range on the Strengths and Difficulties Questionnaire (SDQ).

The recently released paper by the Australian National Council on Drugs (ANCD) (2006), 'Drug Use in the Family: Impacts and Implications for Children', highlighted the lack of direct research evidence on children affected by parental drug use. Consequently, impacts can only be inferred from current data sources, as was presented in the report. Data from the 2004 NDSHS were re-analysed according to the sub-sample of adults who lived in the same household as dependent children under the age of 12 years. Analyses for risk of child exposure to alcohol and other drug use in these households were conducted by primary drug of use. It was concluded that for every 1000 adults in Australia, 49 dependent children under the age of 12 are living in a household with an adult who had used methamphetamine in the last year, and 8.4 children are living in households with an adult using methamphetamine at least monthly (Australian National Council on Drugs, 2006).

The ANCD report also analysed the 'Patterns of Amphetamine Use' database obtained by the Crime and Misconduct Commission. This sample consisted of 690 individuals of which 207 individuals (56% women) reported having children. In comparison to amphetamine users without children, those with children were significantly more likely to use base and crystal methamphetamine, as well as benzodiazepines (Australian National Council on Drugs, 2006). Of note, over a six-month period, those with children reported using crystal methamphetamine on twice as many days as those without children (55.1 versus 27.6 days). Of further concern was the prevalence of family violence in these households. It was reported that a higher proportion of amphetamine users with children had experienced physical violence from partners and nearly three times as many experienced regular partner violence compared to amphetamine users without children.

The ANCD report indicated that perhaps the most significant outcome for children raised by parents using illicit drugs was the increased prevalence of child maltreatment, both child abuse and neglect. However, it acknowledged that poor child outcomes cannot be directly attributed to parental illicit drug use given the variety of other adverse conditions commonly encountered, such as socioeconomic disadvantage (e.g., unemployment, poverty, transient lifestyle), poor mental health (e.g., co-morbid psychopathology) and social isolation (e.g., absence of social supports).

## Manufacture

In addition to parental use of methamphetamine limiting the ability to adequately care for and supervise children, manufacture of ATS in or near the home creates a high-risk, unhealthy and unsafe environment (Gutchewsky, 2003). Manufacture of ATS can involve a relatively simple chemical process that uses highly flammable, very toxic and corrosive chemicals (Caldicott et al., 2005). Several groups of people are therefore placed at risk in relation to manufacturing, including other adults, children, police, forensic scientists and emergency workers. Special consideration must also be given to environmental decontamination of ATS clandestine laboratory sites and to the protection of exposed populations during this process. Disposal of chemical waste products from ATS production, such as phosphorous-based solvents, can create pollution, and human and environmental risk (Irvine & Chin, 1991).

The Minnesota Department of Health (2002) outlined the following common chemicals found in methamphetamine laboratories and their physical effects:

- Solvents (e.g., acetone, ether/starter fluid, methanol, white gas, xylene), which have been linked to irritation to skin, eyes, nose and throat; headaches; dizziness; depression; nausea; vomiting; visual disturbance and cancer;
- Corrosives/irritants (e.g., anhydrous ammonia, hydriodic acid, hydrochloric acid, phosphine, sodium hydroxide, sulphuric acid), which have been linked to coughing; eye, skin and respiratory irritation; burns and inflammation; gastrointestinal disturbances; thirst; chest tightness; muscle pain; dizziness; and convulsions; and
- Metals/salts (e.g., iodine, lithium metal, red phosphorous, yellow phosphorous, sodium metal), which have been linked with eye, skin, nose and respiratory irritation; chest tightness; headaches; stomach pain; birth defects; and jaundice/kidney damage.

ATS are often manufactured in private residences, or 'backyard clandestine laboratories', and this can place children at high risk. In the United States, the National Drug Intelligence Centre (2002) noted that 2028 children were present at seized methamphetamine laboratory sites and that 35% of those tested positive for toxic levels of chemicals. Health effects for children exposed to these chemicals include gastrointestinal problems, chemical burns, brain damage, headaches, skin and eye irritations (Horton, Berkowitz & Kaye, 2003), tachycardia, agitation, irritability and vomiting (Kolecki, 1998).

Such issues are receiving increasing attention in Australia. For example, the *Drug Misuse and Trafficking Amendment Act* (NSW) recently established new penalties for the endangerment of children by exposure to illicit drug manufacture.

### 3.7 Summary

The primary action of ATS in the brain is to elevate levels of dopamine, serotonin and noradrenaline. Methamphetamine has a stronger effect on dopamine levels while ecstasy is more strongly associated with serotonin levels. The sought after effects of ATS include a sense of wellbeing, euphoria, increased alertness and concentration, diminished appetite, enhanced confidence, sharpened sensory awareness. The short-term adverse effects include restlessness, irritation, anxiety, teeth grinding, insomnia, sweating and increased heart rate.

Prolonged use of ATS can also have several long-term effects in diverse areas of functioning. The primary adverse cognitive effects for all types of ATS appear to be deficits in working memory, attention and executive function. Several psychological problems have been identified in association with ATS use, most notably, depression, anxiety and psychosis. Well documented is the link between use of crystal methamphetamine and psychotic symptoms, which can be associated with violent behaviour. Dependence is another adverse outcome of ATS use, associated more with the use of methamphetamine than ecstasy. Dependence is also more strongly associated with injecting and smoking methamphetamine, than with other routes of administration such as snorting and swallowing. Other effects are specific to route of administration; for example, increased

risk of blood borne virus transmission with certain injecting practices. In addition, there are several adverse physical outcomes of ATS use such as hypertension, irregular body temperature, cardiac arrhythmia, metabolic disturbances, poor dental hygiene and lethargy. There is some research on neurotoxicity and overdose associated with ATS use, with deaths more often resulting from use of methamphetamine than ecstasy.

ATS use can also have adverse behavioural and social effects. Many ATS users are polydrug users and use of ATS in combination with other drugs, including alcohol, can increase related harms. Certain contexts of use increase the risk of harm. For example, ATS use can impair driving ability and workplace safety. ATS use has been associated with risky sexual practices, such as a failure to use protection thereby increasing the risk of sexually transmitted infections. There is growing research on the use of ATS in homosexual populations, particularly among gay males. Methamphetamine has also been associated with aggression and violence, and linked to some criminal activity.

In addition to the effects of ATS use on the individual, there may be a wider impact on family, friends and the broad community. ATS use can have a detrimental effect on relationships, with the user becoming increasingly alienated from social networks. ATS use during pregnancy can negatively affect the developing foetus as can use while breastfeeding. Parental ATS use can result in adverse outcomes for children. Finally, exposure to methamphetamine manufacture represents a potential harm for children and the wider community, including those responsible for cleaning up production sites.

The need for further research into the effects of ATS use was raised during consultations. The most neglected areas of research were seen as epidemiological information about patterns of drug use and related problems; the long-term effects of ATS use; neuropsychological deficits and their impact on the effectiveness of treatment; effects of ATS use during pregnancy; memory deficits associated with use; and strategies to enhance engagement with treatment services.