Concurrent use and order of use of cocaine and alcohol: behavioural differences between users of crack cocaine and cocaine powder

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ABSTRACT

Aims The study investigates patterns of cocaine use and alcohol use when these substances were taken on their own, the order of administration of alcohol and of cocaine when the two substances were taken together, and changes in the doses of alcohol and of cocaine when the two substances were taken together. The study further investigates differences in the combined use of the two substances by users of cocaine powder and crack cocaine. **Design** Entry criteria for the study were current (previous 30 days) use of both alcohol and cocaine. Study participants ($n = 102$) were recruited from clinical and non-clinical settings. Data were collected by face-to-face structured interviews. **Findings** Different patterns of combined cocaine and alcohol use were reported by cocaine powder and crack cocaine users. Cocaine powder users tended to take increased doses of both cocaine and alcohol when these were used in combination. During high-dose crack using episodes, crack users tended to drink lower amounts of alcohol than usual. Cocaine powder users tended to use cocaine and alcohol concurrently. Crack users tended to use alcohol at the end of crack-using sessions. **Conclusions** The observed differences are not understood clearly but may be influenced by differential effects of route of administration upon absorption, bioavailability and the balance of euphoric/dysphoric effects. Research studies of the combined use of cocaine and alcohol should distinguish explicitly between the use of cocaine by different routes of administration, and this should be specified in the description of subject samples.

Keywords Alcohol, cocaethylene, cocaine, concurrent use, route of administration.

INTRODUCTION

Recent British surveys have shown increases in the use of cocaine [1] and in the prevalence of heavy drinking [2]. The investigation of drug and alcohol misuse problems has often been conducted separately on a substance-by-substance basis. However, many substance misusers take several different drugs, and the realities of multiple substance use pose major challenges for research [3–5]. Certain forms of multiple drug use are more common than others. It has been known for many years that one commonly occurring pattern of multiple substance misuse involves the concurrent use of cocaine and alcohol [6–8]. Indeed, it has been suggested that the concurrent use of alcohol may be an integral component of cocaine misuse [9].

The combined use of alcohol and cocaine has been found to produce increased and prolonged subjective euphoria compared to the use of either substance on its own [10], and experimental studies have investigated possible mechanisms of action underlying this form of multiple substance misuse. The rewarding effects of both cocaine and alcohol are mediated by the mesolimbic pathway, with the two substances acting synergistically to increase dopaminergic activity [11]. Harris *et al.* [10] reported a dose-dependent response to cocaine–alcohol combinations, due probably to increased peak plasma cocaine concentrations when cocaine is used in combination with alcohol [9,12].

The enhanced effect of combined use of cocaine and alcohol may also be due to the interaction of cocaine and alcohol leading to the formation of cocaethylene, a cocaine homologue and metabolite. Cocaethylene is

formed only as a result of the combined use of cocaine and alcohol. It shares many neurochemical and pharmacological properties with cocaine, and is similar to cocaine in its actions as an indirect dopamine agonist [13]. Cocaethylene administration produces euphoric effects which are indistinguishable from those of cocaine [13] and the formation of cocaethylene is, at least partly, responsible for the more intense and longer-lasting effects reported when cocaine and alcohol are used in combination [14].

The simultaneous use of cocaine and alcohol leads to serious health risks. Cocaethylene levels in excess of cocaine have been found among emergency room patients and following fatal overdoses [15]. As with cocaine, cocaethylene increases heart rate and systolic blood pressure [13] and the combined use of cocaine and alcohol increases cardiovascular effects and heart rate over that observed when either substance was administered alone. Cocaine and alcohol have been found to be more cardiotoxic when they are used together than when used on their own [16]. Among the cardiovascular causes of morbidity associated with cocaine use are organ ischaemia, infarction and arrhythmia [17], and the risk of such adverse events is increased with combined use of cocaine and alcohol [9].

Laboratory studies have provided important knowledge about the effects of concurrent use of cocaine and alcohol and about the mechanisms underlying such effects. However, the experimental procedures in such studies often differ in important respects from the circumstances of drug misuse in the real world. For example, many laboratory studies have involved the administration of single doses of cocaine and/or alcohol [12,18,19]. Single-dose studies are limited, in that they do not represent the usual pattern of use of these drugs [9]. The concurrent use of cocaine and alcohol often involves high doses and occurs repeatedly and over prolonged periods of time [20]. For ethical reasons, such patterns of use cannot be replicated easily in experimental studies with human subjects.

Few studies have distinguished explicitly between the use of alcohol with different forms of cocaine. The most commonly used forms of cocaine are cocaine powder (cocaine hydrochloride) and crack cocaine. These tend to be used by different routes of administration [21]. Cocaine powder is generally taken either by intranasal use or by injection and is not suitable for smoking, as this destroys much of the active form of the drug. Crack cocaine is typically (but not invariably) smoked. Although the route of administration is known to influence the reinforcing effects of cocaine [22], relatively little is known about the ways in which the concurrent use of cocaine and alcohol may be related to the use of different forms of cocaine, or to different routes of administration of cocaine.

The present study investigates patterns of cocaine use and alcohol use when these substances are taken on their own, the order of administration of alcohol and of cocaine when the two substances are taken together, and changes in the doses of alcohol and of cocaine when the two substances are taken together. These issues are investigated further with attention to differences in the combined use of the two substances by users of cocaine powder and crack cocaine.

METHOD

Entry criteria for the study were current use of both alcohol and cocaine. These criteria were defined operationally as (i) use of alcohol in the previous 30 days and (ii) use of cocaine in the previous 30 days. Participants were recruited from both clinical and community (non-clinical) settings in the greater London area. Participants from clinical settings were approached at a south London treatment centre which provided services for a wide range of drug misuse problems, including opiate dependence, stimulant problems and cannabis problems, and which also offered HIV counselling services.

The community sample of respondents was contacted using snowball sampling methods. This involved the identification of alcohol- and cocaine-using individuals who were known to the research interviewers. Each person that was contacted was asked to nominate another suitable candidate for the study. This process was repeated until a sufficient number of participants had been interviewed. This procedure has been used successfully in other studies of drug users [23,24]. Interviews with the community sample were conducted in a range of settings, including the participants' homes, pubs, clubs and other social settings. Where interviews were conducted in a public place, efforts were made to provide privacy and to reassure respondents of the confidentiality of any information provided.

Data were collected by means of face-to-face structured interviews. The interview contained items and scales developed specifically for this project as well as measures adapted from published instruments. All data were obtained by self-report. Self-report data have been found to be sufficiently reliable and valid to provide descriptions of current substance use, drug-related problems and the natural history of substance use [25,26].

Measures were taken of personal and social demographics (age, sex, accommodation, marital status/living arrangements, educational attainment, employment). Substance use behaviours were assessed using the Maudsley Addiction Profile (MAP). The MAP is a brief questionnaire with established reliability and validity [27]. Substance use was assessed by asking participants to report the number of days on which they used each of the

target drugs in the past 30 days (current use), the typical amount used on a using occasion and the route of administration (e.g. snorting/intranasal, smoking/chasing, injection). Cocaine consumptions measures were taken separately for use of crack cocaine and cocaine powder.

Measures of alcohol consumption included quantity recorded in terms of standard UK units of alcohol (with 1 unit = 8 g of ethanol). Measures were taken both of the amount of alcohol consumed during a typical drinking episode, and the greatest amount of alcohol consumed during a drinking episode. Detailed questions were included to enquire about the patterns of use of alcohol or cocaine when these substances were taken separately, and also about the use of alcohol and cocaine when the two substances were used during the same episode of use. The questions about the combined use of alcohol and cocaine requested information about self-reported 'typical' amounts and 'maximum' amounts of both alcohol and cocaine that had been used by participants during recent episodes of use.

All participants were informed that the information they were being asked to provide would be anonymous and would be treated in confidence, and that their participation was voluntary. All interviews were conducted by research psychologists who were trained in the administration of the interview.

RESULTS

Of the 110 contacted drug misusers who reported having used both alcohol and cocaine in the previous month, 69 reported that they had used cocaine powder and 33 reported that they had used crack cocaine. A further eight subjects reported that they had used both crack and cocaine powder. The present study compares cocaine and alcohol use among users of crack cocaine and cocaine powder: for this reason, the eight participants who reported use of both forms of cocaine were excluded from the subsequent statistical comparisons. Consequently, for the purposes of analysis, the present study sample comprised 102 people.

The sample comprised 53 men (52%) and 49 women (48%). Their mean age was 30.3 [standard deviation (SD) 6.0] years. There was no difference between the crack cocaine and the cocaine powder user groups in terms of age, sex or relationship status. The crack cocaine users were significantly less likely to have completed their education (21% versus 50%, $P < 0.01$), had fewer years in education (12.2 versus 15.2, $P < 0.001$) and had been in paid employment for fewer days than the cocaine powder users (6.7 versus 26.9, $P < 0.001$) during the month prior to the interview.

All cocaine powder users reported use of the drug by intranasal administration during the previous month. Of the crack cocaine users, the majority (86%) reported using crack only by smoking/chasing, but 14% reported that in addition to their smoking/chasing, they had also taken crack by injection on one or more occasions during the previous month.

Changes in alcohol use when taken with cocaine

Comparisons were made of the changes in alcohol consumption when cocaine and alcohol were used together, with separate analyses of the data for the cocaine powder and the crack cocaine groups. Due to the skewed distribution of scores for measures of cocaine and alcohol use, statistical analyses of changes in substance use were performed using Wilcoxon's non-parametric tests.

Among the intranasal users of cocaine powder, when alcohol and cocaine were taken together the mean amount of alcohol consumed during a drinking episode increased. The mean amount of alcohol consumed by the cocaine powder users during a typical drinking episode when not using cocaine was 13.5 units. When alcohol and cocaine were taken together, the mean amount of alcohol consumed typically during a drinking episode increased to 18.4 units: this increase is statistically significant (see Table 1).

Similar results were obtained when comparisons were made for the maximum amount of alcohol used. During a drinking episode when not using cocaine, the mean maximum amount of alcohol consumed by the cocaine powder users was 22.8 units. As reported above for typical amounts, when alcohol and cocaine were taken together there was a statistically significant increase in the mean maximum amount of alcohol consumed during a drinking episode, with this increasing to 31.3 units.

In contrast, among the crack cocaine users, when alcohol and cocaine were used together, there was a statistically significant *decrease* both in the mean amounts of alcohol consumed during a typical drinking episode and in the maximum amount of alcohol consumed. Typical alcohol consumption fell from 11.1 to 4.4 units, and the maximum amount fell from 15.2 to 7.4 units.

Changes in cocaine use when taken with alcohol

Separate analyses were conducted for the cocaine powder users and for the crack users to investigate possible changes in cocaine use when cocaine was used either with or without alcohol.

Among the cocaine powder users, there was a statistically significant increase in the mean amount of cocaine consumed during episodes when cocaine and alcohol were used together (see Table 2). This increase in cocaine use was found both for the amount of cocaine powder consumed during a typical cocaine-using episode (when cocaine use increased by about two-thirds of a gram) and

Table 1 Changes in quantity of alcohol when taken with cocaine.

	Alcohol only/ typical amount Mean (SD)	*Alcohol with cocaine/ typical amount* Mean (SD)	*Change score*	*Z (p)*
Cocaine powder users	13.5 (6.0)	18.4 (10.2)	+4.9	5.62 (P < 0.001)
Crack cocaine users	11.1 (8.6)	4.4 (6.5)	−6.7	3.38 (P < 0.001)
	Alcohol only/ maximum amount Mean (SD)	*Alcohol with cocaine/ maximum amount* Mean (SD)		
Cocaine powder users	22.8 (13.3)	31.3 (15.5)	+8.5	5.90 (P < 0.001)
Crack cocaine users	15.2 (13.4)	7.4 (13.6)	−7.8	3.73 (P < 0.001)

Quantity of alcohol consumption is shown in standard UK units (1 unit = 8 g).

Table 2 Changes in cocaine dose when taken with alcohol.

	Cocaine only/ typical amount Mean (SD)	*Cocaine with alcohol/ typical amount* Mean (SD)	*Change score*	*Z (p)*
Cocaine powder users	0.2 (0.3)	0.9 (0.5)	+0.7	6.67 (P < 0.001)
Crack cocaine users	0.9 (1.0)	1.1 (2.1)	+0.2	1.77 (P = 0.08; NS)
	Cocaine only/ maximum amount Mean (SD)	*Cocaine with alcohol/ maximum amount* Mean (SD)		
Cocaine powder users	0.4 (0.6)	1.6 (0.8)	+1.2	6.59 (P < 0.001)
Crack cocaine users	1.4 (1.5)	1.1 (1.5)	−0.3	2.42 (P < 0.05)

Quantity of cocaine use is shown in grams (for cocaine powder) and gram equivalents for crack cocaine (with four 'rocks' = 1 gram).

for the maximum amount of cocaine used (with a mean increase of more than a gram).

Again, the results for the crack cocaine users differed from those found for the cocaine powder users. Among the users of crack cocaine, no statistically significant increases were found in the amount of crack cocaine used during cocaine-using episodes when cocaine and alcohol were used together (see Table 2). For measures of typical amounts of crack cocaine consumed, there was a small but non-significant reported increase in crack cocaine consumption. For ratings of the maximum amount of crack cocaine consumed during a cocaine-using episode, the amount of crack cocaine used was significantly *lower* when cocaine and alcohol were used together (falling from 1.4 to 1.1 gram-equivalents).

Order and sequencing of use

Further differences were found between the cocaine powder and the crack cocaine user groups in the order in which cocaine and alcohol were used when the two substances were taken together. Among the crack cocaine users, alcohol use prior to using crack cocaine was reported by 21%; alcohol use while using crack cocaine was reported by 12%; and alcohol use subsequent to using crack cocaine was reported by 36%. Paired contrasts showed that drinking after crack cocaine use was significantly more likely than during an episode of crack cocaine use (McNemar, P < 0.05).

Cocaine powder users were more likely than crack cocaine users to report drinking alcohol at all stages of cocaine use (before using cocaine, 96%; while using, 96%; and after using cocaine, 93%) (P < 0.001 for all contrasts). For the cocaine powder users, there were no statistically significant differences in their likelihood of drinking alcohol between the stages of cocaine use.

Relatively few users in either the crack cocaine or the powder cocaine groups reported that episodes of combined use of both alcohol and cocaine involved prolonged use of alcohol followed by cocaine use (reported by 13% of both the cocaine powder and crack cocaine user groups).

DISCUSSION

Where cocaine and alcohol were used together, different patterns of combined use of the two substances were reported by cocaine powder users and users of crack

cocaine. Differences were found both with regard to amounts used and order of use. The cocaine powder users typically used alcohol and cocaine concurrently and in alternating doses. They often drank alcohol in excessive amounts and also tended to increase the amounts of both cocaine and alcohol when the two substances were used in combination. Increased amounts were used both during typical episodes of substance use and during highest-dose episodes. The use of increased doses of both substances is a matter for concern, because these substances are more cardiotoxic when used together than when either is used alone [16], and the lethal effects of both cocaine and cocaethylene are potentiated by alcohol [28,29].

In contrast, the pattern of combined cocaine and alcohol use among the crack cocaine users was different from that among the users of cocaine powder. The crack users tended to use alcohol at the end of a session of crack use. They also tended to drink less alcohol than usual when they were taking crack cocaine. Unlike the cocaine powder users, the crack users did not typically take larger amounts of crack cocaine when this was taken with alcohol. Indeed, during high-dose episodes of alcohol use, they reported using lower doses of crack when they were also drinking.

The effects of combined cocaine and alcohol use are complex, and where cocaine and alcohol are used together a number of actions and interactions (sometimes with opposite effects) may occur. The increased reward following combined use of the two substances may reflect increases in the positively reinforcing effects of cocaine [10,12]. Increases in the reinforcing effects of combined cocaine and alcohol use may be due to alcohol attenuating the aversive properties of cocaine, especially when cocaine is taken in high doses or for prolonged periods of time [30–31]. However, the rewarding effects of cocaine are not simply dose-dependent. Acute tolerance to the effects of cocaine occurs rapidly with repeated administration during a session of use, with the rewarding effects of cocaine tending to be greatest after the first few doses, with subsequent doses maintaining but not increasing the initial effect [32,33]. The relative balance of these reinforcing and aversive effects could be expected to influence patterns of substance misuse.

Where concurrent use of cocaine and alcohol produces subjectively rewarding effects, it is likely that many drug misusers will seek such effects. The finding that cocaine powder users took higher doses of both cocaine and alcohol during episodes of concurrent use is consistent with the results of other studies which have reported increased levels of 'high' and other subjectively rewarding effects associated with the combined use of cocaine and alcohol [10,11,13,34]. When cocaine and alcohol were used together by the crack cocaine users, this

tended to involve the use of lower doses of both substances. This suggests that the concurrent use of the two substances was perceived as less rewarding by the crack users than by users of cocaine powder.

It is known that the order of administration of cocaine and alcohol alters the combined effects of the two substances. Alcohol may increase the effects of cocaine when taken prior to cocaine but not when used afterwards [35,36]. Cocaine may be used to offset the sedating effects of alcohol without affecting the subjective experience of intoxication [34]. After the initial euphoric effects, prolonged use of cocaine often produces aversive effects characterized by dysphoria and anxiety, and many cocaine users report using alcohol to attenuate these negative effects [37–39].

It is unlikely that the observed differences in behavioural patterns involving the concurrent use of cocaine and alcohol among the crack and cocaine powder users were due to the form of the cocaine used. Powder and crack cocaine are (with the exception of some minor adulterants) both forms of the same drug. It is possible, however, that different routes of administration may influence the rewarding effects of cocaine and alcohol when these are taken together.

The route of administration can alter a number of drug effects, including speed of onset, peak plasma levels and intensity of subjective euphoria [22,40]. Alcohol produces nasal capillary vasodilation which could lead to more rapid cocaine absorption and increased cocaine bioavailability when the drug was used by snorting [10]. Conversely, cocaine may reduce the absorption of alcohol due to its vasoconstrictive effects [36]. When used with alcohol, the route of cocaine administration had differential effects upon the accumulation of cocaethylene in body tissues [41]. Because cocaethylene is longer-acting and less anxiogenic than cocaine [42], this may mask or counteract subjectively dysphoric effects among the cocaine powder users.

In interpreting these findings, we wish to draw attention to a number of limitations in the design of the present study. The sampling procedures are opportunistic and neither the clinical nor the community samples can be regarded as representative. Also, there are known socio-economic and other differences between the crack and powder cocaine users, and it is possible that these differences may have influenced the observed patterns of alcohol and cocaine use. However, relatively little is known about specific behavioural patterns of concurrent alcohol and cocaine use, or how this may be affected by different routes of cocaine administration. We suggest that this issue deserves further research attention. In particular, we suggest that future studies of the combined use of cocaine and alcohol (or other drugs) should distinguish explicitly between the use of cocaine by different routes of

administration, and that this should be specified in the description of subject samples.

Acknowledgements

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