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Ketamine Experiences

Quantifying the Psychological Effects of Ketamine: From Euphoria to the k-Hole

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52 ketamine users were "opportunistically" recruited to take part in a survey of the psychological effects of the drug, in Manchester, United Kingdom in 2008. Twenty-seven ketamine-naïve respondents were also recruited for comparison in respect of "other" recreational drug use and level of schizotypy. Ketamine users attributed a wide range of appetitive, aversive, after-effect, and dissociative experiences to the drug. They also reported using a much wider range of other recreational drugs than ketamine non-users. Former users reported significantly fewer positive or dissociative experiences than current users.

Keywords ketamine; k-hole experiences; schizotypy

Introduction

Ketamine was developed as a "safer" alternative anaesthetic to phencyclidine (PCP) in the early 1960s. Today, it continues to be used occasionally in a variety of medical settings: as an anaesthetic in veterinary medicine, and, for humans, as an analgesic for treating burn-related neuralgia (Enarson, Hays, and Woodroffe, 1999) and cancer (Fine, 1999). It has an excellent safety record (Reich and Silvay, 1989) and, in anaesthetic studies, there have been few reported long-term detrimental health effects (Jansen and Theron, 2003). However, a major drawback of its use in humans is its induction of so-called "emergence reactions" (Curran and Morgan, 2000), most likely to be experienced as anaesthesia wears off. These dysphoric effects may include dissociative and transcendental experiences, floating sensations, and various sensory distortions.

In clinical settings, ketamine is usually administered by intravenous injection, and some heavy recreational users may also use this route. However, a psychoactive dose of ketamine is about 1/5 the surgical dose, and most recreational users inhale the drug intranasally (Tori, 1996). As a recreational drug its use and popularity is reported to be on the increase (Copeland and Dillon, 2005). Travis (2005) reported that it was one of the six most

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common drugs for sale in UK cities. Its reputation as a "harmless substance" has meant that it has quickly established itself as a "drug of choice" for many people associated with the dance/rave scene (Moore and Measham, 2008) with about 1 in 3 Australian respondents from this milieu acknowledging "use" of ketamine in the previous 12 months (Dillon, Copeland, and Jansen, 2003). In the United Kingdom, our recent survey of recreational drug use in young adults has established a rate of 4% ever having tried ketamine, with the majority of these being irregular users (Stirling et al., 2008). Therefore, at present, its use appears not to be widespread but rather confined to particular sub-groups.

Ketamine, like PCP, is an uncompetitive NMDA antagonist, directly affecting glutamate functioning, and indirectly affecting other neurotransmitter systems (notably dopamine) in the brain (Curran and Morgan, 2000). However, there is currently a debate about whether its overall effect is to antagonise glutamate function or simply reduce activity at NMDA receptors whilst increasing activity (via spill-over) at adjacent non-NMDA receptors, or downstream (Deakin et al., 2008). Whatever its pharmacological action(s), several lines of enquiry have led to the suggestion that NMDA antagonist effects might serve as a model for certain psychotic symptoms; particularly those seen in schizophrenia. Early reports by Allen and Young (1978), Jentsch and Roth (1999), and Luisada and Brown (1976) had indicated that PCP could induce psychotomimetic effects in users sufficient to merit psychiatric admission, and Javitt and Zukin (1991) had reported that PCP could induce various positive, negative, and cognitive symptoms in "normal" volunteers resembling clinical symptoms seen in patients with schizophrenia. Krystal et al. (1994) reported similar though usually shorter lived or less pronounced effects in relation to ketamine intoxication in healthy volunteers, and Lahti, Weiler, Michaelidis, Parwani, and Tamminga (2001) found that the drug exacerbated symptomatology in a group of patients with latent schizophrenia. More recently, Rowland et al. (2005) have reported increased glutamate turnover in the anterior cingulate following ketamine administration, and Theberge et al. (2003) have found evidence of glutamate perturbation in both cortical and sub-cortical structures in people with chronic schizophrenia. A model linking these disparate research findings is slowly emerging, in which endogenous glutamate dysfunction is related to schizophrenia symptomatology, and the psychotomimetic effects of ketamine are mediated by its "exogenous" influence on the same system (Corlett et al., 2006; Corlett, Honey, and Fletcher, 2007.

Despite progress at the neurobiological level, the phenomenology of ketamine intoxication remains poorly characterized. In addition to the loosely defined "psychedelic" features of the k-hole (Jansen, 2001) and the dissociative and passivity signs reported elsewhere (Adler et al., 1999), other less-specific neurocognitive and amotivational impairments have also been reported (Morgan, Muetzelfeldt, and Curran, 2009). However, these have often been recorded either anecdotally (e.g., Jansen, 1999) with small samples of respondents (e.g., Radant, Bowdle, Cowley, Kharasch, and Roy-Byrne, 1998) or following the application of ketamine to healthy volunteers not previously acquainted with the drug (e.g., Morgan, Mofeez, Brandner, Bromley, and Curran, 2004). Currently missing from the literature is any comprehensive quantification of typical ketamine-induced "experiences" reported by a respectably large sample of users.

For some time our research group has pursued a "parallel-track" of seeking to record core experiences of cannabis users during and after cannabis consumption (Barkus and Lewis 2008; Barkus, Stirling, Hopkins, and Lewis, 2006; Stirling et al., 2008). We have developed the self-report Cannabis Experiences Questionnaire (CEQ) for this purpose, and more than 1,100 respondents have now completed it. In addition to basic background information about consumption, expenditure, and other drug use, its two-substantive sections comprise checklists requiring a five-point Likert response to indicate the frequency

of common cannabis-induced concurrent and after-effect experiences. It takes about 5 min to complete; it can be used repeatedly, and has good test–retest reliability.

Like ketamine, cannabis has psychotomimetic properties (Van Os et al., 2002), and many of the appetitive, aversive, and after-effect experiences listed in the CEQ are also reported by ketamine users. In view of these areas of overlap, we sought to adapt the CEQ as a tool to measure common ketamine experiences, and to administer it to a sample of ketamine users as a test of its suitability for this purpose in further larger scale studies of ketamine-induced phenomenology. As a second focus of interest for our research group is the personality trait of schizotypy (Claridge et al., 1996; Raine, 1991), which we have repeatedly shown to predict certain aversive and dysphoric cannabis experiences; we also included a brief measure of schizotypy in the current investigation, hypothesizing that ketamine users evincing higher schizotypy scores might also report fewer positive and more aversive/dysphoric ketamine experiences.

Method

Participants

Seventy-nine individuals were recruited to the study, 52 of whom were current or past recreational ketamine users. The remainder ($n = 27$) had never used ketamine although many currently used or had experimented with other recreational drugs.

Participants were opportunistically recruited in two ways: Initially, respondents were invited to take part in a survey of "recreational drug use and personality" via flyers and notices posted around the two Manchester universities. They were asked to contact the second author by mail, email, or in person to complete hard copies of the questionnaires, and return them in pre-addressed envelopes provided. In view of our particular wish to recruit as many ketamine users as possible, those indicating that they currently (or had in the past) used the drug were asked to direct the attention of any fellow users toward our request for respondents in a true "snow-balling" recruitment procedure. In this way 43 respondents anonymously completed our questionnaires. To further increase recruitment, we temporarily posted information about our survey on a personal social network facility, *Facebook*, inviting respondents to complete our questionnaires and return them to us (in pre-paid envelopes) via the mail. A further nine respondents were recruited by this means.

Measures

The CEQ (Stirling et al., 2008) was adapted in two ways: Firstly, all references to cannabis were replaced by "ketamine." Thus, for example, respondents were asked to indicate how regularly they used "ketamine," and whether and to what extent "ketamine" made them sleepy/depressed/fearful/ecstatic etc. Secondly, an additional section was created to identify and quantify the specific set of dissociative experiences not typically associated with cannabis use but characterized by ketamine users as (features of) the "k-hole," based on descriptions by Jansen (2001). The format of this section was identical to the concurrent and after-effect experiences sections in the original CEQ (requiring a five-point Likert type response) and included the 16 experiences most frequently associated with the "k-hole." A final section of the CEQ inviting respondents to provide qualitative information about any additional cannabis experiences not already covered by the questionnaire was retained, although the name "ketamine" was once again substituted. The final version of our Ketamine Experiences Questionnaire (KEQ) thus comprised an opening section on ketamine

use/familiarity and expenditure; a section to identify experience with other recreational drugs (including alcohol and tobacco); the substantive checklists for concurrent (42 items) and after-effect experiences (12 items); an additional section for k-hole experiences (16 items); and a final open section to record additional experiences not already captured in early parts of the questionnaire.

Schizotypy

To obtain an indication of level of schizotypy, the brief version of the Schizotypal Personality Questionnaire (SPQ-B; Raine and Benishay, 1995) was employed. This comprises the most "informative" 22 items from the full SPQ, providing an overall score and scores on three subscales: The cognitive-perceptual subscale consists of eight items related to odd beliefs/magical thinking, paranoid ideation, self-referential thinking, and unusual perceptual experiences. The interpersonal subscale comprises eight items related to social and interpersonal anxiety. The disorganised subscale includes just six items which relate to strange behavior and odd speech.

Procedure

Irrespective of means of recruitment, all respondents completed hard copies of the questionnaires. A cover sheet explained the general nature of our research, and provided assurances regarding anonymity. All participants signed a "consent" form acknowledging that they understood the general purpose of our study and their right to withdraw from it without prejudice at any time. Consent was affirmed by submission of the completed documents.

Ethical Considerations

Strenuous efforts were made to conduct this research within the guidelines set out by the British Psychological Society. The study was approved locally by the Psychological Research ethics panel Manchester Metropolitan University. Participants identified themselves only by PIN and password (provided on the front page of each questionnaire) permitting anonymous (but identifiable) data collection. This procedure enabled interested respondents willing to waive their rights to full anonymity to obtain a summary of the main findings of the study on completion.

Results

Thirty-five current and 17 past users comprised the ketamine user group. Twenty-seven respondents made up the ketamine non-user group. The modal age of respondents was 22 years. Marginally more males ($n = 45$) than females ($n = 34$) were recruited, although these were evenly distributed in the two groups. Almost the entire ketamine user group also currently used (or had used) other recreational drugs including alcohol (49/52), cannabis (47/52), MDMA (44/52), tobacco (37/52), and cocaine (36/52). 26/27 of the ketamine non-user group used alcohol. The next most widely used drug in this group was cannabis (16/27) followed by tobacco (15/27), cocaine (7/27), and MDMA (6/27). Overall, the modal number of "other drugs" used by the ketamine user group was seven compared with two in the ketamine non-user group ($t = 6.18$, $df = 77$, $p < .001$).

In regard to frequency of ketamine use, 1/3 of the ketamine user respondents used the drug at least once a month, with 17% using it at least once a week. Five respondents

Table 1
Positive (appetitive) concurrent ketamine-induced experiences: percentage of ketamine users endorsing each "experience" ($n = 52$)

	Rarely or never	From time to time	Sometimes yes & sometimes no	More often than not	Almost always or always
Feeling happy	5.8	9.6	28.8	28.8	26.9
Enhanced perceptual awareness	19.2	9.6	23.1	25.0	23.1
Powerful (strong)	48.1	17.3	23.1	5.8	5.8
Excited	11.5	19.2	30.8	21.2	17.3
Sentimental	26.9	26.9	25.0	15.4	5.8
Energized	23.1	26.9	23.1	23.1	3.8
Feeling all-powerful (like you could do anything)	48.1	13.5	25.0	9.6	3.8
Able to understand the world better	19.2	19.2	21.2	25.0	15.4
Being relaxed	11.5	7.7	28.8	30.8	21.2
Sleepy	23.1	30.8	23.1	17.3	5.8
Laid back	7.7	19.2	23.1	28.8	21.2
Looking for excitement	19.2	19.2	36.5	19.2	5.8
Religious	69.2	15.4	7.7	5.8	1.9
Full of plans	30.8	15.4	21.2	21.2	11.5
Ecstatic	26.9	21.2	32.7	13.5	5.8
Feeling more creative	23.1	28.8	25.0	11.5	11.5
Out-of-body experiences	42.3	5.8	21.2	21.2	9.6
Feeling full of ideas	19.2	19.2	36.5	11.5	13.5

reported daily usage. However, modal expenditure on the drug was less than £15 ($23) per week, although two users spent more than £60 ($90) per week.

Users were also asked to "guesstimate" how many times they had ever used ketamine, and to indicate their age at first use. Mean lifetime usage was estimated at 233 times (median = 40, range = 1 to >2,000) and average age at first exposure was 19 years, 6 months (*SD* = 2.48 years).

Effects of ketamine

Positive concurrent experiences (see Table 1). The KEQ comprises the same 18 positive/appetitive items as the CEQ, and all (bar one: feeling religious) were endorsed by at least 50% of ketamine users at least occasionally. The most frequently reported positive experiences were feeling happy, feeling laidback, being relaxed, and having enhanced perceptual abilities.

Negative concurrent experiences (see Table 2). Once again the KEQ comprised the same 24 negative concurrent experiences listed on recent versions of the CEQ. All (bar one: feeling angry) were endorsed by more than 50% of ketamine users at least occasionally. The most frequently reported negative effects included losing one's sense of reality, a slowing of time, slurring of speech, and reduced level of consciousness.

After-effects (see Table 3). The same 12 after-effects from the CEQ appeared on the KEQ, and all were endorsed at least occasionally by more than 50% of the group. The least common experiences included feeling paranoid without reason, and feeling suspicious. Conversely, almost all respondents (96%) reported feeling physically slowed down at least occasionally, and almost as many attested to experiencing a reduced level of attention and low motivation at least occasionally. De-motivation and a sense of thinking being slowed down were also frequently endorsed.

k-hole phenomena (see Table 4). The most frequently endorsed items included marked confusion, difficulties in speaking, unexplainable experiences, floating sensations, and mind/body dissociation. The least frequently endorsed items included near-death experiences, astral travel, and alien phenomena.

Other experiences. The following were identified in the final section of the KEQ by at least two ketamine users as experiences additional to those already listed in the KEQ:

- Translocation: A feeling of being in a completely different location to where they actually were (i.e., believing that they were in a club when in fact they were in their house).
- Visual anomalies/distortions: Seeing everything through a kaleidoscope effect: "smashed mirror vision" (each shard of glass showing a different visual image).
- Out-of-body experiences: Seeing oneself from the other side of the room/from above.
- Transcendental experiences: Thinking thoughts that are "universal" and "deterministic," an awareness of a deeper separate consciousness; a strong sense of deeper understanding at a "cosmic" level.
- Distorted sense of self: Feeling that other people saw them as evil; thinking that they had physically changed from a human into an object/ animal; a sense of being permanently moulded into another person.

In addition, several ketamine users reported the following side-effects: marked mood swings, cognitive slippage such as forgetting how to spell/pronounce simple words or even how to walk, increased libido, frequent night terrors/sleep paralysis, a reluctance to look at oneself in a mirror, feeling dizzy/numb, feeling a "wave" sensation coursing through one's body.

Overall KEQ Experiences Versus CEQ Experiences

From previous research, mean positive, negative, and after-effect experiences scores reported by cannabis users were 42.26, 43.99, and 22.87 respectively (Stirling et al., 2008). These bear comparison with values of 49.40 ($SD = 12.11$), 63.15 ($SD = 14.37$), and 34.71 ($SD = 8.46$) respectively for ketamine users in the present study. Analysis (with one-sample t) indicated that in each domain, ketamine experiences are significantly more likely to be endorsed than cannabis experiences (positive experiences, $t = 4.39$; negative experiences, $t = 9.60$, after-effect experiences, $t = 10.05$, all $df = 51$, all $p < .001$ two tailed).

Table 2
Negative (aversive) concurrent experiences: percentage of ketamine users endorsing each "experience" ($n = 52$)

	Rarely or never	From time to time	Sometimes yes & sometimes no	More often than not	Almost always or always
Fearful	28.8	30.8	28.8	11.5	0.0
Paranoid	32.7	28.8	19.2	17.3	1.9
Uncomfortably sleepy	44.2	21.2	21.2	9.6	3.8
Anxious for no reason	36.5	23.1	25.0	9.6	5.8
Compulsive: (something you just had to do)	44.2	9.6	28.8	13.5	3.8
Deluded: (believing something you later knew to be untrue)	19.2	17.3	19.2	30.8	13.5
Threatened by unknown force	48.1	17.3	25.0	5.8	3.8
Lethargic	21.1	28.8	23.1	19.2	7.7
Nervy	32.7	26.9	26.9	9.6	3.8
Slurred speech	11.5	7.7	26.9	34.6	19.2
Slowing of time	9.6	5.8	21.2	30.8	32.7
Hearing things others could not hear: (auditory hallucinations)	26.9	19.2	25.0	11.5	17.3
Losing your sense of reality	3.8	15.4	17.3	32.7	30.8
Having visions: (visual hallucinations)	17.3	7.7	25.0	34.6	15.4
Fearful of going crazy/mad	32.7	17.3	30.8	17.3	1.9
Depressed	50.0	36.5	11.5	0.0	1.9
Obsessive: fixed on something	21.2	25.0	30.8	17.3	5.8
Disturbed thinking	15.4	34.6	25.0	19.2	5.8
No longer knowing one's-self	30.8	23.1	23.1	17.3	5.8
Sad	48.1	25.0	26.9	0.0	0.0
Things not feeling "right" on your skin or in your body	25.0	11.5	26.9	25.0	11.5
Angry	69.2	25.0	3.8	1.9	0.0
Uncontrollable thoughts	15.4	21.2	23.1	28.8	11.5
Reduced level of consciousness	15.4	19.2	32.7	17.3	15.4

Table 3
Ketamine after-effects: percentage of ketamine users endorsing each "experience" ($n = 52$)

	Rarely or never	From time to time	Sometimes yes & sometimes no	More often than not	Almost always or always
Disinhibited	30.8	26.9	13.5	23.1	5.8
Not wanting to do anything	9.6	23.1	30.8	30.8	5.8
Feeling generally slowed down (physically)	3.8	17.3	30.8	38.5	9.6
Feeling demotivated	5.8	17.3	26.9	38.5	11.5
Feeling that your thinking has been slowed down	9.6	17.3	23.1	34.6	15.4
Being unable to concentrate	11.5	19.2	15.4	36.5	17.3
Having a sense of slowing of time	28.8	7.7	21.2	32.7	9.6
Paranoid without reason	42.3	15.4	23.1	15.4	3.8
Suspicious of people, events, or things without reason	48.1	19.2	17.3	11.5	3.8
Feeling depersonalized	32.7	21.2	30.8	7.7	7.7
Being unable to remember things	19.2	11.5	23.1	30.8	15.4
Having reduced attention	5.8	15.4	25.0	40.4	13.5

Current Versus Former Users

We compared current and former users in terms of both pattern(s) of use and ketamine experiences. The groups did not differ on any measure of usage apart from total times used ($t = 3.36$, $df = 35$, $p = .002$) and a related "contrived" measure of consumption derived from averaged standardised scores for expenditure, frequency of use, and number of times used ($t = 3.45$, $df = 49$, $p = .001$), both of which were, not surprisingly, higher amongst current users. The groups did not differ either in terms of age at first use or familiarity with other recreational drugs. In terms of ketamine-related effects, the groups did not differ significantly in respect of either negative or after-effect experiences. However, former users reported significantly fewer positive concurrent effects ($t = 2.07$, $df = 50$, $p = .04$) and marginally fewer k-hole experiences ($t = 1.93$, $df = 50$, $p = .06$) than current users.

Schizotypy and KEQ Experiences

Schizotypal Personality Questionnaire total was not correlated significantly with either positive, negative, or after-effects experiences total scores (all $p > .05$). However, it was

Table 4
Ketamine k-hole effects: percentage of ketamine users endorsing each "experience" ($n = 52$)

	Rarely or never	From time to time	Sometimes yes & sometimes no	More often than not	Almost always or always
A sense of floating	15.4	13.5	34.6	23.1	13.5
Disassociation of mind/body	15.4	17.3	32.7	23.1	11.5
Marked confusion	7.7	13.5	30.8	36.5	11.5
Feelings of peace and love	19.2	23.1	26.9	23.1	7.7
Feeling paralyzed	44.2	21.2	13.5	11.5	9.6
Entering/leaving a transitional world (tunnel-like experience)	38.5	17.3	25.0	11.5	7.7
Emerging into bright lights	55.8	13.5	9.6	17.3	3.8
Difficulty in speaking/putting thoughts into words	7.7	21.2	36.5	28.8	5.8
A sense of "seeing" the fabric of universe	46.2	17.3	23.1	9.6	3.8
Interactions with God-like or alien phenomena	55.8	17.3	23.1	1.9	1.9
Oneness: connected with others	26.9	19.2	26.9	19.2	7.7
Near-death experience(s)	73.1	7.7	7.7	7.7	3.8
Astral travel	69.2	13.5	13.5	0.0	3.8
Past/future revelations	50.0	17.3	13.5	11.5	7.7
Seeing additional world dimensions	38.5	17.3	26.9	5.8	11.5
Unexplainable transcendental experiences	13.5	15.4	25.0	25.0	21.2

positively correlated with total k-hole experiences, ($r = 0.354$, $p = .01$). Further analysis indicated that k-hole experiences correlated with the SPQ cognitive-perceptual subscale ($r = 0.282$, $n = 52$, $p < .05$) and the SPQ interpersonal subscale ($r = 0.297$, $n = 52$, $p < .05$), though not with the SPQ disorganised subscale ($p > .05$). SPQ total was not correlated with age at first use or average weekly expenditure (both $p > .05$). However, it

was positively correlated with number of times used ($r = 0.273$, $n = 52$, $p < .05$), and with our contrived measure of consumption ($r = 0.313$, $n = 51$, $p < .05$).

Schizotypy in Ketamine Users, Former Users, and Non-Users

There were no significant differences in either SPQ total or any of the three sub-scales between current and former ketamine users. When comparing ketamine users (past or present) with non-users, there was a trend toward increased schizotypy (SPQ total and each of the schizotypy sub-scales) in users, although this only reached statistical significance for the cognitive-perceptual sub-scale ($t = 2.07$; $df = 61$, $p = .04$); a result that would not have survived correction for multiple significance testing.

Discussion

In this study, we set out to "establish" an impression of ketamine-induced experiences in individuals familiar with the drug, many of whom continue to use it on a regular basis. Such respondents report a wide range of experiences encompassing both appetitive and aversive concurrent and after-effect phenomena, similar in scope to the reported experiences of recreational cannabis users. However, a crude comparison suggests that the "intensity" of ketamine-induced phenomena is more pronounced than experiences related to cannabis consumption. This "elevated" response pattern is apparent in each domain, but more pronounced in regard to negative/aversive experiences.

The use of a Likert scale to establish frequency of reported experiences both enriches and complicates the interpretation of our results. However, if we consider experiences endorsed "at least 50% of the time" (i.e., sometimes yes and sometimes no; more often than not, and almost always), the following pattern of reporting emerges: Amongst positive concurrent experiences, most users (84%) said that ketamine made them feel *happy*, and 71% said it gave them a sense of enhanced perceptual powers; 69% reported that ketamine made them feel excited, and 62% said it gave them a better understanding of the world; 81% and 73% respectively of respondents reported that ketamine made them feel relaxed, and laid back. More than half of the respondents said it made them feel full-of-plans (54%) and ecstatic (52%); 64% and 62% of the respondents respectively reported that ketamine increased their speed of thought and made them feel full-of-ideas.

Turning to negative/aversive experiences that were endorsed at least 50% of the time, 63% reported that ketamine induced delusional thinking, 81% indicated that it made their speech slurred, and 85% said it made time appear to slow down; 80% also reported that it loosened their grasp on reality, 75% said it induced anomalous visual imagery, and 63% reported that it affected somatosensation (things not feeling right on one's skin). Obsessive thoughts (54%), disturbed thinking (51%), and a sense of sadness (52%) were also endorsed by more than half of ketamine users.

In terms of after-effects, a strong impression of a ketamine-induced amotivational syndrome emerged: 68% of respondents said it made them not want to do anything, 77% felt de-motivated, and 79% reported that it made them feel slowed down both physically and emotionally. Almost as many reported that ketamine slowed down their thinking (73%) and adversely affected their ability to concentrate (70%); 69% reported that ketamine adversely affected their memory and 79% said it adversely affected their attention skills.

As for k-hole experiences, a sense of floating (71%), confusion (79%), and disturbed speech (71%) were frequently reported, as was the sense of things being unexplainable (also 71%). The more psychedelic phenomena of mind-body dissociation (66%), oneness

(57%), and a sense of peace and love (57%) were also reported by the majority of ketamine users. All the other k-hole experiences received less than 50% endorsement, with those that might be referred to as "out-of-this-world" such as encountering alien phenomena (27%), near-death experiences (19%), and astral travel (17%) receiving the lowest rates of endorsement.

Overall, our findings suggest that ketamine can reliably induce a "raft" of intense experiences including some that could be characterized as positive and negative psychotic-like features. However, it is important to remember that our data collection relied on checklists and self-reports rather than clinical interviews, and our impression is that unequivocal instances of ketamine-induced "first rank" phenomena (Schneider, 1958) were rarely reported. On the other hand, expansive and psychedelic/dissociative experiences were frequently reported, as were disturbances in speech, visual, and somatosensory perception. The most frequently endorsed ketamine experiences encompass various signs of intoxication and increased hedonistic tone overlaid with amotivational and marked dissociative features. The lower endorsement rate of positive and dissociative experiences in former users suggests that discontinuation (of use) may depend on a crude cost-benefit analysis of appetitive and aversive ketamine effects.

The emerging profile of ketamine-related experiences inevitably raises questions about the extent of the drug's psychotomimetic properties and, more generally, the status of NMDA antagonists as drug-models of functional psychosis (Javitt and Zukin, 1991; WHO, 2006). The clinical literature suggests that instances of "unambiguous ketamine-induced psychosis" are rare (Jansen, 1999), and that ketamine-related psychotic states are typically short-lived with complete resolution (Lahti et al., 2001). Doubts have also been raised about the extent to which ketamine can model the wide range of symptoms of schizophrenia (Abi-Saab, D'Souza, Moghaddam, and Krystal, 1998). While Krystal et al. (1994) reported that it could induce increases in both positive and negative features, others have only found increases in positive symptoms (Lahti, Koffel, LaPorte, and Tamminga, 1995), and even Krystal's group acknowledged that it was difficult to disentangle the negative features from the sedative effects of the drug (Krystal et al., 1998). The adoption of more effective psychological assessments is now beginning to clarify this situation: For example, Gouzoulis-Mayfrank et al. (2005) compared the effects of ketamine with those of the serotonergic agonist and hallucinogen dimethyltryptamine (DMT) in a cross-over study in healthy volunteers. The group reported that while DMT was more likely to induce positive psychotic features, ketamine was strongly associated with the induction of negative, cognitive, and amotivational features. In similar vein, Pomarol-Clotet et al. (2006) concluded that intravenously administered ketamine was likely to induce perceptual distortions but not true hallucinations, self-referential and delusional ideas, but no clear formal thought disorder, and negative rather than positive symptoms. We concur with these authors: Ketamine clearly induces aversive, dissociative, and anomalous experiences, particularly in the visual, and to a lesser extent, somatosensory domains. However, these generally lack the "conviction" of true psychotic features (Sims, 2002), and are, in any case, typically countered by concomitant appetitive experiences and hedonistic tone.

Our failure to find higher levels of schizotypy in ketamine users compared to non-users was not altogether surprising in view of the widespread level of "other" recreational drug use in the latter group. In fact, ignoring alcohol, 11/27 of this group did not report any other drug use, and they *did* evince lower levels of schizotypy than the ketamine user group, but the disparity in group sizes makes this statistical finding unreliable. Within the ketamine user group, schizotypy was modestly correlated with breadth and intensity of k-hole experiences (though not significantly with other concurrent or after-effect experiences) and, as predicted,

with total use and overall consumption. The relative absence of association between drug-induced experiences (the k-hole excepted) and schizotypy is at odds with our findings of associations between schizotypy and cannabis-induced experiences (Barkus, Stirling, Hopkins, and Lewis, 2006; Stirling et al., 2008). However, it is important to remember that cannabis use is comparatively widespread in young people, with at least 2/3 of the respondents in our recent studies having used it at least once, and many acknowledging regular use; compared to about one in 25 admitting to ketamine use. In other words, the comparison is not "like-for-like," and while we predicted an association between schizotypy and ketamine-induced experiences, social affiliations (such as involvement in the "dance" or "rave" scene), inclination toward poly-drug use, and other factors, such as sensation-seeking behaviour and even ease of access to drugs, appear to have undermined or confounded any general associations between ketamine-induced experiences and this aspect of personality.

Study's Limitations

In interpreting our findings, some notes of caution should be sounded. In pursuit of as-large-a-sample of ketamine users as possible, we opportunistically recruited respondents using a "snowball" technique, which provides little or no control over those who actually took part in our survey. We had no independent means of verifying current or past recreational drug consumption. Nor were we able to accurately quantify consumption other than in terms of frequency of use. No exclusion criteria were applied, and as we recorded minimal demographic details, we were not able, for example, to compare the effects of ketamine in individuals with/without a family history of mental illness. Any further survey of ketamine effects should take account of these methodological shortcomings.

On the other hand, we set out to establish a broad picture of the pre-eminent psychological effects of ketamine in recreational users by adapting a questionnaire measure previously employed only to assess the concurrent experiences and after-effects of cannabis, and in this respect achieved our aim. The KEQ clearly serves this purpose effectively. Like the CEQ, it is easy to understand, simple, and quick to complete and, with its adaptations, provides a useful "snap-shot" of the predominant effects of the drug. We are happy to make copies of it available on request.

Finally, in addition to these practical considerations, we have shown that the effects of ketamine (at recreational doses) are more subtle than often reported. Ketamine was, for example, as likely to induce fear, depression, and anxiety as cannabis. On the other hand, it was more likely to induce anomalous sensory, dissociative, and psychedelic experiences, disturbed thinking, impaired speech, and lethargy. Users also readily attested to its hedonistic properties of enhanced awareness, ecstasy, and euphoria. Such "mood-altering," amotivational, and dissociative effects chime with the views of Corlett et al. (2007) who have offered an alternative interpretation of the psychopathological effects of ketamine. In their view, rather than inducing a broad swathe of psychotic symptoms, a more accurate description of its effects for recreational users would be that it induces transient psychological changes similar to those seen in prodromal and very early stages of psychotic illness, during which delusional mood, perceptual distortions, and altered motivational state may predominate (Lencz, Smith, Auther, Correll, and Cornblatt, 2004).

Declaration of Interest

The authors report no conflict of interest. The authors alone are responsible for the content and writing of this paper.

RÉSUMÉ

Quantifiant Les Effects Psychologiques De La Ketamine: De l'euphorie au k-hole

En 2008, 52 utilisateurs de la Kétamine ont été recrutés de façon «opportuniste» afin de participer à une enquête, menée à Manchester en Angleterre, sur les effets psychologiques de cette drogue. 27 non-utilisateurs de la Kétamine ont également été recrutés afin de comparer l'utilisation d'autres drogues récréatives et le niveau de schizotypie. Les utilisateurs de la Kétamine ont attribué une large palette d'effets appétitifs et aversifs et des expériences de dissociation à la drogue. Ils ont également rapporté une utilisation beaucoup plus étendue d'autres drogues récréatives que les non-utilisateurs de la Kétamine. D'anciens utilisateurs rapportaient nettement moins d'expériences positives ou de dissociation que les utilisateurs.

RESUMEN

Cuantificando Los Efectos Psicologocos De Ketamina: euforia al k-agujero

52 consumidores de ketamina fueron alistados oportunisticamente para participar en una encuesta de los efectos psicológicos de la droga en Manchester, Inglaterra, en 2008. 27 encuestados no consumidores de ketamina también fueron alistados para una comparación con 'otras' drogas recreativas y nivel de esquizotipia. Consumidores de ketamina atribuyeron a la droga una amplia gama de experiencias aversivas, disociativas y efectos secundarios. También contaron que consumían una gama mucho más amplia de otras drogas recreativas que los no consumidores de ketamina. Ex consumidores de ketamina relataron significativamente menos experiencias positivas o disociativas que consumidores actuales.

THE AUTHORS

John Stirling has been a faculty member in psychology at Manchester Metropolitan University (MMU) for over 30 years, having graduated from London University and then from the University of York. This period of work has been interrupted only by a yearlong visiting professorship to CSU (Sacramento) in 1992/1993, and a research secondment to the University of Manchester from 2002–2005 He has also taught short courses in the United States, Belgium, Germany, Holland, and Hong Kong. His teaching has encompassed biopsychology, neuropsychology, psychopathology, statistics, and research methods.

His research interests have ranged widely from "the early predictors of psychosis outcome" to "cerebellar signs in dyslexia." He has published over 30 journal articles and is the author of three books, the most recent of which (*Introducing Neuropsychology*, cowritten with Rebecca Elliott) appeared as a fully revised second edition in June 2008. His current research interests focus on "the concept of the continuum of psychosis in the general population" and "the

psychotomimetic effects of recreational drugs." He is a senior visiting research fellow to the neuroscience and psychiatry unit at the University of Manchester.

Lauren McCoy graduated from MMU in 2009. In her final student year, supervised by JS, she conducted the research study on which this report is based. Following graduation, she worked as a volunteer social worker in Colombia (South America) for 6 months, and is now formally training for a career in social work in the United Kingdom.

Glossary

k-hole experiences: A cluster of psychedelic/dissociative experiences frequently reported by ketamine users, especially in relation to heavy use.

Passivity signs: A group of "psychological experiences" characterized by the sense of loss of self-agency, frequently reported by individuals diagnosed with a psychotic disorder.

Prodromal stages of psychotic illness: A period of distinct psychological disturbance preceding a full psychotic break that may last for several months, during which the individual may experience changes in perception, mood, and anxiety.

Psychotomimetic: A term (loosely) used to describe a drug that induces effects similar to those reported by people with a psychotic disorder.

Schizotypy: A "trait" measure of personality. People with high scores may report experiences and feelings that resemble, in certain respects, "attenuated" forms of psychotic signs and symptoms.

Uncompetitive NMDA antagonist: One of a groups of agents that blocks the ion channel (associated with the n-methyl d-aspartate receptor) that would otherwise be opened by the neurotransmitter glutamate.

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