Acute and subacute psychoactive effects of Kambô, the secretion of the Amazonian Giant Maki Frog (Phyllomedusa bicolor): retrospective reports

Timo Torsten Schmidt1,2, Simon Reiche2, Caroline L. C. Hage2, Felix Bermpohl3 & Tomislav Majić2,3*

Kambô, the secretion of the Amazonian Giant Leaf Frog (Phyllomedusa bicolor) contains a plethora of bioactive peptides and was originally used by indigenous communities from the Amazon basin as medicine for improving hunting capacities. In the last 20 years, Kambô has spread to Western urban healing circles. To date it is still controversial whether the acute effects of Kambô include alterations of consciousness similar to known psychoactive substance like serotonergic psychedelics. Here we retrospectively assessed psychological effects of Kambô in a sample of anonymous users (n = 22, mean age: 39 years, ± 8.5; 45.5% female), administering standardized questionnaires for the assessment of altered states of consciousness (ASC), including the Altered States of Consciousness Rating Scale, the Phenomenology of Consciousness Inventory (PCI), the Mystical Experience Questionnaire (MEQ), the Challenging Experience Questionnaire (CEO) for acute effects and the Persisting Effects Questionnaire (PEQ) and a scale assessing connectedness for subacute effects. The intensity of retrospectively reported acute psychological effects remained on a mild to moderate level, with no psychedelic-type distortions of perception or thinking. Conversely, persisting effects were predominantly described as positive and pleasant, revealing high scores on measures of personal and spiritual significance.

Kambô is the Matsé name for the secretion of the Giant Leaf Frog (Phyllomedusa bicolor), which is ritually used by different ethnicities in the Amazon basin of Brazil and Peru1. A variety of potent bioactive peptides have been identified in the frog’s secretion, including phyllocaerulein, phyllokinin, phyllomedusin, sauvagine, ceruletide2, adenoregulin, and the potent opioids dermorphin and deltorphin1. Kambô is obtained from the frog by carefully tying it up and rubbing its skin with a hard instrument, collecting the secretion on a wooden stick2. It has been emphasized that in most cases the frog is treated with utmost respect and caution, in order to not harm it, and released it to its natural habitat once that the secretion is collected3.

Kambô is most commonly applied by the applicator to the recipient via several fresh superficial burns (“dots”) on the arms, legs or chest4. It has been described that within minutes, the secretion likely enters the lymphatic system and subsequently the blood1, thereby inducing an intense reaction that includes hypotension, sweating, tachycardia, heavy vomiting and edema, usually subsiding within an hour6. This is followed by listlessness or sleep and, subsequently, a state “perhaps to be described as euphoric”1, characterized by increased stamina and clarity of thoughts with an increased capacity for hunting. In Amazonian indigenous communities, Kambô is used as a cleansing ritual to enhance the recipient’s hunting capacities once that cleansing has occurred and acute effects have subsided1. The recipient is thereby supposed to be liberated from “panema”, originally meaning “bad luck in hunting” or “bad principles”. Labate and Lima have pointed out, however, that the definition of “panema” has been broadened by urban Kambô practitioners, suggesting the notion of “Indian depression”5, accordingly making Kambô to a panacea to heal depression-like states and many other negative conditions and diseases.
During the last 20 years, Kambô has found its way to Western urban centers in Brazil and all over the world. From its Amazonian origins to its use in the context of Brazilian syncretic religions like the Santo Daime and the União do Vegetal and, finally, to its use in Western healing circles, Kambô has often been associated with the spread of the serotonergic psychedelic ayahuasca. Ayahuasca is an Amazonian shamanic concoction of different plants, including plants (e.g. Psychotria viridis) which contain the serotonergic psychedelic N,N-dimethyltryptamine (N,N-DMT) and Banisteriopsis caapi, which contain inhibitors of monoaminoxidase (MAO-I) that render N,N-DMT orally active. Notably, Kambô does not necessarily have to be applied by a shaman and is not considered as a shamanic ritual itself, in contrast to ayahuasca and other ritual plants, where use is restricted to a shamanic framework. During its spread to Western urban centers, however, the Kambô ritual has been transformed from a hunting ritual into therapeutic approaches and a neo-shamanic healing ritual, a process which has been labeled as "shamanization of Kambô".

In contrast to nature-derived serotonergic psychedelics, no serotonergic activity has been identified for Kambô up to date. However, the association with ayahuasca, is not the only connection to serotonergic psychedelics. Notably, different names used for the frog’s secretion include "Kambô", "kampu", "vaccino da floresta" and also "sapo", which incorrectly means "toad" in Spanish. This variability of the terms has sometimes led to a confusion of Kambô with the secretion of the Sonoran Desert Toad (Bufo alvarius), which is also referred to as "sapo". In contrast to Kambô, however, the toad’s secretion contains the potent serotonergic psychedelics 5-methoxy-N,N-dimethyltryptamine (5-MeO-DMT) and bufotenine, which is usually smoked or snorted, immediately inducing strong psychedelic experiences. Given the different application routes, the two substances are usually not confused by users, even though ceremonies where secretions from Kambô and Bufo alvarius are combined have recently been proposed in Western psychedelic circles.

Another interesting overlap between Kambô and the use of plant-derived psychedelics can be found in anecdotal reports describing beneficial after-effects on wellbeing, medical and mental health problems and personal and spiritual development—attributes which have previously been associated with the use of serotonergic psychedelics. Of note, the effects of serotonergic psychedelics underlie unique temporal dynamics, with distinct acute ("psychedelic experiences" or "states") and subacute effects ("afterglow phenomena") which can be conceptualized as states of "elevated and energetic mood with a relative freedom from concerns of the past and from guilt and anxiety", which are associated with an enhanced willingness "to enter into close interpersonal relationships", lasting between 2 weeks and a month. If these effects are comparable to the after-effects of Kambô is an open question.

Despite the close cultural and sub-cultural associations between the use of Kambô and different nature-derived psychedelics, no systematic characterization of the acute or subacute effects of Kambô has been reported. Here, we report results of a paper–pencil study among Kambô users employing standardized and validated questionnaires to retrospectively report acute and subacute effects of Kambô. As Kambô is typically applied with a healing purpose, the collected reports will be influenced by user’s expectations on positive effects, which might also be present in the given retrospective reports. The standardized assessment was intended to assess the pattern of effects (i.e. the relative strength of various consciousness aspects) and thereby allow a comparison to data from other psychoactive substances to answers in how far the effects of Kambô display similarities with serotonergic psychedelics.

Our study was designed to (1) systematically characterize the retrospective report of acute effects of Kambô, enabling a comparison to acute effects of e.g. plant-derived serotonergic psychedelics, (2) explore if Kambô displays subacute effects which might be comparable to the psychedelic afterglow phenomena, including retrospective appraisal of the experiences by the recipients.

Results
Sample characteristics. We received n = 27 sets of anonymously completed paper–pencil questionnaires via mail, n = 5 of which were excluded due to an insufficient reliability index in the Phenomenology of Consciousness Inventory (PCI; cut-off h > 2), leaving a final dataset of n = 22 for the first part of the study. The consecutive part of the study on the subacute effects of Kambô was completed by n = 14, where one participant’s Persisting Effects Questionnaire (PEQ) data and one participants’ CS data were excluded due to inappropriate completion, leaving for each n = 13 datasets.

The sample characteristics are summarized in Table 1. With regards to lifetime drug consumption, 15 participants (68.2%) reported experiences with serotonergic hallucinogens—e.g., lysergic acid diethylamide (LSD), N,N-DMT, 2,5-Dimethoxy-4-methylamphetamine (DOM)—and 19 (86.4%) reported experiences with ritual plants or traditional indigenous medicines (e.g., ayahuasca, peyote, San Pedro, psilocybin mushrooms, ibogaine, 5-MeO-DMT, bufotenin). Participants reported consumption of other psychotropic substances in their lifetime as follows: cannabis (n = 21, 95.5%), opioids (n = 7, 32.8%), cocaine (n = 10, 45.3%), amphetamine (n = 13, 59.1%), 3,4-Methyldioxy-N-methylamphetamine (MDMA) (n = 15, 68.2%), tranquilizer (n = 4, 18.2%).

Participants were asked to report on the importance of spiritual practices in their life on a scale from 0 (“not at all”) to 100 = “extraordinarily important”), which resulted in an average of 72.7% (±21.8%).

Retrospective reports of acute subjective effects of Kambô. The Kambô secretion was administered for n = 15 (68.2%) participants by an alternative health practitioner, western healer or “neo-shaman”. In n = 2 (9.1%) cases an indigenous shaman and in n = 3 (13.6%) cases a layperson was reported to have administered Kambô (n = 1 “other” and n = 1 not specified). N = 14 (63.6%) of the participants reported being the only client while receiving Kambô, while n = 7 (31.8%) received it in a group setting (n = 1 not specified). The setting and environment was described as follows: a healing place or temple (n = 11, 52.4%), at home (n = 4, 19.0%), in
Reports of acute effects of Kambô. In the first part of our study, we set out to test if users report the Kambô induced acute effects as altered states of consciousness (ASCs) comparable to psychedelics. The core of psychedelic experience is currently best assessed with the ASC rating scale, the most commonly used tool to assess drug-induced ASCs. It allows for characterization of subjective effects along 11 factors of change in conscious experience. Psychedelic experiences are typically characterized by high scores on the scales Elementary
17. In contrast, for Kambô we found only relatively low scores on these dimensions. Thus, our study demonstrates with standardized questionnaire data that the acute effects of Kambô are not reported to include effects on consciousness comparable to serotonergic psychedelics, especially no comparable effects are reported on perception and thinking.

Moreover, we applied the Mystical Experience Questionnaire (MEQ). This tool is used to test for the occurrence of spiritual/mystical experiences, which are thought to have the potential to facilitate conversions, attitude-changes, or even life-changes under special circumstances. High values of “full-blown” mystical experiences have been reported for several serotonergic psychedelics including LSD19, psilocybin20, and 5-MeO-DMT21. In our sample, few participants reported to have had experienced pronounced aspects of mystical experiences, reflected by relatively low mean scores on the four MEQ factors, with a few higher outlier datapoints. Even if Kambô effects cannot be compared to intense mystical experiences as reported after the use of serotonergic psychedelics22 with regard to intensity and completeness of the mystical state, our finding suggests that participants might have experienced psychological and spiritual effects beyond merely somatic reactions. However, this conclusion remains somewhat speculative, as expectational and setting factors could have contributed to these reports.

In order to explain Kambô’s potential therapeutic mechanisms of action, Hesselink and Winkelman10 proposed a conceptual model in which different aspects interact: (1) potent pharmacological effects of the various bioactive peptides, including effects on the autonomous and somatic nervous system (2) psychological effects of ritual frameworks and expectations associated with Kambô, and (3) symbolic and metaphorical aspects, associated with the experience of a strong physical, psychological and spiritual cleansing process induced by Kambô. This is in line with observations suggesting that the interplay between pharmacological effects and a spiritual perspective might underlie potential healing processes in Kambô7.

Given the complex interactions between pharmacological and non-pharmacological mechanisms, however, it remains speculative how specific peptides would relate to the reported psychological effects. Placebo-controlled studies investigating the individual components of Kambô would be needed to identify their contributions. Especially for the observed subacute effects it remains an interesting question for future research, if these are mediated by a direct pharmacological action or what more complex physiological mechanisms contribute to them.

The Challenging Experience Questionnaire (CEQ) includes self-report items designed for the investigation of challenging experiences under psilocybin and other serotonergic psychedelics. These include fear, grief, physical distress, insanity, isolation, fear of death and paranoia, which are symptoms that can occur in challenging experiences (also referred to as “bad trips”) under serotonergic psychedelics23. The challenging experiences reported

and Complex Imagery, Insightfulness, Spiritual Experience, Experience of Unity and Blissful State17. In contrast, for Kambô we found only relatively low scores on these dimensions. Thus, our study demonstrates with standardized questionnaire data that the acute effects of Kambô are not reported to include effects on consciousness comparable to serotonergic psychedelics, especially no comparable effects are reported on perception and thinking.

Moreover, we applied the Mystical Experience Questionnaire (MEQ). This tool is used to test for the occurrence of spiritual/mystical experiences, which are thought to have the potential to facilitate conversions, attitude-changes, or even life-changes under special circumstances. High values of “full-blown” mystical experiences have been reported for several serotonergic psychedelics including LSD19, psilocybin20, and 5-MeO-DMT21. In our sample, few participants reported to have had experienced pronounced aspects of mystical experiences, reflected by relatively low mean scores on the four MEQ factors, with a few higher outlier datapoints. Even if Kambô effects cannot be compared to intense mystical experiences as reported after the use of serotonergic psychedelics22 with regard to intensity and completeness of the mystical state, our finding suggests that participants might have experienced psychological and spiritual effects beyond merely somatic reactions. However, this conclusion remains somewhat speculative, as expectational and setting factors could have contributed to these reports.

In order to explain Kambô’s potential therapeutic mechanisms of action, Hesselink and Winkelman10 proposed a conceptual model in which different aspects interact: (1) potent pharmacological effects of the various bioactive peptides, including effects on the autonomous and somatic nervous system (2) psychological effects of ritual frameworks and expectations associated with Kambô, and (3) symbolic and metaphorical aspects, associated with the experience of a strong physical, psychological and spiritual cleansing process induced by Kambô. This is in line with observations suggesting that the interplay between pharmacological effects and a spiritual perspective might underlie potential healing processes in Kambô7.

Given the complex interactions between pharmacological and non-pharmacological mechanisms, however, it remains speculative how specific peptides would relate to the reported psychological effects. Placebo-controlled studies investigating the individual components of Kambô would be needed to identify their contributions. Especially for the observed subacute effects it remains an interesting question for future research, if these are mediated by a direct pharmacological action or what more complex physiological mechanisms contribute to them.

The Challenging Experience Questionnaire (CEQ) includes self-report items designed for the investigation of challenging experiences under psilocybin and other serotonergic psychedelics. These include fear, grief, physical distress, insanity, isolation, fear of death and paranoia, which are symptoms that can occur in challenging experiences (also referred to as “bad trips”) under serotonergic psychedelics23. The challenging experiences reported

and Complex Imagery, Insightfulness, Spiritual Experience, Experience of Unity and Blissful State17. In contrast, for Kambô we found only relatively low scores on these dimensions. Thus, our study demonstrates with standardized questionnaire data that the acute effects of Kambô are not reported to include effects on consciousness comparable to serotonergic psychedelics, especially no comparable effects are reported on perception and thinking.

Moreover, we applied the Mystical Experience Questionnaire (MEQ). This tool is used to test for the occurrence of spiritual/mystical experiences, which are thought to have the potential to facilitate conversions, attitude-changes, or even life-changes under special circumstances. High values of “full-blown” mystical experiences have been reported for several serotonergic psychedelics including LSD19, psilocybin20, and 5-MeO-DMT21. In our sample, few participants reported to have had experienced pronounced aspects of mystical experiences, reflected by relatively low mean scores on the four MEQ factors, with a few higher outlier datapoints. Even if Kambô effects cannot be compared to intense mystical experiences as reported after the use of serotonergic psychedelics22 with regard to intensity and completeness of the mystical state, our finding suggests that participants might have experienced psychological and spiritual effects beyond merely somatic reactions. However, this conclusion remains somewhat speculative, as expectational and setting factors could have contributed to these reports.

In order to explain Kambô’s potential therapeutic mechanisms of action, Hesselink and Winkelman10 proposed a conceptual model in which different aspects interact: (1) potent pharmacological effects of the various bioactive peptides, including effects on the autonomous and somatic nervous system (2) psychological effects of ritual frameworks and expectations associated with Kambô, and (3) symbolic and metaphorical aspects, associated with the experience of a strong physical, psychological and spiritual cleansing process induced by Kambô. This is in line with observations suggesting that the interplay between pharmacological effects and a spiritual perspective might underlie potential healing processes in Kambô7.

Given the complex interactions between pharmacological and non-pharmacological mechanisms, however, it remains speculative how specific peptides would relate to the reported psychological effects. Placebo-controlled studies investigating the individual components of Kambô would be needed to identify their contributions. Especially for the observed subacute effects it remains an interesting question for future research, if these are mediated by a direct pharmacological action or what more complex physiological mechanisms contribute to them.

The Challenging Experience Questionnaire (CEQ) includes self-report items designed for the investigation of challenging experiences under psilocybin and other serotonergic psychedelics. These include fear, grief, physical distress, insanity, isolation, fear of death and paranoia, which are symptoms that can occur in challenging experiences (also referred to as “bad trips”) under serotonergic psychedelics23. The challenging experiences reported
|                          | Mean | SD  | T    | p   |
|--------------------------|------|-----|------|-----|
| **5D-ASC**               |      |     |      |     |
| Total ASC score          | 13.0 | 12.4| 4.94 | 0.000|
| Oceanic Boundlessness    | 19.1 | 21.2| 4.22 | 0.000|
| Dread of Ego Dissolution | 10.5 | 11.5| 4.26 | 0.000|
| Visionary Restructualizartion | 7.0 | 10.0| 3.26 | 0.002|
| Auditory Alterations     | 3.4  | 6.3 | 2.57 | 0.009|
| Vigilance Reduction      | 20.5 | 17.3| 2.84 | 0.005|
| **11-ASC**               |      |     |      |     |
| Experience of Unity      | 18.7 | 26.8| 3.27 | 0.002|
| Spiritual Experience     | 24.8 | 26.3| 4.42 | 0.000|
| Blissful State           | 23.5 | 28.0| 3.94 | 0.000|
| Insightfulness           | 12.0 | 19.2| 2.93 | 0.004|
| Disembodiment            | 9.7  | 15.7| 2.89 | 0.004|
| Impaired Control and Cognition | 9.1 | 13.6| 3.15 | 0.002|
| Anxiety                  | 7.1  | 9.6 | 3.47 | 0.001|
| Complex Imagery          | 9.4  | 16.4| 2.68 | 0.007|
| Elementary Imagery       | 8.1  | 15.5| 2.46 | 0.011|
| Audio-Visual Synesthesia | 11.6 | 13.1| 4.15 | 0.000|
| Changed Meaning of Percepts | 8.3 | 13.9| 2.82 | 0.005|
| **PCT**                  |      |     |      |     |
| Altered State of Awareness | 2.4 | 1.9 |      |     |
| Altered Experience       | 1.9  | 1.4 |      |     |
| Volitional Control       | 2.9  | 1.1 |      |     |
| Self-Awareness           | 4.7  | 1.1 |      |     |
| Rationality              | 4.3  | 1.1 |      |     |
| Internal Dialogue        | 0.7  | 1.4 |      |     |
| Positive Affect          | 1.4  | 1.1 |      |     |
| Negative Affect          | 1.1  | 1.1 |      |     |
| Imagery                  | 1.6  | 1.2 |      |     |
| Attention                | 4.5  | 0.9 |      |     |
| Memory                   | 4.4  | 1.3 |      |     |
| Arousal                  | 2.7  | 1.9 |      |     |
| Body Image               | 1.8  | 1.5 |      |     |
| Time Sense               | 2.2  | 1.8 |      |     |
| Perception               | 1.0  | 1.1 |      |     |
| Meaning                  | 2.3  | 1.7 |      |     |
| Joy                      | 1.5  | 1.7 |      |     |
| Sexual excitement        | 2.5  | 1.8 |      |     |
| Love                     | 0.6  | 1.4 |      |     |
| Anger                    | 0.6  | 1.4 |      |     |
| Sadness                  | 0.8  | 1.2 |      |     |
| Fear                     | 1.9  | 1.9 |      |     |
| Imagery amount           | 1.0  | 1.3 |      |     |
| Imagery vividness        | 2.3  | 1.7 |      |     |
| Direction of attention   | 4.3  | 1.2 |      |     |
| Absorption               | 4.8  | 1.0 |      |     |
| **MEQ**                  |      |     |      |     |
| Mystical                 | 25.7 | 25.1| 4.79 | 0.000|
| Positive Mood            | 33.5 | 26.4| 5.95 | 0.000|
| Transcendence of time and space | 20.2 | 21.8| 4.34 | 0.000|
| Ineffability             | 46.1 | 27.0| 8.01 | 0.000|
| Total Score              | 28.5 | 23.4| 5.72 | 0.000|
| **CEQ**                  |      |     |      |     |
| Fear                     | 18.2 | 21.9| 3.53 | 0.001|
| Grief                    | 23.5 | 27.1| 3.68 | 0.001|
| Physical Distress        | 54.0 | 17.9| 8.07 | 0.000|

Continued
for acute effects of Kambô were mostly limited to “physical distress”. Challenging experiences of a rather psychological nature were barely reported—suggesting unspecific fearful reactions to the strong vegetative effects, but without induction of psychedelic-type psychological crises including insanity, isolation, death or paranoid ideation in the sense of “bad trips”, reflecting distortions of ego functions and self-processing. In addition to the risk of fearful physical reactions, a few case reports have been published highlighting severe complications that might have been associated with Kambô use, including psychological problems like a case of psychosis24, and physical side effects like dermatomyositis25, toxic hepatitis26 and a case of sudden death27 possibly related to Kambô. In addition, several cases of hyponatraemia28,29 and syndrome of inappropriate antidiuretic hormone secretion (SIADH)30 have been reported, probably associated with excessive water intake during some Kambô ceremonies.

Ratings on the PCI allow for comparison of Kambô experiences with hypnosis or meditation techniques to investigate potential shared aspects. Similar to hypnotic or meditative states, participants reported to have experienced a reduction of positive and negative affect31. With regard to the question if or how Kambô elicits psychoactive effects, it is noteworthy that the obtained scores on “self-awareness”, “rationality”, “attention” and “memory” indicate that the participants did not feel confused or muddled—at least according to their retrospective memory of the state—which would be expected from centrally active drugs like alcohol or barbiturates.

Table 2. Group level summary statistics for acute effects. N = 22; To allow comparison with previous datasets mean ± SD for all group level scores of the applied questionnaires are provided. For the SD-ASC, the ASC in its 11 factor analysis, MEQ, CEQ scores, we performed one sample t-tests (df = 21) against zero and provide p-values. Please note that data is reported in its completeness and raw significance values are reported instead of significance thresholding. The scores of the ASC, MEQ and CEQ are designed to assess differences from zero, while the PCI items are anchored with two opposing statements (See “Methods”) to the end of the scale [0: minimum; 6: maximum], therefore not being tested against zero.

|                  | Mean | SD  | T   | p   |
|------------------|------|-----|-----|-----|
| Insanity         | 7.6  | 14.6| 2.20| 0.021|
| Isolation        | 9.4  | 17.3| 2.30| 0.017|
| Death            | 8.6  | 21.0| 1.74| 0.050|
| Paranoia         | 0.5  | 2.1 | 0.90| 0.189|

Figure 2. Subacute subjective effects of Kambô. Subacute effects (n = 13) were assessed with the PEQ and the CS and are displayed as box plots for the dimensions or items of the two questionnaires. In comparison to Table 3, the box plots provided here illustrate the data distribution.
assessment in the present study indicates that Kambô induces a state of self-centered inwardness. The pattern of responses does not match with typical characteristics of psychedelic-induced states. Although the pharmacodynamics of the Kambô secretion have only been partially investigated, it has been suggested that Kambô’s pharmacological effects are restricted to the cardiovascular, gastroenterological, endocrine and immune systems, the autonomic nervous system and the endogenous opioid system\(^\text{10}\). On the one hand, this appears to be plausible given the compounds’ peptide structures which prevent them from passing the blood–brain barrier. On the other hand, the authors hypothesize that the neuropeptide opioids in Kambô (dermorphin and deltorphin) could be responsible for the observed “alterations of consciousness”, suggesting psychoactive effects. However, given the neuropeptide structure, these opioids have been reported to be centrally active via intrathecal application only. In addition, the reported acute and subacute effects of Kambô resemble stimulant effects rather than those of substances with mu-receptor activity. Thus, the given reports of acute and subacute effects in our sample are divergent from known psychoactive effects of mu-receptor agonists, suggesting that other compounds or complex interactions between vegetative, neuro-endocrinological and psychological effects might be considered as underlying biological correlates of the Kambô experience. Nevertheless, to date no compounds have been identified that could explain the induction of an ASC during the acute period of Kambô effects and no such phenomena were reported by our participants.

The subacute effects of Kambô. In the second part of our study, we retrospectively investigated subacute effects of Kambô up to 2–3 weeks after the reported exemplary session to find first indications if these effects were comparable to psychedelic afterglow phenomena (See\(^\text{15}\)). Since no systematic characterization of afterglow phenomena exists to date, even for psychedelics, a quantitative comparison was not possible. Therefore, as a

| Persistent Effects Questionnaire (PEQ)                      | Mean  | SD     | T     | p    |
|------------------------------------------------------------|-------|--------|-------|------|
| Positive attitudes about life or self                       | 56.6  | 18.7   | 10.89 | 0.000|
| Negative attitudes about life or self                       | 3.7   | 6.6    | 2.02  | 0.033|
| Positive mood changes                                       | 58.1  | 25.9   | 8.10  | 0.000|
| Negative mood changes                                       | 0.8   | 2.8    | 1.00  | 0.169|
| Altruistic/positive social effects                          | 47.5  | 23.2   | 7.38  | 0.000|
| Antisocial/negative social effects                          | 6.2   | 9.1    | 2.44  | 0.016|
| Positive behaviour changes                                  | 64.6  | 27.3   | 8.54  | 0.000|
| Negative behaviour changes                                  | 6.2   | 17.1   | 1.30  | 0.109|

Table 3. Group level summary statistics for subacute effects. Note that data (n = 13, each for CS and PEQ) is reported in its completeness and raw significance values are reported instead of significance thresholding. For the PEQ scores we performed t-tests against zero and provide p-values.
first description of the subacute effects we used the PEQ, previously applied to characterize psychedelic effects mainly in therapeutic contexts. Additionally, we used a questionnaire measuring connectedness, which has not yet been validated.

Notably, subacute effects of Kambô were appraised very positively, including factors of “positive attitudes”, “positive mood”, “altruistic” and “positive behavioral changes”, whereas negative aspects have been reported to be negligible. This is in line with observations describing a euphoric state after the acute effects of Kambô have subsided. Moreover, subacute effects involved dimensions of mood, overall wellbeing, but also aspects on a spiritual and transpersonal level. The intensity of subacute positive effects was pronounced, even if not as intense as after-effects of LSD or psilocybin.

Interestingly, the ratings of items describing connectedness to internal aspects of oneself were high in our sample, such as being connected to “my senses”, “a range of emotions”, “my body”, “deeper aspects of myself” and “insight/intuition”, and to “have been fully able to experience emotion, whether positive or negative”. In contrast, ratings of items referring to connectedness to external aspects (e.g. “a community”, “strangers”, “all humanity”, “a purpose in life”, “spiritual essence” and “a source of universal love”) were far less pronounced, except for the experience of being “connected to nature”. This is in line with anecdotal observations including participants’ subjective experiences of an active interaction with a frog’s “spirit”, which detects and eliminates toxins and bad energy from their mind and body. However, this finding is only partially comparable to mystical experiences associated with acute and subacute effects of serotonergic psychedelics, where states of increased connectedness to both the self and other beings have been reported (i.e. the notion that “everything is interconnected”). Notably, even if the subacute effects were not comparable to those reported after the use of serotonergic psychedelics regarding intensity and qualitative aspects, some of the phenomena which outlasted the acute effects were surprisingly intensive and complex, showing overlaps with psychedelic “afterglow phenomena”, including increases in positive mood, behavior, attitudes and social interaction.

Limitations
The effects of Kambô reported by our study participants could partially be related to the ritualistic setting of consumption. Our data were collected retrospectively from a group of Western Kambô users recruited through a public workshop on Kambô and a group of practitioners devoted to a specific ritual setting. This might have induced a bias of expectations or motivations for use and thereby involved the placebo dimension. The observed variability in the assessed acute effects suggests that expectational factors and setting might have played a role for some reports. In order to make final conclusions about the psychoactive properties of Kambô, randomized placebo-controlled trials are necessary.

Conclusion
Our data shows that the retrospective reports of acute Kambô effects are very different from the effects of serotonergic psychedelics. While the acute effects of Kambô were reported to be dominated by strong physical reactions followed by a state of increased inwardness, psychedelic effects appear to facilitate loosening of ego barriers and increased connectedness with oneself and the outer world. Our findings are congruent with anecdotal reports that the subacute effects of Kambô include feelings of being energized with increased stamina and clarity of thoughts, following an initial state of physical sickness and exhaustion. Nevertheless, subacutely, Kambô does exhibit some overlap with serotonergic psychedelics in regard to the reported “afterglow” phenomenon. This finding is remarkable given the unique temporal dynamics of subacute psychedelic effects, incomparable to any other group of psychoactive substances, Kambô thereby appears to be associated with afterglow-like effects, but without preceding psychedelic states. In agreement with our findings, it has been suggested that the transformative and transpersonal effects of Kambô might be comparable to those associated with the use of serotonergic psychedelics.

Methods
Participants and procedure. All data of this study was collected anonymously. Potential participants were recruited at a drug information event in Berlin and through Kambô practitioners who forwarded study material to their clients. Participants were informed about the study aim and that data collection is fully anonymously. They were handed out a printed set of paper/pencil-questionnaires together with a pre-paid envelope for returning completed sets of questionnaires and gave consent by filling the questionnaire and sending it back anonymously. All procedures were conducted in accordance with the Declaration of Helsinki and were approved by the Ethics committee of the Charité Universitätsmedizin Berlin (EA2/185/17). All questionnaires were applied in German. The first set of questions addressed person specific characteristics, such as age, gender and drug consumption history.

Apart from questions referring to demographic information, a set of questionnaires was given to the participants that comprised the following two parts: (1) questionnaires on the acute effects of an exemplary Kambô session, (2) questionnaires on subacute effects of the exemplary Kambô session. All participants were requested to fill in demographic information and (1). Participants were asked to fill in (2) only if the exemplary Kambô session that they reported about in (1) happened between 2 and 3 weeks ago, as the questions on the acute effects addressed this period after the Kambô session.

As exclusion criterion for data of insufficient quality we used the reliability index (h) of the PCI, which is a measure for the participants consistency in completing the questionnaire.

Assessment of acute subjective effects of Kambô. The second set of questions comprised four well established and validated psychometric tools to assess acute subjective experiences of consciousness alterations:
Altered States of Consciousness (ASC) Rating Scale: The ASC rating scale originated from two former versions, the initial APZ (Abnormal Mental States; GERMAN: Abnorme Psychische Zustände) and the revised version OAV and has become one of the most frequently used questionnaires in the assessment of altered states of consciousness phenomena. The ASC rating scale is supposed to investigate characteristics of consciousness alterations that are invariant across various conditions including both pharmacological (e.g., psilocybin, ketamine, DMT) and behavioral induction methods (e.g., sensory deprivation, hypnosis, autogenic training). Over the course of more than 30 years, the questionnaire underwent several refinements finally leading to the currently used version which comprises 94 items. Currently two different analysis schemata are used: the original 5-dimensional scheme (5D-ASC) and the 11-factorial scheme (11-ASC).

Phenomenology of Consciousness Inventory (PCI): The PCI was developed in the context of an interdisciplinary approach described as empirical-phenomenology. Most notably influenced by Tart and conception of ASCs, where different states are characterized by distinct structures and patterns of the subjective experience. The PCI assesses subjective experiences along multiple dimensions, where corresponding scales were constructed on the basis of several cluster and factor analyses. Items are presented as two opposing statements (e.g. “I felt ecstatic and joyful”—“I felt no feelings of being ecstatic and joyful”) located on the two poles of a 7-point Likert scale. We used the German version by Rux (2002).

Mystical Experiences Questionnaire (MEQ): The MEQ was first used in the ‘Good Friday Experiment’, where it was intended to assess differences regarding aspects of mystical experience between a group taking psilocybin and a control group taking a placebo. Since then, the MEQ has been applied as an instrument for the quantitative assessment of pharmacologically induced mystical experience. Items of the MEQ were chosen based on literature about mysticism including first-person accounts as well as theoretical work, most notably by W. James (1902) and W. T. Stace (1960). The initial MEQ has been further developed by Pahnke (1969), Richards (1975), Griffiths et al. (2006, 2011), and MacLean et al. (2012). The most recent version is the MEQ30, a condensed version of the MEQ with thirty items and four empirical scales.

Challenging Experiences Questionnaire (CEQ): The CEQ was designed to provide a tool for the comprehensive assessment of acute negative effects of temporarily induced altered states of consciousness, based on three questionnaires: Hallucinogenic Rating Scale (HRS), 5D-ASC, and States of Consciousness Questionnaire (SOCQ). The conceptual scope of the 26-item CEQ is informed by literature on psychological and physical distress following hallucinogen intake and covers a variety of adverse cognitive, affective, and somatic reactions which are clustered into seven distinct dimensions of challenging experiences. Analyzing data from an online survey on negative experiences with psilocybin, corresponding scales for the first six dimensions were derived by exploratory factor analysis, complemented by the Paranoia scale, and subsequently validated through confirmatory factor analysis. Items are rated on a 6-point scale adopted from the SOCQ.

Assessment of subacute subjective effects of Kambô. The third set of questionnaires addressing subacute effects was introduced with the instructions to fill out the following questionnaires only if the exemplary Kambô session (for which the acute effects were reported) had happened up to 3 weeks before the day of completing the questionnaire. The set of questions comprised the following two questionnaires:

Items about Connectedness: We used a previously unpublished set of 23 questions to measure different aspects of connectedness. The items include aspects of connectedness to one’s self, connectedness to the universe and connectedness to others. The items stem from the development of a connectedness scale (CS). As no validation or confirmation of a factor structure had been published until now, the scores on this scale are presented for the individual items.

Persisting Effects Questionnaire (PEQ): The PEQ was developed as a follow-up questionnaire to the States of Consciousness Questionnaire (SOCQ), which was an intermediate version of the MEQ. The PEQ assesses long-term changes in participants. We used a German version of the extended PEQ version reported in. This version uses 140 items rated on a 6-point Likert scale from 0 (‘not at all’) to 5 (‘extremely’), and three items on the retrospective assessment of the importance and effects of the experiences.

Data analysis and visualization. Questionnaire data were analyzed using standardized analysis sheets. Data visualization was performed with RStudio v.1.2.1335 and package ggplot2 v.3.2.1. Boxplots represent the lower and upper hinges corresponding to the first and third quartiles (the 25th and 75th percentiles), the median as a horizontal bar and the whiskers indicate the range of the data (limited to 1.5 times interquartile range). Discrete individual data points are shown as green dots. To display overlapping data points the size of the dots represents the number of observations at each value. Data points not lying within the range of the whiskers are outliers. The mean, without any outlier exclusion, is displayed as a diamond shape. For comparability with previous reports, the means and SD for all questionnaire data are provided in Table 2 (without outlier exclusion).

Data availability
Data is available upon personal request.

Received: 20 June 2020; Accepted: 20 November 2020
Published online: 09 December 2020

References
1. Daly, J. et al. Frog secretions and hunting magic in the upper Amazon—Identification of a peptide that interacts with an adenosine receptor. Proc. Natl. Acad. Sci. USA 89(22), 10960–10963. https://doi.org/10.1073/pnas.89.22.10960 (1992).
42. Tart, C.T. States of consciousness and state-specific sciences. Science 176(4040):1203–1210. https://doi.org/10.1126/science.176.4040.1203 (1972).

43. Rux. Erprobung der deutschen Übersetzung des Phenomenology of Consciousness Inventory von Pekala: Normwerte, Gütekriterien, Änderungsvorschläge. 2002.

44. Pahnke, W.N. Drugs and Mysticism: An Analysis of the Relationship between Psychedelic Drugs and the Mystical Consciousness (Harvard University Press, Cambridge, 1963).

45. Pahnke, W.N. Drugs and mysticism. Int. J. Parapsychol. 8, 295–314 (1966). http://docs.google.com/a/religionandcognition.com/fileview?id=F.9d41d6a0-0d13-4dc4-b719-04218b36d632.

46. MacLean, K.A., Leoultakos, J.M.S., Johnson, M.W. & Griffiths, R.R. Factor analysis of the mystical experience questionnaire: A study of experiences occasioned by the hallucinogen psilocybin. J. Sci. Study Relig. 51, 721–737. https://doi.org/10.1111/j.1468-5906.2012.01685.x (2012).

47. Barrett, F.S. & Griffiths, R.R. The factor structure of the Mystical Experience Questionnaire (MEQ): Reply to Bouso et al. (2016). Hum. Psychopharmacol. 32(1), 2564. https://doi.org/10.1002/hup.2564 (2016).

48. Barrett, F.S., Johnson, M.W. & Griffiths, R.R. Validation of the revised Mystical Experience Questionnaire in experimental sessions with psilocybin. J. Psychopharmacol. https://doi.org/10.1177/0269881115609019 (2015).

49. Barrett, F.S., Bradstreet, M.P., Leoultakos, J.M.S., Johnson, M.W. & Griffiths, R.R. The Challenging Experience Questionnaire: Characterization of challenging experiences with psilocybin mushrooms. J. Psychopharmacol. 30(12), 1279–1295. https://doi.org/10.1177/0269881116678781 (2016).

50. Watts, R., Day, C., Krzanowski, J., Nett, D. & Carhart-Harris, R. Patients’ accounts of increased “connectedness” and “acceptance” after psilocybin for treatment-resistant depression. J. Human. Psychol. 57(5), 520–564 (2017).

Acknowledgements
The authors would like to thank Tobias Thon† for help in recruitment of participants and Amy Romanello for proof reading of the manuscript.

Author contributions
T.T.S. and T.M. designed the study. T.T.S., C.H. and S.R. analyzed the data, S.R. designed figures and tables and T.T.S., T.M. and F.B. wrote the manuscript. All authors edited the manuscript and approved its final version. All authors agreed to be personally accountable for their own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

Funding
Open Access funding enabled and organized by Projekt DEAL.

Competing interests
The authors declare no competing interests.

Additional information
Correspondence and requests for materials should be addressed to T.M.

Reprints and permissions information is available at www.nature.com/reprints.

Publisher’s note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

© The Author(s) 2020