Original Article

PSYCHOLOGICAL EXPLORATIONS OF THE MAGIC MUSHROOM (PSILOCYBIN) EXPERIENCE, PART I: *SUBJECTIVE EFFECTS AND TIME PASSAGE PERCEPTION*

Explorações Psicológicas da Experiência com Cogumelos Mágicos (Psilocibina), Parte I: Efeitos Subjetivos e Passagem Subjetiva do Tempo

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ABSTRACT

Magic mushrooms are rich in the active compound psilocybin, whose activity on consciousness deeply alters cognitive functions, can promote spiritual/mystical experiences and has high biomedical and psychotherapeutic importance. Twenty-eight participants underwent a magic mushroom experience after consuming dehydrated Psilocybe cubensis mushrooms at the dosage of 55.6 mg/Kg (350 µg/kg of psilocybin). Results of subjective aspects of the experience through the Hallucinogen Rating Scale revealed equivalent dosage effects comparable to other studies and similar to those of the psychedelic beverage Ayahuasca. The effects on subjective perception of time duration verified an underestimation of the velocity of temporal passage by participants after substance intake, in which subjects presented longer subjective durations of seconds. Results are discussed in the context of literature produced in the psychopharmacological and cognitive fields.

KEY WORDS: Time experience; Hallucinogens; Psychedelics; Psychotomimetics; Cognition.

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RESUMO

Os cogumelos mágicos são ricos em psilocibina, psicoativo responsável por promover alterações na consciência e percepção, podendo promover experiências místicas/espirituais e com atual importância biomédica e psicoterapêutica. Vinte e oito pessoas no total participaram do estudo, conduzido em grupos. Os resultados acerca dos aspectos subjetivos mensurados pela Escala de Avaliação Alucinogênica (HRS-Test) mostraram achados similares com outras pesquisas para a dosagem utilizada, bem como similaridade de efeitos com a bebida ayahuasca. Os participantes apresentaram subestimação da passagem subjetiva do tempo após o consumo dos cogumelos, realizando durações subjetivas de segundos mais longos que o pré-teste. Os resultados são discutidos de acordo com a literatura produzida no campo da psicofarmacologia e cognição.
PALAVRAS-CHAVE: Experiência temporal; Alucinógenos; Psicodélicos; Psicotomimético; Cognição.

INTRODUCTION

Magic mushrooms of the genus *Psilocybe* are psychoactive fungi found in some places in the world (1), including Brazil (2, 3). Human consumption of magic mushrooms stretches back to pre-history and has traditionally accompanied magic rituals in American cultures (4-9). The role of the consumption of these and other substances with psychoactive activity on the evolution of the human mind could have been relevant (10, 11).

Psilocybe mushrooms have the active compounds psilocybin and psilocin, which act as agonists to serotonin receptors (5-HT, 5-hydroxytryptamine), causing modifications in sensorial perception, mood, emotion, memory and cognitive processes (12). Contemporary use/abuse of these mushrooms occurs mainly in a recreational mode, but epidemiological studies in Brazil could not register an important occurrence of abuse (13-16).

The complexity of effects on consciousness caused by psilocybin and analogous substances (e.g. DMT, LSD, mescaline) was better expressed in the past by use of the term *psychedelic* (mind-altering). Others terms like hallucinogenic (causing perceptions without a real base), psychotomimetic (psychosis mimesis) and entheogen ("God within") are also used in the literature (12, 17, 18).

Recently, it still has been necessary to define what a psychedelic experience could be (19, 20). Due to the unique peculiarity of these substances on mental processes, they are becoming important tools to investigate biological correlations of altered states of consciousness, exploration of psyche and also as facilitators of psychotherapy (12, 21-26).

The ability of psilocybin to diminish the capacity of subjects to use contextual information has been seeing as an indicator of an increase in creativity. In short, it could be explained as an amplification of consciousness that permits subject to realize unusual semantic relationships of information or content. In this way, subjective experience reflects an increase in creativity with parallel decrease of performance in objective measures under the state of altered consciousness, making remote mental associations more accessible (27, 28). The increase in intrusive information from internal and external orders to cortical areas, by this amplification of consciousness, can be interpreted as an amplification or increase of conscious information processing (24, 25).

Alterations of psilocybin action on subjective perception of time were observed. Studies found difficulties/deficiencies of the subjects in accurately determining intervals of time. The alterations found indicate an incapacity to keep synchronization or correctly reproduce intervals of time, showing a

tendency toward slower subjective time ratings (29, 30).

PET studies (*Positron Emission Tomography*) have demonstrated that psilocybin, by serotonergic action, promotes hyper-frontality, i.e., an increase of neuronal activation in the prefrontal cortex and the brain as a whole (25, 31, 32). It is believed that a primary or secondary imbalance of neurotransmission by psychedelics affects the mechanism responsible for information processing and "filtering" of sensorial information, causing increased information intrusion to the system and consequent hyper-activation of the prefrontal cortex (24, 25, 32, 33).

Research done on psilocybin focused on visual processes has shown its ability to induce illusions of global motion of static objects or of textured surfaces. This is explained as due to the regulation of visual process by serotonin receptors in visual areas of the brain, on which psilocybin acts (34). The influence of serotonin receptors on attention mechanisms concerned with binocular rivalry have been demonstrated, whose substantial action results in a decrease of interruption rates and increase of transition and confusion of perceptual experience (35). Significant results on perceptual rivalry on Tibetan monks after meditation were similar to those found for psilocybin (36), suggesting a qualitative similarity of functioning between psychedelic states and meditative/mystical states, as suggested by some researchers (37-46).

Some fMRI (functional magnetic resonance imaging) studies point to the importance of physiological regulation of serotonin receptors 5-$HT_{1A/2A}$ on attention brain processes by frontal cortex activity (47). Carter et al. (2005) have shown the action of psilocybin on reducing attention on the ability of object tracking, that suggests an independence between attention and working memory, normally attributed to be functionally dependent mechanisms, or that co-dependence of these mechanisms is more limiting than suggested by the current literature (48).

Studies with psychedelics seem to present a common root with psychopathologies. This idea has existed in science since the early studies with these substances began a century ago (49). Contemporary studies are still investigating the relationships of psychedelic and schizophrenic conscious states (12, 24, 25, 31, 50).

Psychopharmacology studies with psilocybin and analogous substances are one of several research spheres of human cognition. All of which contribute to elucidating mental/neuronal functioning in uncommon states of consciousness like psychopathology, religious experience, mind/self-transformations and psychotherapy (21, 51). Therefore, investigations with psilocybin have been developed in scientific fields concerned with perception, neuroimaging, neurotheology, language, psychology and psychotherapy. Such research constitutes an important tool for understanding brain functioning under psychedelic states as well as psychological processes in general. Our study is the first exploratory study developed in Brazil with *Psilocybe* mushrooms on humans, according to our literature review. Here, we present some subjective results exploring viability of developing psychological investigations of a special state of consciousness promoted by magic mushroom consumption and their impacts for our understanding of human mind functioning.

METHODOLOGY

Volunteers

Volunteers were solicited by the distribution of pamphlets and word-of-mouth at the Federal University of Pernambuco (UFPE). Selected participants were contacted by e-mail and/or phone and requested to appear at a later date to complete questionnaires, clarifying research information, and group distribution and sign the informed-consent declaration. We used the following exclusion criteria: participants younger than 18 years old, those with recent psychiatric episodes (less than two years), those with cases of schizophrenia in close family members, those with cardiac disease and hypertension and those in a

psychologically depressed state at the time of the study.

Twenty-eight volunteers were selected from 37 candidates, 8 women (28.6%) and 20 men (71.4%). Originally we formed seven groups but because of problems with two of these, the analysis was performed using five groups (n=4), two trios and a couple. Arrangements of the groups were done by participants, allowing grouping of people with affinity. Educational levels of participants were at an undergraduate-level (19), completed secondary school (3) and graduate-level (6). The mean age was 23.21±3.06 years (18-28) and mean weight was 67.93±12.51 Kg (47-100). Just 35.7% (n=10) of participants had never consumed magic mushrooms in their life, 46.4% had consumed them up to 5 times and 17.9% had consumed them more than 5 (max. 15) times. Except for one participant, all of them had experimented with *Cannabis sativa*, 89.3% (n=25) were habitual users. Concerning the subjects' historical use of psychedelic substances, use of Ayahuasca (42.9%), LSD (57.1%), Ecstasy/MDMA (21.4%), Mushrooms (64.3%) were related and 25% (n=7) had never had contact with psychedelics. We categorized use of psychedelics by participants according the number of times used and substance types as "light use" (n=9), "intermediate use" (n=4), "heavy use" (n=8) and "no use" (n=7).

Magic Mushrooms (Psilocybe cubensis)

Magic mushrooms were collected in Recife, Pernambuco (8° 04' 03'' S, 34° 55' 00'' W) and Serra Negra, Bezerros, Pernambuco (8° 17' 00" S, 35° 58' 34" W) in cow pastures. Around 80 hours of collection were done over 20 days during the rainy season (Apr-Aug). Specimens were identified as *Psilocybe cubensis* (Earle) Singer at the Mycology Department of the Biological Sciences Center at UFPE.

The material collected was sterilized and dehydrated in a dark stove with active ventilation for 30-48 h and stored in a hermetically sealed recipient, protected from light exposure, with silica gel to complete dehydration and conservation of active compounds. After definition of groups and study dates, dehydrated material was macerated, homogenized and weighed using an analytical-grade balance to determine proper dosage based on a proportion of dose/weight (mg/Kg; mushrooms/person). The material was then stored again until the day of experiments.

Dosage used was determined considering mean concentration of active compounds found in dehydrated *Psilocybe cubensis* (0.63%) collected in Brazil (52). In accordance with contemporary studies developed with psilocybin, we choose a dosage of 55.6 mg/Kg of dehydrated mushrooms/person weight (equivalent to 0.35 mg/Kg or 350 µg/Kg of active psilocybin/person weight).

Hallucinogen Rating Scale Test (HRS-test)

Version 3.06 of the HRS-test was conceived by Dr. Rick Strassman (53, 54), originally used in studies of the Hoaska Project in Brazil (55, 56), and fitted to our study. The test has 100 questions in a Likert scale (0, no/nothing; 1, light; 2, intermediate; 3, high and 4, intense) and identify individual subjective effects experienced in a particular session. It considers six aspects: somaestesy, affect, perception, cognition, volition and intensity. The HRS-test was always administered at the end of the experiment (around 6:30 h after mushroom consumption).

Subjective Time Perception Task

The subjective perception of time passage of the participants was analyzed at five stages: once before mushroom consumption and the other four occurred during the psychedelic experience. Consequently, the test consisted of t0, which was considered a pre-test, and t1, t2, t3 and t4, as post-tests, assessed from the first hour after mushroom consumption until the fourth hour, at one-hour intervals. The task was applied

individually, but always in the same order considering the group of persons.

Each participant was requested to mentally count fifteen seconds. They were instructed to count aloud the first and last seconds (1 and 15 s) as markers of the beginning and end of the task. Counting was accompanied by a chronometer and the participant initiated count after the "bip" sound. The chronometer was stopped when the participant said, "15." All the participants received training for this task. All measures were realized in quintuplicate.

Experimental Design

The study was conducted in a researcher-group format (five groups of four people; three trios and a couple). The semi-manipulated setting was composed of a room, used to develop the intervention tests during psychedelic experience, two bedrooms, kitchen, bathroom and external environment with flower-garden. Participants were instructed to not leave the propriety limits after the beginning of the experiment. The experimental design aimed to mimic the context of recreational use of magic mushrooms.

Participants arrived at the experimental locale the night before the experiment day at 7-8:30 PM. Training of tests were done and informal conversation was important to familiarize the group and researcher. Everybody slept in the same bedroom. At 8 AM participants ate breakfast and instructions were reinforced. Pre-tests of tasks were realized and after this, generally at 10 AM, everyone consumed their respective dose. The setting was completed with music during the entire experience and its volume was diminished at the moment of test intervention.

Test interventions during the experience were carried out until the fourth hour of the psychedelic experience. After the fifth hour, the researcher began to prepare a lunch (it was ready around 4 PM). Participants could assist in the preparation if they wanted. The HRS-test, the last task, was done after the meal. The group left together between 7:30-8 h after consumption of the mushrooms (normally between 6-7 PM). Some out-going groups related their encounters with other groups in passing. Comments were always positive and served to motivate the in-coming group. Participants were informed before the experiment of their freedom to desist from research at any moment if they wish, but no one did.

RESULTS

HRS-test

Mean values recorded by the HRS-test subscales of participants in relation to psychedelic use categories were ordered according to the Kruskal-Wallis test. Ordered means related to people that had made light use of psychedelic substances in their life were always larger in all subscales than for participants of other categories, but we observed no statistical differences between categories of psychedelics use (Table 1). Global scoring of subjective effects on HRS-test subscales are presented in Figure 1. We excluded data from three participants in our analysis on subscale Intensity (heavy use= 1; no use= 2) and one from Perception and Cognition subscales (heavy use, same person in both subscales). Exclusions were done based on incomplete resolution of questions of a specific HRS subscale.

TABLE 1. Ordered means of participants for HRS-test subscales in relation to psychedelic use categories according Kruskal-Wallis test.

Psychedelic Substances Use	Intensity (n=25)	Somaestesy (n=28)	Perception (n=27)	Affect (n=28)	Cognition (n=27)	Volition (n=28)
No Use	11.90	10.64	13.86	14.43	13.50	11.71
Light Use	16.06	18.56	15.50	16.00	18.06	19.39
Intermediate Use	9.38	13.25	11.25	12.00	12.63	14.63
Heavy Use	11.93	13.94	13.79	14.13	10.07	11.38
$\chi 2$	2.859	3.868	0.811	0.689	4.229	5.206
p	0.414	0.276	0.847	0.876	0.238	0.157

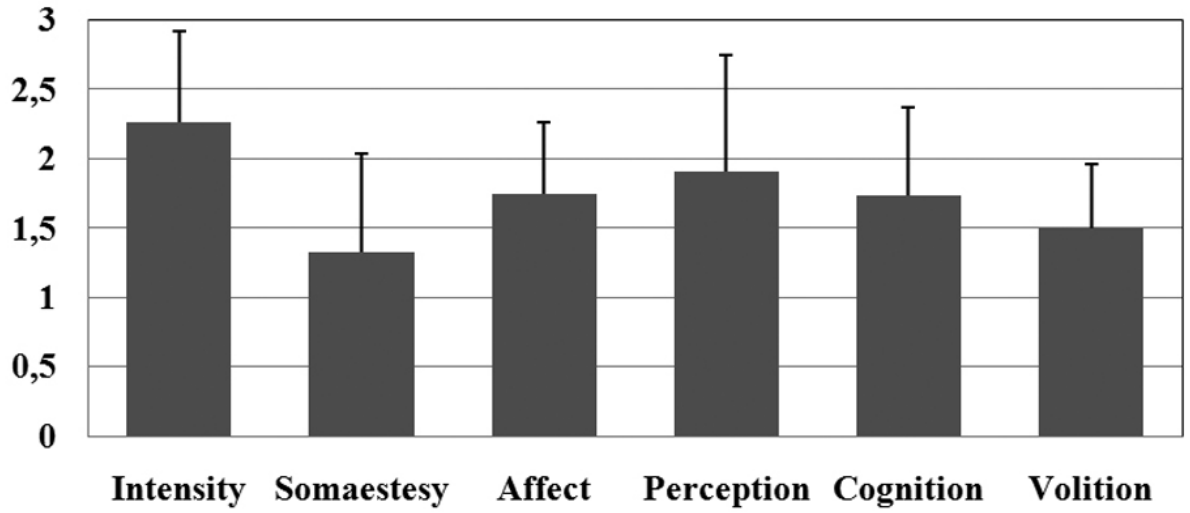

Figure 1. Global scores obtained for HRS-test subscales by participants of the study (max.= 4; intensity, n= 25; perception and cognition, n= 27; affect, somaestesy and volition, n= 28).

Participants were able to perform all tasks under the effect of the substance administered. In general, a little anxiety occurred in the participants until the first hour after the consumption of mushrooms, dissipating in a wild state of joy after that. Anxiety was usually accompanied by discomfort in the abdominal region. From the fourth to the fifth hour the participants were more introspective. With the fading of the effects provided by the substance, we could observe a gradual increase in sociability among the participants of the group with the researcher.

Only one participant presented a transitional moment of experience "not pleasant or frightening" around the fifth hour (format double-researcher, male), easily dissipated by conversation. All participants felt well after the experience, except one, who reported

mental fatigue and dizziness (format researcher-group, female). The group left the place after dissipation of the malaise of the participant, about an hour later. There were no reports of physical or psychological discomfort until the fourth month after the experiment.

Some acute subjective effects were selected according to issues of HRS-test as a way of illustrating the complexity of the emotional sphere of the participants during the entire experiment (Figure 2).

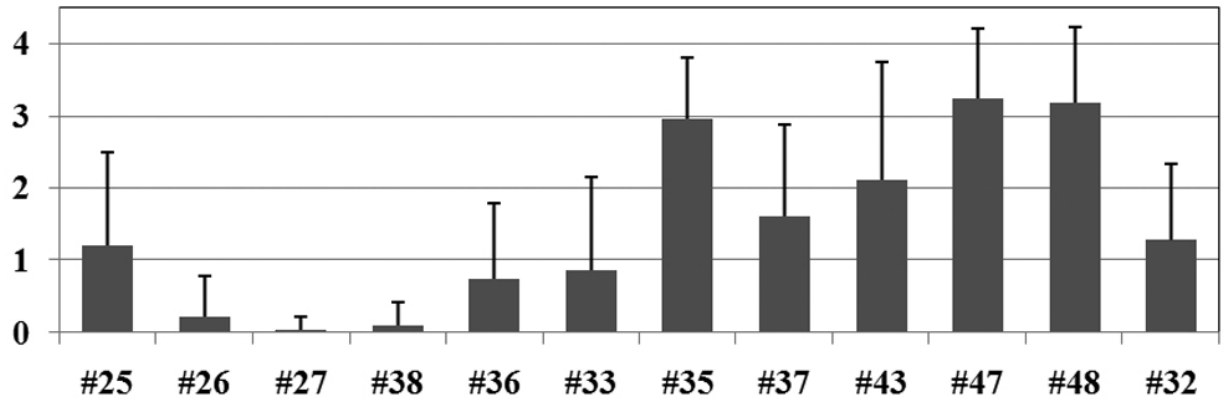

Figure 2. Some acute subjective effects during magic mushroom experience, according to the HRS-test. Questions selected were: #25, anxious; #26, frightened; #27, panic; #38, despair; #36, sadness; #33, numinosity; #35, happiness; #37, euphoria; #43, unity with the universe; #47, did you like it?; #48, how soon would you like to repeat it?; #32, safe. For all questions, except #48, the Likert scale referred as 0= not at all, 1= slightly, 2= moderately, 3= very much, and 4= intensely. For question #48, Likert scale referred to 0= never, 1= within one week, 2= within one month, 3= within one year, and 4= as soon as possible. Our results show that 57.14% of participants choose the maximum value for question #48 and just two people marked 3 as value on it.

Subjective Time Passage

Mean values and standard deviations of this task from t0 (pre-test) to t4 (t1, t2, t3, and t4, during mushroom experience) are shown in Table 2. The mean variation patterns of the measures over time presented by participants are summarized in Figure 3.

One participant was excluded from the analysis because he did not carry out the measurement task in the third hour (t3), as he did not want to participate, stating, "because at that time, I was reviewing things and wonderful truths and did not want to disrupt the flow of experience." The same subject performed all other tasks in other periods of experience, including the last task of measuring the subjective perception of time, by free will.

TABLE 2. Means and standard deviations obtained for the subjective time passage perception task by participants of the study (n=27). SD= standard deviation.

Measure	Mean	SD
t0	14.38	±1.94
t1	15.48	±2.03
t2	15.04	±2.15
t3	15.28	±2.08
t4	14.49	±1.91

To investigate the differences between these obtained mean values, we performed an analysis of variance with repeated measures, considering the variable within subjects the measurements of subjective time (5: t0, t1, t2, t3 and t4). We found a significant main effect of this variable Time of Measurement [$F(4, 104)= 3.146$, $p<0.017$]. *A posteriori* Tukey analysis in order to verify the significant differences indicated that measures before the consumption of mushrooms (t0) was lower than those measured 1 hour after (difference= 1.101, $p<0.01$), t4 was less than the mean found at t1 (difference= 0.1108, $p<0.01$), and t3 was more than t4 (difference= 0.7982, $p<0.05$). There were no other significant differences in relation to the times measured (α=5%), however there was a tendency to differentiate t0 and t3 as well as comparisons between t2 and t4 ($0.1<p>0.05$).

There were no statistical differences between Time of Measurement and Categories of psychedelic substance use (repeated measures; 5:4) as well as for sex (repeated measures; 5:2), however participants who made heavy use of psychedelics presented a profile of time variation of only one peak (in the first hour) and returned to baseline more rapidly than other categories (data not shown). No significant differences were found for subjective values of time in relation to gender.

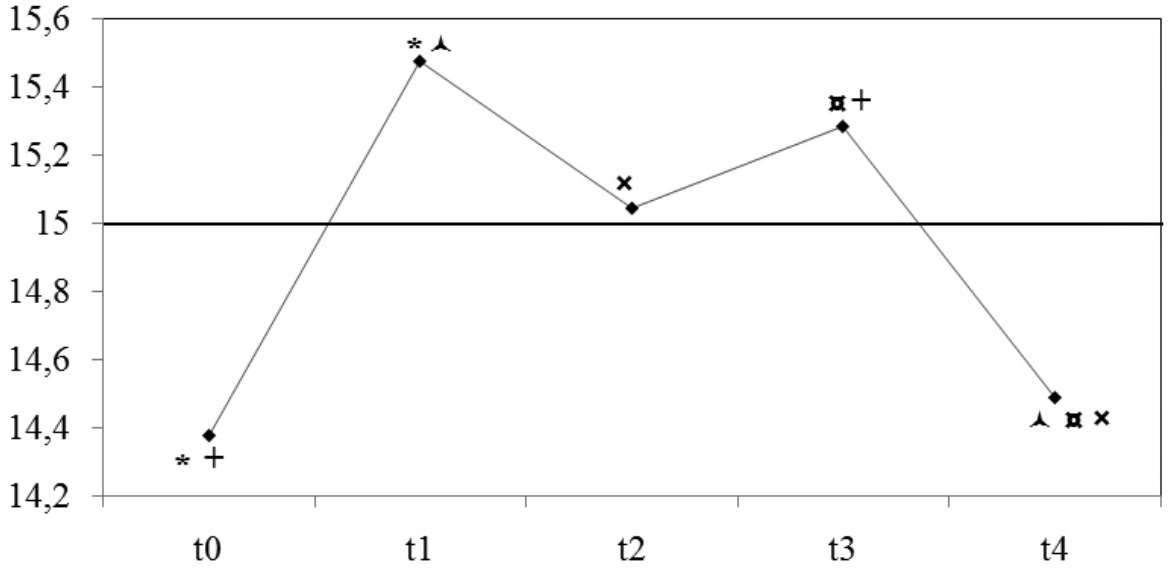

Figure 3. Subjective time passage perception before and after consumption of magic mushrooms. Before mushroom consumption, participants presented a subjective overestimate of time passage, i.e., they indicated a subjective perception of the passage of 15 seconds before the actual passage of 15 seconds. During the mushroom experience, we found statistically significant underestimations of time passage, in which more time was needed to estimate the passage of 15 seconds, returning to baseline levels with decrease of psychedelic effects (n=27). Equal symbols indicate statistical significant differences between measures (*,©,¤ = $p<0.05$; ×,+ = $p<0.1$).

DISCUSSION

The experiment design of the *setting* aimed to reduce the incidence of anxiety and avoid laboratory/clinical associations, creating an environment similar to the context in which most uncontrolled experiments with magic mushrooms are performed, i.e., mimicking the context of recreational use. The effectiveness of the environmental context (*setting*) in the research points to its relative importance in the execution of the experiment. Although the relationship between the quality of experience and the *setting* is unclear, attention was paid to the potential effects from intervention of external factors in conducting the experiment and to avoid interference that might arouse discomfort in the participants (40, 42, 57, 58).

A placebo procedure was not adopted in this study for reasons related to the size of the sample size and the undeniable differences observed between the effects of psychedelics and placebos adopted in previous studies (30, 35, 53, 54, 59-61). Support for the unity of the group and the opportunity to obtain more data was prioritized over the insertion of additional controls other than pre- and post-tests. Another important reason was that the placebo would be easily discovered in the format of this experiment as occurred in a previous study with a similar format (46, 62), which could have reconfigured the emotional experience of the participants of the group as a whole or harm the execution of the experiment.

The scores obtained by participants in the HRS were similar to those found by Moreno et al., (2006) with the use of psilocybin at doses of 200 and 300 µg/kg, which were considered as medium and high dosages, respectively. The dose-dependent relationship of mental effects has been previously shown for psychedelic experiences (30, 44, 60). Higher scores on all subscales of the HRS were found in the study by Griffiths et al., (2006), whose concentration of psilocybin was higher than that used in this study. The HRS was effective in determining dose-dependent variations of the subjective effects of the experience, indicating in our investigation using a dose intermediate between the medium and high dosages used in other studies (27, 30, 32, 60).

The scores on the HRS in our study showed similar results to those found for DMT i.v. (intravenous) with doses between 200 and 400 µg/kg (54). Our results showed values intermediate between those two doses of DMT, suggesting compatibility of action for both substances. These two substances act on the serotonergic system and appear to act similarly in relation to their concentrations by weight, both in terms of clinical and mental effects (39, 44, 53-55, 60, 61).

The quest for understanding the relationship between psychedelic experiences and psychotic states and schizophrenia has generated a promising debate among researchers interested in understanding and treating mental illness. The discovery of agonist action on the serotonergic system of most psychedelics and the important role of serotonin on acute schizophrenia, depression and drug addiction reinforces this relationship (24, 25, 31, 32, 50, 63-65).

Psychedelic experiences are usually accompanied by numinous states (39, 44, 62, 66), effects which were seldom observed in the study participants, which may be an effect of the setting designed for the experiment.

Responses on the HRS showed high values for feelings like happiness and euphoria and low values for feelings of fear, despair and panic. Similarly a study found that ayahuasca was able to diminish signs related to the panic and hopelessness in former users of ayahuasca. Thus, our results seem consistent with this characteristic, perhaps associated with the psychedelic experience in general (67).

One noticeable aspect related to noetic experience was the sense of oneness with the universe, as previously described in experiments with psychedelics, and an inherent aspect of the religious experience (37-39, 45, 66, 68-70). The low numinous effect observed in our study suggests that the types of personal motivation, as well as manipulation and configuration of the environment, are crucial

to promote spiritual/mystical characteristics of the experiences at high levels and with healing qualities.

Psychedelic states have been an exciting and curious field of research, since the knowledge of their mental effects represents a major gap added to the problem of mind/body dualism. Some efforts have been made to try to conceptualize the psychedelic experience, whose advances culminated in the classification of such substances as having high therapeutic potential, despite being banned, and currently belonging to Schedule 1, thus contradicting the current assumptions of this classification, generating a great discussion today and push for reconsideration of the legal status of psychedelics (12, 18, 71-73).

Watts (1968) presents, according to their own experiences, four dominant characteristics of the psychedelic experience: (1) polarity consciousness, (2) awareness of relativity, (3) awareness of eternal energy, and (4) concentration on the present. The latter refers to as a characteristic of psychedelics in delaying subjective time, wherein the compulsive expectation about the future decreases, which leaves the experimenter becoming more aware of the importance and interest of what is happening at the moment.

Our results on the subjective passage of time indicated that participants underestimated the speed of passing time after consumption of mushrooms, i.e. in estimating the passage of fifteen seconds of subjective time, participants needed the passage of more actual seconds. Thus, participants underestimated the speed of the passage of real time presenting longer subjective durations of seconds.

We can use the classification of Watts (1968) to understand that the subjective temporal passage becomes sluggish with a resulting concentration on the present, in terms of psychological functioning: the standard conventions of culturally acquired passage of time seem to be moved a new pattern of passage of time during the psychedelic experience. The subjective duration of seconds became longer and the participants experienced a sort of extension of the duration of the present moment. Some participants reported subjective visual effects such as frames slowed down "as if there was time to see any movement as a whole". As the passage of subjective time was extended from the point of view of participants, the passage "real" time was at the other pole, abbreviated.

Other studies have documented the effect of certain drugs on subjective temporal experience. The mechanisms involved are unclear yet. It has been found that amphetamines and caffeine are capable of promoting an overestimation of the experience of time (74). Sedatives such as pentobarbital cause an opposite effect, as well as nitrous oxide and other anesthetic gases (75, 76). As a general rule, the substances that speed up the vital functions are responsible for overestimating the perception of time and those that slow them promote underestimation. Thus, while underestimated the passage time, its real passage is reflected in the subject in a personal slowed-down score the seconds, with the opposite effect observed in the overestimation of the passage time (74).

Research with psilocybin about its alterations on the mechanisms of subjective perception of time revealed deficits in the ability of participants to correctly reproduce the duration of intervals of sound. Individuals also showed a preference to create slower individual personal rhythms after ingestion of psilocybin (30). The results obtained by Wittmann et al., (2007) showed that participants overestimated the passage of time to a statistically significant degree for the task of time reproduction of sound over long intervals, when compared with results from a placebo group, seen as the realization of shorter durations of subjective seconds. These results seem to differ from ours, to the degree in which there was seen an opposite effect. Some neuroimaging studies have shown that psilocybin increased information processing in the frontal cortex, perhaps indicating increased metabolism (25, 31, 32). We ask ourselves about other possible differences of the effects of psilocybin on humans (many already known) and of magic

mushrooms on metabolism in general. Currently, this remains an open question.

Additionally, the results in the sensorimotor synchronization task show a statistically significant overestimation of the speed of passage of time. The subjective perception of seconds had shorter duration than an actual second, which was observed for all conditions of the experiment and all participants (30). However, for this same task, we found that participants in this study, at middle and high doses of psilocybin (115 and 250 mg/kg, respectively) were able to underestimate the subjective duration of seconds when compared to their initial conditions and the placebo. The subjective experience of seconds during the peak of the psychedelic experience lasted longer than that measured before the ingestion of psilocybin. These observations seem consistent with our findings; in both an expansion of the subjective duration of seconds compared to baseline was observed.

We believe it is important to reflect on the nature of tasks applied to measure characteristics of human cognition, for example, the perception of time, in the sense of how its design may interfere with the way in which the cognitive system operates and requires quantitative and qualitative processing attention, memory and decision mechanisms, as pointed out by Wittmann et al., (2007).

The changes observed in this study and that of Wittmann et al., (2007) return to baseline after the effects of psilocybin wear off. The perturbations to the sense of the length of time caused by psilocybin were also accompanied by deficits in working memory and subjective changes in consciousness such as the phenomena of depersonalization and de-realization (30). The observed changes in subjective time returned to baseline at 240 minutes after ingestion of the substance. It was also observed that magic mushrooms caused deficits in working memory in this study, a finding which is discussed in Part II of our research results.

Studies indicate the involvement of working memory processes in the perception of time duration. Among these processes, we find that the amount of information storage, the complexity of events and stimulating factors, together with the efficiency of encoding and storage of information by the cognitive system, can influence the processing of information and alter the subjective duration of time. The increase in number and complexity of events in a given period would require a consequent increase in information processing, overestimating the experience of perception of the length of time (77). Several experiments have shown the relationship of increased complexity of information to the overestimation of subjective time passage (74, 77-79).

The increase of information processing seems to be a feature of psilocybin and other psychedelic substances (25, 31-33). These studies support the idea that the psychedelic experience is accompanied by increased cortical processing of intrusive information due to the decreased ability of information filtering system, causing a frontal-cortical overload. The increased amount of information processed during the psychedelic experience can be related to several factors such as the storage capacity of memory, qualitative changes in information encoding, and emotional changes which can influence cognitive processes and perception, as well as being indirectly influenced by the expectations of participants.

A possible reflection of the inter-related issues of complexity, numerosity and amount of information, and time perception can be made from the observation that periods of time filled with stimuli are normally considered longer than an empty interval (80, 81). It has also noted that people with high expectations overestimate perceived time during empty periods. Thus, studies with empty intervals become dependent on the nature of the situation and task (77, 82). Could the experimental *setting* have directly influenced the participants' performance, or even the type of task?

The perception of time is shown to also be influenced by space and time. By modifying the size of the components of the space or the time relationships of events with which it interacts must affect subjective time perception. Studies have given examples of these relationships (74, 83, 84).

An interesting fact is that the psychedelic experience promotes perceptual alterations in size and shape of space or visual stimuli, for example, the size of objects may change according to individual points of reference. However, the ratio of perceived size of objects and perception in the altered state of consciousness needs to be investigated to be clearly defined.

Furthermore, the attentional processes (not assessed in this study) are also seen as an important variable for understanding time perception (30, 74, 81, 82), whose elucidation may help in understanding interactions with memory processes (48).

The aim of this study was to explore the functioning of basic cognitive processes during the altered state of consciousness caused by the use of magic mushrooms of the species *Psilocybe cubensis* that occur naturally in the region during the rainy season. Recreational use of this fungus has been observed particularly among university students. Different motivations were detected in participants apparently influenced by the information culture and *new age*.

In this first part of the study, we present the results of subjective effects of the action of mushrooms according to the Hallucinogenic Rating Scale and changes in the subjective perception of time duration, as well as discuss these findings in reference to the literature. We also present aspects related to the feasibility of psychological studies in humans in special states of consciousness activated by psychoactive substances, a type of research which is not usually conducted in Brazil, other than for alcohol. Confirming what has been described in the literature, our results indicate that the active ingredient in magic mushrooms was able to promote changes in the functioning of consciousness and various cognitive processes, following a dose-dependent relationship. We note that, similar to isolated psilocybin, magic mushrooms were able to change the perception of time, however, relationships between the findings of research in psychopharmacology and cognitive research require efforts in interdisciplinary research. Finally, the manipulation of the research *setting* proves to be an important factor in the execution and quality in the development of this type of experiment. The success of psychological research on altered states of consciousness must continue to consider the motivations of participants (*set*) and also with the relationship between the dosage *versus* effects of interest to be investigated

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