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Nutrition with 'Light and Water'?

In Strict Isolation for 10 Days without Food – a Critical Case Study

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Key Words
Isolation study · Fasting state · Living on light · Metabolism · Secondary hyperaldosteronism

Summary
Background: In her book 'Living on Light', Jasmuheen tries to animate people worldwide to follow her drastic nutrition rules in order to boost their quality of life. Several deaths have been reported as a fatal consequence. A doctor of chemistry who believably claimed to have been 'living on light' for 2 years, except for the daily intake of up to 1.5 l of fluid containing no or almost no calories was interested in a scientific study on this phenomenon. **Participant and Methods:** The 54-year-old man was subjected to a rigorous 10-day isolation study with complete absence of nutrition. During the study he obtained an unlimited amount of tea and mineral water but had no caloric intake. Parameters to monitor his metabolic and psychological state and vital parameters were measured regularly and the safety of the individual was ensured throughout the study. The subject agreed on these terms and the study was approved by the local ethics committee. **Results:** The most important observations were a permanent urinary excretion of ketones, up to a 3-fold increase in free fatty acid plasma levels, a mean weight loss of 0.26 kg/d, and an initially secondary hyperaldosteronism. Additionally, his ability to exercise was reduced. The subject remained psychologically stable and testing did not reveal any relevant changes. **Conclusion:** The results refute the claim and indicate a phase-II fasting state.

Schlüsselwörter
Isolationsstudie · Fastenzustand · Lichtnahrung · Metabolismus · Sekundärer Hyperaldosteronismus

Zusammenfassung
Hintergrund: In ihrem Buch «Living on Light» versucht Jasmuheen, Menschen weltweit zu einer Befolgung ihrer drastischen Ernährungsregeln zu animieren. Als eine fatale Konsequenz davon ist über mehrere Todesfälle berichtet worden. Ein promovierter Chemiker, der glaubhaft angab, sich seit mehr als 2 Jahren nur noch von «Lichtnahrung» und 1,5 l ganz oder fast kalorienfreier Flüssigkeit zu ernähren, war an einer wissenschaftlichen Untersuchung des Phänomens interessiert. **Proband und Methoden:** Der 54-jährige Mann wurde in einer Isolationsstudie von 10-tägiger Dauer untersucht. In der Isolationsstudie, die unter striktesten Bedingungen in einer Intensivstation durchgeführt wurde, erhielt er eine beliebige Menge ungezuckerten Tee, aber absolut keine Kalorienzufuhr. Während der 10-tägigen Isolation wurden Vitalparameter, metabolische sowie psychologische Variablen regelmäßig gemessen. Der Proband war mit diesen Bedingungen einverstanden, und die Studie wurde von der Ethikkommission des Kantons Bern gutgeheißen. **Ergebnisse:** Während der 10 Tage nahm der Patient täglich durchschnittlich 0,26 kg ab, zeigte eine persistierende Ketonurie und eine bis zu 3-fache Erhöhung der freien Fettsäuren im Plasma sowie initial einen sekundären Hyperaldosteronismus. Außerdem nahm seine körperliche Leistungsfähigkeit ab. Der Proband blieb psychisch stabil und zeigte keine relevanten Veränderungen. **Schlussfolgerungen:** Die vorliegenden Befunde zeigen, dass sich der Patient im Fastenstatus II befand und die Option, sich von Licht zu ernähren, nicht erfüllte.

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Introduction

An Australian woman named Jasmuheen claims not to have eaten since 1993, but instead to 'live on light' [1]. In 1999, an Australian TV show put her to a test. However, the study which had been planned for 10 days was discontinued on the 5th day because the subject showed severe signs of dehydration (*http://sixtyminutes.ninemsn.com.au/60/stories/1999_10_24/story_57.asp*). Yet, Jasmuheen's method of allegedly 'living on light' is promoted on the Internet and has generated much and problematical attraction. Several deaths are reported to be linked to it [2].

In plants, the energy of sunlight serves to generate storable energy (mostly glucose) by means of specialized cellular components, the chloroplasts. Such chloroplasts do not exist in vertebrates or in humans, and the notion of sustaining life without caloric intake contradicts basic scientific assumptions. Nevertheless, historical as well as 'medically proven' examples of such individuals are reported in the lay press as well as in scientific journals [3, 4]. Even sanctifications or explicit acknowledgements by the Catholic Church were based on such 'miraculous' surviving of deeply religious persons. As the Swiss national Saint Niklaus von Flüe [5] centuries ago, or the German nun Therese Neumann von Konnersreuth in recent times [6], and – astonishingly – despite declared systematic checking, no evidence of fakeness could be found in the latter [7].

In this report we describe a 10-day isolation study of a 54-year-old Doctor of Chemistry who claimed to have been 'living on light' as per Jasmuheen, for the previous 2 years. Completely without nutrition, except for the daily intake of up to 1.5 l of liquids with no or almost no calories, such as water, tea, diluted orange or apple juice, but neither milk nor energy drinks.

He started to do so after being overburdened with work and health problems in January 2001. He then radically changed his lifestyle and started living without food, following published instructions [1] after a 3-week personal retreat. He claimed to have lost the sensation of hunger and thirst within the first weeks, his body weight dropped from 85 to 68 kg and remained steady thereafter. He felt in excellent shape physically, emotionally and mentally. His wife, his three grown-up children as well as his co-workers knew and accepted his special way, and he remained fully active and professionally and socially integrated. Personally, he made an impression of normalcy and credibility and did not exhibit overt missionary or psychopathological behaviour.

Based on his professional background he was interested in the metabolic aspects of his own 'experiment' and contacted several physicians before enrolling in our study. Several examinations such as blood tests and calorimetry were performed and were essentially normal. He put himself forward to carry out a rigorous isolation study in order to show that the phenomenon of living without nutrition can be real.

To our knowledge, there has been no scientifically acceptable evidence to prove or disprove such claims yet. Therefore, we decided to carry out a critical 10-day trial in strict and controlled isolation to test the following hypotheses: i) the subject started fasting at or shortly before the beginning of the study (fasting phase I), or ii) the subject started fasting more than 10 days earlier (fasting phase II), or iii) the subject does not show signs of fasting or food deprivation, despite confirmation of 100% food deprivation.

Methods

Setting, Isolation, Medical Care and Security

The study was carried out in a large and fully equipped separate isolation room of an intensive-care unit. For the 10 days, rigorous isolation was maintained by the following measures: A 24-h video surveillance was assured and recorded for an a posteriori check. The large window (on the 3rd floor above a parking lot) provided natural daylight but remained locked; fresh air and a constant room temperature were provided by the hospital's automatic air-conditioning and heating systems. At night, a dim electric light was left on to allow for video surveillance. The subject agreed not to leave the room, to have no private visits, and to communicate to the external world only by e-mail and telephone. All personnel, including cleaning staff, nurses, etc. were admitted only in escort with authorized medical staff, and visiting investigators had to identify themselves. All examinations were carried out in the room, and mobile technical devices were used, e.g. for radiological examination and for the toilet. Upon entrance, all luggage and clothes were checked for nutritional items. To allow for daily physical activity as planned by the subject (2 × 30 min per day, morning and afternoon), a bicycle ergometer training unit was placed in the room. Training was supervised. For other personal activities and recreation, a television, a radio, a music CD-player and personal literature were available.

During the 10 days, complete food deprivation but an unlimited supply of mineral water and sugar-free tea were organized. No other nutrients were allowed. High medical security was provided by continuous cardiac and regular cardiovascular monitoring and systematic psychological and metabolic testing. A regular 24-h care service was provided by nurses. Medical visits took place twice a day, in order to supervise the subject's medical and psychological condition and to allow for decisions to stop the study in case of complications. Any important event had to be announced immediately to the principal investigators and to the ethics committee.

The investigations had been chosen in close agreement with a local metabolism specialist (KLH) as well as an internationally recognised specialist for nutrition and endocrinology from the University of Basel. During the first 2 days, neurological as well as cardiovascular examinations were carried out, in order to exclude any health risks and pathologies known to result from starvation trials [8]. The isolation study was to continue after the first 2 days only if no risk was discernible. Additionally, at days 1, 6 and 10 two plain abdominal radiographs were taken, to exclude intestinal body packing, aiming to substitute the lack of nutrients similar to those packings for drugs [9].

Measured Variables

Anthropometric and Systemic Cardiovascular: Heart rate, blood pressure and body temperature were assessed four times daily, and weight determined twice a day.

Systemic Metabolic Assessment: At days 1, 6, and 10, oxygen consumption (VO2) and carbon dioxide production (VCO2) were measured by indirect calorimetry (Deltatrac, Datex Corp., USA), corrected by Haldane's equation to calculate basal metabolic rate (BMR) and respiratory quotient (RQ, VCO2/VO2). Carbohydrate and lipid oxidation rates were calculated using the equations by Simonson and DeFronzo [10]. Additionally, this

Table 1. Study scheme including testing of metabolic parameters. The table shows all parameters that were measured during the 10-day study

Pre-hospitalization (up to 14 days)		Day									
		1	2	3	4	5	6	7	8	9	10
Psychiatric consultation	Presentation of subject to the respective nursing personnel in the intensive-care unit	x									x
Clinical interview and medical visit	Body weight, height, temperature, blood pressure, heart rate, 24-h ECG, fluid balance	x	x	x	x	x	x	x	x	x	x
Assessing the subject's condition and diagnosing possible concomitant diseases	Anamnesis, clinical status, selective clinical and neurological tests (heart auscultation, liver palpation, tendon reflexes etc.)		x			x					x
Blood-screen	Glucose, creatinine, urea, uric acid, creatine kinase, albumin, sodium, potassium, chloride, calcium, phosphate, magnesium, amylase, hemoglobin, hematocrit, blood count	x	x	x	x	x	x	x	x	x	x
Special analyses 1	fT3, fT4, basal TSH, glucagon, insulin, vitamins, total protein, copper, iron, ferritin, lipase, LAP	x									x
Special analyses 2	glucagon, insulin, free fatty acids, β-hydroxybutyrate, amylase, total cholesterol, LDL-cholesterol, triglycerides			x				x			x
Special analyses 3	free fatty acids, β-hydroxybutyrate, amylase		x			x	x		x	x	x
Urine 24-h excretion	sodium, potassium, calcium, creatinine, urea, uric acid		x	x	x	x	x	x	x	x	x
Urine test strip	specific gravity, pH, leucocytes, nitrite, protein, glucose, ketone, urobilinogen, bilirubin, blood	x	x	x	x	x	x	x	x	x	x
Testing of autonomic nervous system		x				x	x			x	x
Psychometric testing: FPI, STAXI, Depression (ADS-L), SF-36		x			x			x			x
Physical exercise, daily, supervised		x	x	x	x	x	x	x	x	x	x

value was compared with the calculated resting energy expenditure (REE) using the Harris-Benedict formula and urea nitrogen loss was used to calculate protein loss (see below).

Blood and Urine Parameters: Blood morphology and chemistry were determined on a regular schedule (table 1). The calculation of urea nitrogen excretion per day can be used to estimate the fraction of energy lost as protein [11]. As the caloric intake of our patient was 'zero' and physical activity was minimal, the ratio of urinary nitrogen loss to the measured BMR is a proxy for the fraction of energy lost as protein according to the formula:

$$P_{ratio} = \frac{\text{Urinary N loss (g)} \times 6.25 \times 18.6 \text{ (kJ/g)}}{\text{BMR (kJ)}}$$

where P_{ratio} is the fraction of energy loss due to protein oxidation, BMR is the basal metabolic rate, 6.25 is the conversion factor for nitrogen to protein, and 18.6 is the metabolic energy equivalent for protein.

Autonomic Nervous System: Measurements of heart rate variability (HRV) by means of 24-h ECG (electrocardiogram) monitoring were conducted (data not shown). On the same investigational days, a non-invasive testing of the autonomic nervous system to determine spectral values and activities of the sympathetic as well as the parasympathetic nervous systems, including the determination of central baroreceptor sensitivity was performed. The patient was examined in bed in a reclining position. Three testing phases were consecutively applied: a resting phase of 15 min, a mental stress test (Stroop Color Interference test) of 10 min and recovery phase of 10 min. We used the Task Force® Monitor (CNS-Systems, Graz), a non-invasive computer-supported 'beat-to-beat' measuring system to assess autonomic functions. By means of ECG leads I and II, and oscillometric as well as continuous blood pressure ('beat-to-beat') measuring using a finger cuff (Finapres® system), cardiovascular autonomic function data were assessed. The software determines parasympathetic and sympathetic tone as well as central baroreceptor sensitivity by means of Peñaz's vascular unloading technique and time series of heart period data. All data were visually controlled for outliers and artefacts. A commercial soft-

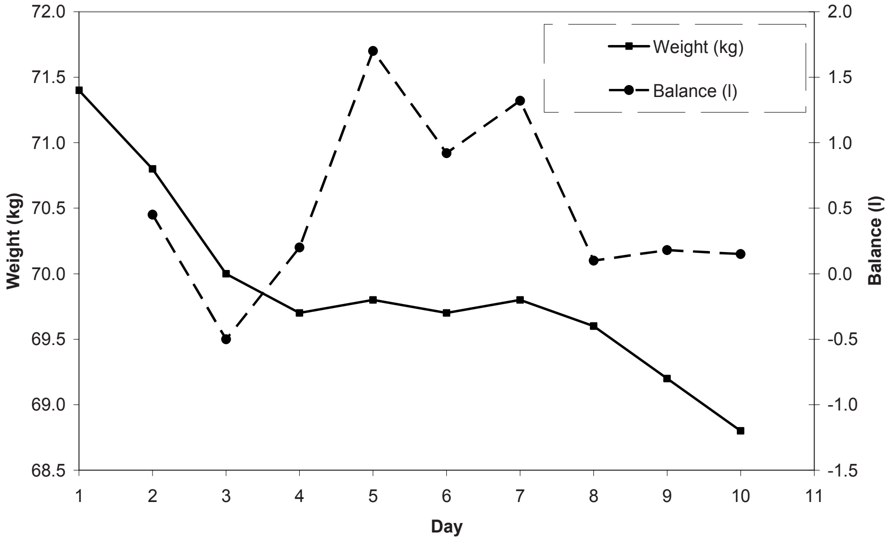

Fig. 1. Changes in body weight (left y-axis, solid line) and fluid balance (right y-axis, dashed line) during 10 days of fasting.

ware package (TGM Software V2.4, CNS-Systems, Graz, Austria [12]) was used to determine HRV with an adaptive autoregressive model (AAR) as proposed by Bianchi et al. [13], using a recursive least squares algorithm [14] (for further details see [15]).

Psychometric Tests: The Freiburg Personality Inventory, German version (FPI [16]), State-Trait-Anger-Expression Inventory, German version (STAXI [17]), Health Survey, German version (SF-36 [18]), and the General Depression Scale (ADS-L [19]) were administered at days 1, 4, 7, and 10. In all four testing sequences, the same questionnaire set was used to ascertain uniformity. However, changes were not expected in these instruments during the 10-day study (retest period too short), except for the ADS-L.

Ethics

The study was approved by the Ethics Committee of the Canton of Bern (KEK) (Ref. No. 133/03). The Declaration of Helsinki Principles were observed, and written informed consent was obtained from the subject and his wife prior to the study. Before starting the study a psychiatric evaluation was carried out by one of the senior psychiatrists at the University of Bern, to rule out a psychopathologic disorder, to judge the subject's stability for completing the study and his vulnerability for possible psychological damage from the isolation. No anomaly was found, and full capacity of rational judgment was attested.

Statistics

For all measurements descriptive statistics were calculated. All values were summarized using mean (M) and standard deviations (SD) of the first two and the last two determinations. Differences (pre and post measurement) were calculated using Student's t test or Kruskal-Wallis where appropriate. For the autonomic raw values a normalization by natural logarithm and standardization was performed according to Malliani et al. [20] and Pagani et al. [21]. Statistical significance was set to $p < 0.05$.

Results

During the 10 days, the subject lost 2.6 kg of net weight, i.e. about 0.26 kg/d (fig. 1). This weight loss was a true loss of mass due to BMR (measured at days 1, 5, and 10), non-exercise activity thermogenesis (NEAT, estimated at about 8%/d), and exercise activity thermogenesis (EAT) ranging from 15.8 to 64.5 kcal, depending on the subject's reported activity (table 2). Additionally, insensible perspiration, which also has to be taken into account [19], was estimated to be about 0.7 l/d [20, 21], because we could not measure it.

Values for RQ and REE (measured and calculated) were comparable at days 1 and 6, but substantially lower on day 10; BMR values were similar on days 1 and 6 but lower on day 10 (table 3).

The mean daily fluid intake was 1,866 ml (range 500–2,900 ml), the mean urinary excretion was 1,364 ml (830–2,120 ml) and the mean fluid balance was 502 ml (–500 to 1,700 ml).

The excretion of sodium decreased from 68.0 (normal) to <17–33 mmol/d (below normal) and excretion of potassium decreased from 45–66 mmol/d (day 1 to 4; normal values 41–125 mmol/d) to 18–15 mmol/d (from day 5 on, below normal). Excretion of calcium was always elevated at 14.1 to 24.8 mmol/d with a maximum on day 6. Excretion of uric acid was always below normal at 737 to 1,610 μmol/d. Equally, urea excretion was below normal at 201 to 334 mmol/d. The calculated fraction of energy lost as protein was 0.101–0.145 during the study. The excretion of ketones remained consistent at 4+ during the whole study. Urinary creatinine excretion was normal.

The following blood parameters were normal and did not change significantly: whole blood count, hematocrit, MCV, MCH, MCHC, neutrophil, eosinophil, and basophil leucocytes, monocytes, and thrombocytes. The same is true for C-reactive protein, total protein, albumin, magnesium and sodium. Chloride level was slightly diminished but remained constant. Serum calcium was normal at first and increased above normal range from day 8 on. The following parameters were normal again: phosphorus, copper, creatinine, urea, amylase, free T3, free T4 and basal TSH. Creatinine kinase decreased from 131 to 59 U/l. Glucagon and insulin were below normal for the entire period. Total and LDL-cholesterol were above normal levels and decreased to normal levels, whilst triglycerides were

Table 2. Calculation algorithm of weight loss

		Reference
Weight loss during study, kg	2.6	
Mean daily weight loss, kg	0.26	
Mean BMR, kcal/d	1628	
Mean exercise activity thermogenesis, kcal/d	37.4	
Mean daily loss of calories due to insensible perspiration and thermogenesis, kcal/d	576	
Non-exercise activity thermogenesis, kcal/d	179.4	[36]
Total daily energy expenditure, kcal/d	*2420.8*	
Calculated energy gain using fat as substrate, kcal/d	2418	[37, 38]

Table 3. Comparison of indirect calorimetry variables during the study

	Day		
	1	6	10
RQ	0.70	0.74	0.64
REE*, kcal/d	1588	1605	1400
BMR*, kcal/d	1648	1641	1481

*Measured.

Table 4. Heart rate spectral values (ms^2), transformed by ln, during the 10-day study under resting, mental stress, and recovery conditions. Low frequency power denotes mainly sympathetic activity, high frequency exclusively represents parasympathetic activity, and total power means overall activity of the autonomic nervous system

	Day		
	1	5	10
Total Power HRV			
Resting state	6,764	6,818	5,180
Mental stress state	5,509	6,280	5,730
Recovery state	5,719	5,784	5,493
Low Frequency HRV			
Resting state	4,348	4,325	4,256
Mental stress state	4,395	4,407	4,453
Recovery state	4,304	4,170	4,333
High Frequency HRV			
Resting state	2,944	3,164	3,241
Mental stress state	2,768	2,883	2,592
Recovery state	3,109	3,510	3,011

normal and remained almost at the same levels. Free fatty acids varied between 806 and 2,188 μmol/l and thus were elevated approximately 3-fold throughout the study. Plasma β-hydroxybutyrate showed a tendency to diminish from day 3 to 9 (from 5,720 to 3,838 μmol/l) and increased to 4,659 μmol/l on day 10. Glucose was normal and did not change significantly. All measured plasma vitamin levels except vitamin B12 consistently fell during the isolation study. Plasma uric acid was elevated at the beginning of the study but remained more or less constant. Lipase values were decreased and remained that way during the whole study.

Blood pressure, heart rate, and body temperature were normal throughout the study and did not change significantly. The autonomic nervous system showed a not only mathematically but also clinically significant decrease in resting total HRV as well as in low frequency heart rate power (LFHR). In parallel, the activity of high frequency heart rate power (HFHR) – exclusively representing parasympathetic activity – increased significantly ($p < 0.01$) (table 4). This is in line with lowered sympathetic and elevated parasympathetic activity seen in fasting states.

Psychological questionnaires were delivered at days 1, 4, 7, and 10. The psychological profile showed normal values in general well-being (physical and psychological health) at the beginning as well as at the end of the study. However, in terms of emotional arousal, the subject showed interestingly high levels of anger control (9; stanine-normalized values) in the STAXI. Also, high values of extraversion from 6 to 9, competition from 6 to 9, social orientation from 6 to 8, and satisfaction with actual life situation from 7 to 9, all stanine-normalized, in the FPI. The ADS-L had normal values between 0 and 3 (sum scale) showing no sign of depression during the study.

Discussion

The 10-day strict isolation study of the subject who claimed to 'live on light' revealed a metabolic adaptation that is highly compatible with a fasting state II, i.e. with our second hypothesis of food deprivation for more than 10 days before onset of the study. Some of the measured values would also be compatible with the first hypothesis, an onset of fasting at or shortly before the beginning of the study; but none of them was exclusively specific for phase-I fasting.

A number of metabolic results underline the notion of a phase-II fasting as does the initial discrete increase and then substantial decrease of the BMR [22, 23], as well as the persistent ketonuria which points to an elevated oxidation of stored fat [24]. In individuals with low to moderate physical activity (as in the subject) this mainly leads to elevated serum triglycerides and free fatty acids [25]. The fact that β-hydroxybutyrate and free fatty acids were elevated up to 12-fold higher than normal values from the beginning, also indicates an earlier fasting, starting at least several days before the study began, because glycogen stores were already depleted, and the high plasma levels of free fatty acids indicate an activated lipolysis [26–28]. Likewise, the values or the changes in values for glucagon, uric acid, cholesterol, vitamins B1, B2, B6, C, folic acid and iron (all of which were still normal but reduced after 10 days) match with a phase-II fasting state [29].

The weight loss seems rather low for phase-I fasting [30] but it is in line with phase-II fasting and the overall weight loss is similar to values found in the literature [31]. The weight loss was partially affected by an initial reduction in fluid consumption. In this context, the analysis suggests a secondary hyperaldosteronism with initially higher and subsequently lower serum potassium concentrations. In parallel, a change in urinary excretion during the first 3 days, until fluid balance had been achieved was observed. A secondary hyperaldosteronism due to fasting is not uncommon [32] and is mainly due to reduced fluid intake as in our subject.

The mean difference between fluid balance and weight loss was 0.79 kg/d and varied between 0.3 and 1.6 kg/d. This difference corresponds to the loss of mass (combined fat and fat-free mass without fluid) and loss due to perspiration, which could not be measured but was estimated at 0.7 l/d in an air-conditioned room with the subject exercising twice a day (normal sedentary perspiration 0.5 l, plus 0.2–0.3 l due to exercising) [33]. Thus, on days 3 and 8 the difference between fluid balance and weight loss was up to 0.4 kg/d smaller than the assumed 0.7 l/d due to perspiration. This could indicate a possible gain of mass. However, it is more reasonable to assume a lower perspiration on those days, because they were the two days with the lowest fluid intake. Hence, the body was probably less hydrated than on other days and perspiration consequently reduced. The amount of exercise diminished over the observation period but no correlation between the amount of exercise and loss of mass was found. The loss due to blood sampling did not exceed 20 ml/d and is not relevant. As expected, the BMR was lower at the end of the study compared to the beginning.

Besides the weight loss, the high values of β-hydroxybutyrate, free serum fatty acids and uric acid, undoubtedly indicate a loss of body mass. The elevated serum calcium was most probably caused by the ketoacidosis together with immobilization when the subject mobilized his fat stores. The slightly reduced serum chloride is mostly caused by a fasting induced acidosis and a concomitant mild rise in serum calcium is an effect due to bone demineralization [34] to buffer the low pH. The values of the calculated P ratio fit well with the model described by Dulloo and Jacquet [35] and confirm the starvation situation of the subject.

Finally, the third hypothesis, that the subject would not show signs of fasting or food deprivation was not supported by the results.

The autonomic nervous system responded with an increase of parasympathetic activity. This is a well-known effect of starvation, to profoundly increase parasympathetic tone in order to lower BMR so as to conserve energy. This may not parallel subjective impressions of being more stressed, since correlations of autonomic functions to subjective perception are known to be highly influenced by cognitive processes.

In the psychometric tests no anomalies and no signs of depression were detected during the whole study. However, these questionnaires may not reveal changes in the relatively short time of 10 days. The obtained scores point to the fact that the individual has a fairly stable and well-integrated personality with no obvious level of psychopathology, not even on the level of the psychological profile measures. This corroborates the findings of the previously performed psychiatric evaluation.

Subject's View of the Study

When asked to comment on the outcome of the study the subject brought forward that he had already realized in the course of the study that he was in a catabolic state. According to him the loss of body mass was due to being in an air-conditioned room without natural (outdoor) 'vital' air which he considers essential for himself. Secondly, having been under observation and exposed to light 24 h a day, having been constrained to a small room and attached to the wires of medical devices, meant an additional strain which may have enhanced the weight loss. Yet, the large window facing west appeared to provide enough natural daylight (plants usually grow without problems behind windows, and, according to Jasmuheen, *light* is the source of nutrition in this case). However, the subject gave the impression of credibility, the psychiatric investigation and our psychological investigations had not revealed any pathology, and there was no factual evidence of having cheated. So, proponents of 'living on light' might argue that the study was not externally valid, that the phenomenon was real but could not persist under such tightly controlled conditions. But then, the fact of already being in a catabolic state at the outset of the study remains to be explained.

Be it as it may, the subject considers carrying out another study, implementing a design allowing him to have access to a 'natural' environment and possibly even to follow his daily routine.

Conclusion

Under the strict experimental conditions of a 10-day isolation study with proven 100% food deprivation and an unlimited supply of zero-calorie liquids, the subject's claim to be able to 'live on light' (hypothesis 3) could not be verified. The most plausible explanation of the altered metabolic parameters is provided by hypothesis 2: the subject was in a permanent phase-II fasting state which most likely began more than 10 days before the study started.

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