

The relationship between lighting and setting in coma patients

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Abstract

This report relates to the first set of results obtained during phase 1, conducted at the Rehabilitative Medicine department of Bologna's Ospedale Maggiore during the period September 2003- September 2004.

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Objectives:

The experimental hypothesis is that specific environmental conditions — and lighting in particular — can facilitate cognitive and precognitive performance.

1st HYPOTHESIS:

to establish whether or not, in a sensorially controlled environment, an illumination profile of predetermined and controlled variability will induce variations in the responsiveness of subjects with profound brain dysfunction.

2nd HYPOTHESIS:

to study the effects of lighting engineering solutions and relative application programs on the mood and the emotional background of the patient in the context of the rehabilitative process.

3rd HYPOTHESIS:

to study the effects of lighting engineering solutions and relative application programs on the reorganization of sleep-wake rhythm (conducted at the Casa dei Risvegli clinic, Bologna).

Patients:

The study of the 1st hypothesis includes subjects in *VEGETATIVE STATE* or *MINIMALLY CONSCIOUS STATE* induced by trauma, anoxia or vascular disorder with at least 7 days in coma.

VEGETATIVE STATE:

the patient appears to be wakeful, with cycles of eye closure and opening that resemble those of sleeping and waking. However there is no evidence that the patient can perceive the environment or his/her own body, communicate with others or form intentions. Patients are wakeful without awareness, typically breathing spontaneously and having stable circulation. VS may be a transitional phase in recovery from coma, or it may persist until death.

MINIMALLY CONSCIOUS STATE:

the patient provides inconsistent but clearly discernible responses that can be interpreted as an expression indicating awareness of self or of the environment and can be distinguished from coma or from SV by the presence of behavioural responses not found in these other two conditions. MCS can be a transitional state, or it may be a permanent outcome

Sensorially controlled environment means:

- reduction of background noise attributable both to nursing activity, and to visitors, television audio or other sources of sound
- suitable stimuli (use of key words or communication in sign language) of limited intensity or repetition, so as to avoid conditions that can favour habituation, with appropriate interstimulus intervals
- periods of programmed rest, with no stimulation whatever
- use of structured assessment criteria to monitor, over time, both the basic behaviour of the patient and behavioural response to specific stimuli
- management of whatever treatment may be administered to the patient, using a form of sensory stimulation that requires careful control.

Methods:

The 10 subjects are enrolled in the cognitive facilitation programme for a total duration of 8 weeks. 15 days of treatment are alternated with 15 days of non-treatment. Treatment is administered effectively on 5 days per week, and consists in a single daily session lasting 30 minutes.

The treatment is administered in the patient's own room, by an operator. The subject sits in a wheelchair, and the entire process is recorded by a TV camera trained on the face and hands. An observer is present.

The lamp is positioned behind the subject so that the lighting will be uniform without any glare and it's mounted to a movable support structure and adjustable for height to allow correct positioning relative to the stimulation table and the seat occupied by the patient.

During the study, responsiveness was measured on the electrophysiological level, by qualitative analysis of the EEG and of spectral components (light vs non-light condition), and on the behavioural front (where responses were elicited by way of an induction procedure).

The two different illumination profiles administered are:

a **profile - impulsive-** (illuminance is caused to peak at 3070 lux in 1' and held there for 3', then reduced to 1800 lux for 25')

a **profile – gradual** - (illuminance level is raised over 5' to 1800 lux and maintained at this value for 25').

A. Technical specifications of the appliance

Dynamic illumination is provided by a system utilizing an appliance of the SIVRA Compact series, fitted with seven T16 fluorescent lamps rated 54 watts (n.3 correlated colour temperature 2700 K, and n. 4 correlated colour temperature 6500 K).

An electronic panel provides access to the control functions of the appliance, which can be set manually or piloted automatically using programmable smart cards . The seven T16 lamps of the SIVRA appliance can therefore be controlled individually, allowing the operator to vary both the intensity of light emitted by the SIVRA and the correlated colour temperature, given by the different output settings selected for the 2700K lamps and the 6500K lamps.

B. Experimental test cycles

Measurements were taken on a table top positioned at a distance of 100 cm from the SIVRA appliance and approximately 50 cm from the face of the patient.

Given the continual change in position of the patient's head, it was deemed preferable to measure the level of illuminance at the table top.

Illuminance of 3000 lux registering at the stimulation table produces a value of between 500 and 550 lux measured on a plane corresponding to the face of the patient, at eye level.

The colour temperature value during the test is 4200 k.

Results of phase 1

Increased brain activity (one or more leads) was observed during the impulsive profile, in approximately half of the cases tested.

In the remaining half of cases, there was seen to be either no change or a slight increase in brain activity during both profiles.

From a quantitative and qualitative analysis of the test results, it emerges that where subjects underwent the illuminance experiment only, there were greater variations in frequency of electrical brain activity during exposure to the impulsive profile than during exposure to the gradual profile, and that the behavioural response of patients was higher when subjected to the combined cognitive facilitation and impulsive illuminance test than when subjected to the cognitive facilitation treatment only.

Notwithstanding the results of the experiment are still anecdotal in nature, as the number of cases does not allow a statistically valid generalization, they still afford an indication of great importance insofar as the illuminance context cannot be discarded as a variable devoid of influence on rehabilitation settings applied in cognitive facilitation procedures for the patient with profound brain dysfunction, and moreover, at least one temporal illumination profile among those tested (the impulsive) appears capable of facilitating minimal but recognizable behavioural responses in a patient diagnosed clinically as being in a vegetative or minimally conscious state.