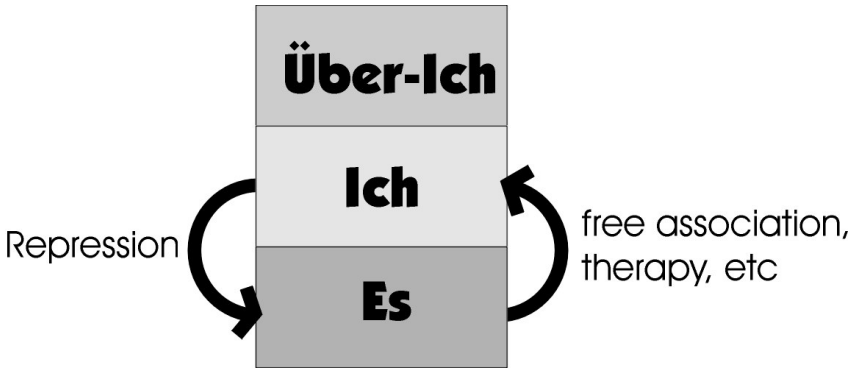
Elecrophysiological Correlates with Informationprocessing between Subconsciousness and Consciousness

by Christoph Veigl for the lecture "Biofeedback", AKH Vienna

1. Experimental psychology: evaluation of Freud's dream theory[1]

1.1 Freud's terminology of „the unconscious" and „repression"

Freud built up a hierarchical model of the human personality that consists of „Über-Ich", „Ich" and „Es". The „Über-Ich" could be considered as some kind of conscience, where parental rules, clerical threats or institutional laws reside. These instances guide or suppress the „Ich", the conscious part of or personality. The „Ich" is a representation of the psychic-areas that we are arware of and that we consider as „ourselvels". The layer of the „Es" symbolizes subconscious material, instincts and drives. These parts of the psyche became unconscious because of traumatic expierience and/or repression. Freud believed that dreams are a gate to these uncovered desires. He used hypnosis and later free association to bring up forgotten or repressed memories into awareness. He believed that psychoanalysis could unlock the real meaning of dreams because it understood the repressing forces. Through the process of free association, parts of the subconscious material are brought up into the „Ich", where they can be understood and interpreted.



Freud's model and the use of free assiciations and dream interpretation led to a revolution in psychology. Although the concept of repression has lots of evidence in the practical psychology there are many critical voices against Freuds theory:

„It is an essential part of brain function to insulate itself from the useless recall of inappropriate data. Freud ignored the possibility that the individual had chosen to seal off his response to certain situations because of their disharmonious and overstimulating quality. When a rational choice is being made in the interests of mental health, there is no need to postulate a repressing force...it is simply a biologically rooted fact that the sleeping brain, during rapid eye movement phases, fires off hallucinatory images from its vast store of recorded material. Without the guidance of the rational and enterprising mind, such hallucinatory images are mere fragments which lack significant meaning at any level. Dream interpretation is especially attractive because of the capacity of the human brain for symbolization. The fact that any symbols have a universal quality does not mean that they reach a level of significance which permits insight into the personality. Manipulating these symbols becomes a magical game which covers up the need to ask serious questions about man's psychic life. All that the study of symbolism shows is that man's cerebral equipment readily symbolizes. It adds images to the vocabulary in the service of the esthetic life. Once it is established that a tower symbolizes an erect penis, vocabulary has been expanded to produce a kind of joke."[2]

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[1] Thomas Köhler, Heiko Borchers, PPmP 46 (1996): 419-422

[2] Paul Rosenfels: Freud and the scientific method, http://eng.hss.cmu.edu/gender/rosenfels/Freud.html#P1S5

1.2 Goal and Method

During the experiment, 15 female students in the age of 21 - 34 were asked to associate to parts of their own dreams and to those of a control subject. Skin conductance reaction (SCR) were assessed during these procedures. In addidtion, the subject had to report as often as possible about accompanying feelings of uneasiness during associations. The experiment should verivy or falsify Freud's assumption that the elements of the dream are particulary close to the repressed unconscious and that free associations starting from them should therefore encounter sucessively growing resistance.

1.3 Procedure & Setting

The students made protocols of the dreams they had last night. One experimental unit had 2 phases: In the first phase, the supervisor chose short sentences or words from the dream-protocol of the test person and shouted them. Then the test person started to whisper free associations for about 2 min. Additionaly, the person had to press 1 of 5 buttons to classify the emotions that came with the association. (button 1: very pleasant, button 2: pleasant, button 3:neutral, button 4: unpleasant, button 5: very unpleasant). The Buttons were scored from -2 (Button1) to 2 (Button5). To evaluate the psychophysiological activity, SCR was recorded during the test. The second phase resembles the first phase, whith the difference that the dream-element that was presented to the test person was taken from the protocol of another person. These steps were repeated 10 times for each testperson, so that after the test the averaged SCR-data and emotional reactions to the word-pairs could be compared.

1.4 Data & Evaluation

SCR	1	2	3	4	5	6	7	8	9	10	all
OWN	42,3	44,1	42,2	43,7	43,2	43,8	45,6	42,3	43,3	41,5	432,5
FOREIGN	40,6	40,2	40,5	41,9	39,4	40,7	41,2	40,6	41,1	40,2	405,5

Fig.1: SCR-Data for own and foreign dream material

The table in Fig.1 shows the SCR-Data of each trial, comparing the own dream-matrerial to the foreign. The skin conductance levels that arise during the association to own dreams are significant higher than the levels of the foreign dream-material.

upl. emotions	1	2	3	4	5	6	7	8	9	10	avg
OWN	0,58	0,0	0,14	0,48	0,23	0,59	0,25	0,0	0,52	-0,47	0,22
FOREIGN	-0,09	-0,27	-0,06	-0,11	-0,17	-0,07	-0,37	-0,38	-0,81	-0,2	-0.17

Fig.2: emotional quality of the test person's associations

Fig.2 shows the averaged emotional classification done by the test persons during associating. (A high positive value means unpleasant emotion, a high negative value means pleasant emotion.)

1.5 Results

The study shows increase of skin condactance and unpleasant emotional reactions when associating to own dream-contents in comparison to foreign dream-contents.
These findings are in accordance with Freud's theories of dreams, resistance and repression.

2. Conscious and non-conscious processes at conditioning

to visual stimuli[3]

2.1 Goal and Method

This study investigates the nonconscious elictation of a previously conditioned response by using a conditioning paradigm with visually masked affectively valent facial schematics. Skin conductance (SCR) and brain acitivity (ERP, event related potentials) were main dependent measures. Following a preconditioning phase in which subjects viewed energy masked pleasant and unpleasant facial schematics, conditioning with an aversive shock was established to unmsked presentations of an unpleasant facial schematic. A postconditioning phase of masked presentations showed how the conditional effect within awareness might affect the same stimuli when presented outside awareness.

The results revealed that responses to the CS+(unpleasant face) changed significally in predicted directions from preconditioning to postcondition-phase when compared with the responses to CS-(pleasant face).

2.2 Procedure

17 right-handed man participated, mean age was 20.8 years.The experiment had 3 phases: precon, con and postcon. in ervery phase, a tone signaled the beginning of a trial (T1) and the subject responded by saying „ready“ (T2) while looking at the fixation point. Four to 6 sec. after T2 the stimulus was presented (S1) (masked or unmasked facial image, depending on the experimental phase). S2 was the shock/no shock event, taking place 2,500ms after S1. Total data collection time was 3 sec for each trial, intertrial time was about 15 sec. The subjects were told that at some point soon after saying „ready“ there would be a quick flash of something on the screen, which might or might not be followed by a shock several seconds later.

Step	Activities
1	Physiological recording preparation: scalp, elecrodermal and aversive shock electrodes attached; subject placed in sound-proof, electrically shielded temperature controlled recording booth
2	Aversive shock stimulus level established
3	Individual visual threshold level established
4	Masked preconditioning (precon) phase: 24 random presentations each of the pleasant and unpleasant face
5	Unmasked contitioning (con) phase: one preparatory presentation each of the stimuli, followed by 24 random presentations each of the pleasant and unpleasant face. Unpleasant face was paired with shock on 20 of 24 trials (propability of shock was 0.83). Conditioning effect established by differential SCR responisivity on four catch trials not paired with shock.
6	Masked postconditioning (postcon) phase: 24 randomized presentations each of the pleasant-unpleasant face
7	Individual visual threshold level retested and compared

The visual stimuli were developed with a medical illustration specialist to control for purely perceptual stimulus characteristics such as lines and angles. The stimuli were presented on 3 x 5 in. white cards. Stimulus duration for the masked (subliminal) presentations was set individually according to the results of a visual threshold procedure that detects the individual varying minimum time for identifying an image. The mean correct time for the 40-trial pretest was 20.59 ms. Stimulus duration for the unmasked (supraliminal) presentations was 50 ms. Presentations of CS+ and CS- were randomized whith each experimental phase, consisting of 48 presentations (24 CS+ and 24 CS-). For masking the images, an energy masking technique was used, that renders the image perceptually inaccessible, so that the person cannot „see“ the masked stimulus. Careful attention to the properties of the masking technique is needed, because differences in light and dark adaption can give rise to greater or lesser perceptual sensitivity.

2.3 Physiological measures

[3]Philip S.Wong, Howard Shevrin, William Williams, Psychophysiology 31 (1994):87-101

Skin conductance was recorded from silver-silver chloride electrodes attached to the index and the middle fingers of the non-preferred hand (left). A constant voltage system was used, with 0.5 V applied across the elctrodes and the output recorded on a DC amplifier.
ERPs were measured at the electrode sites Cz, Oz, P3 and P4 using the (10-20) System of electrode placement with earlobes as reference. All ERP measures were based on an average of 24 presentations per stimulus category and experimental phase.
Stimulating electrodes were attached to the index and the ring finger of the preferred hand (rights). The stimuli for the aversive shock were single 200-ms constant-surrent square-wave pulses. The intense level was determined by each subject and should be annoying or unpleasant.

2.4 Evaluation & Results

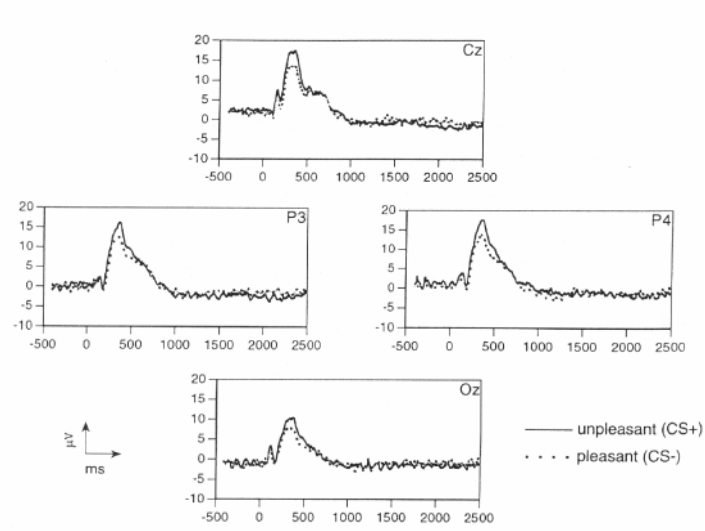


Fig 3: Grand averages for the conditioning phase. S1 (presentation of pleasant-unpleasant pace) at time 0, S2 (shock-no shock) at time 2500.

The peak amplitude of the P300 component for the unpleasant stimulus was significant greater than for the pleasant stimulus during the conditioning. Mean Amplitudes: CZ(320ms), Oz(332ms), P3(340ms), P4(343ms)

ERP findings, Conditioning Phase

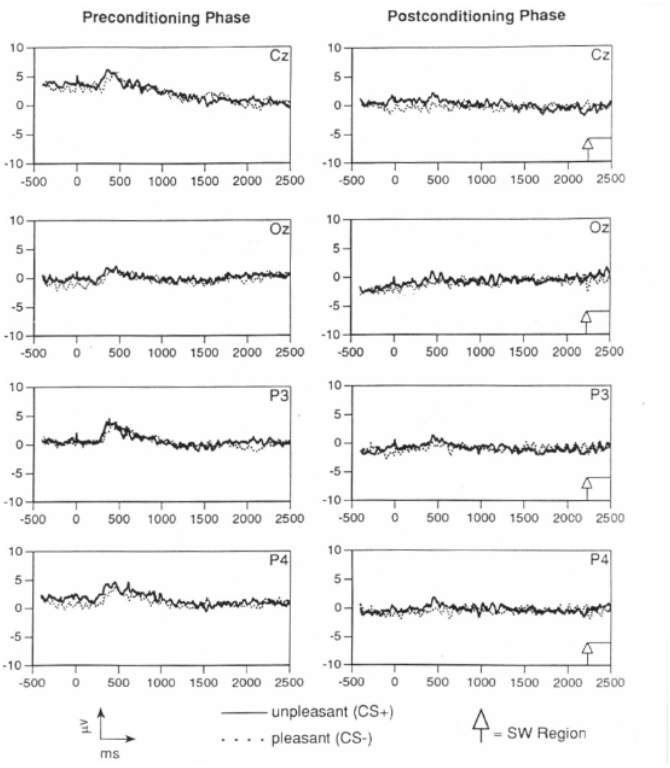


Fig 4: Grand averages for the preconditioning and postconditioning phases, the arrow marks the SW-onset for CS+

The slow wave region analyses are consistent whith the hypothesis. SW changes between precon and postcon phase occured primarily as a function of the shock-linked stimulus (unpleasant face) and can be characterized by a negative to positive voltage deflection just prior to the S2 event.

Preconditioning versus Postconditioning Phase

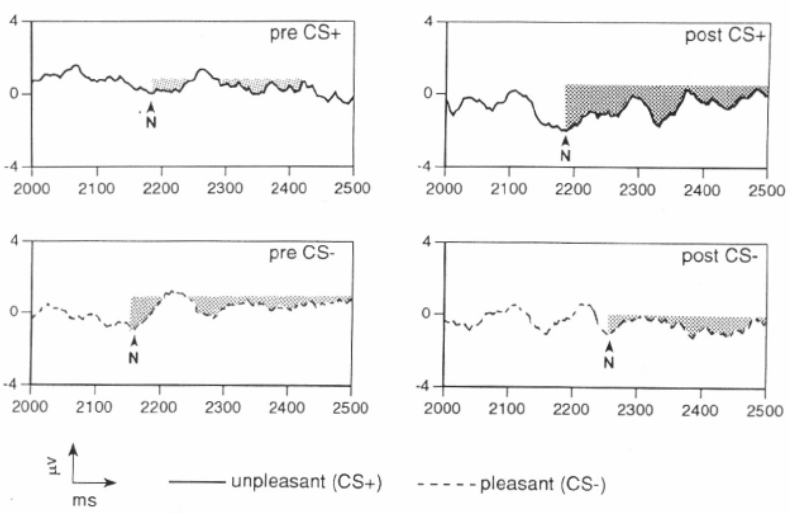
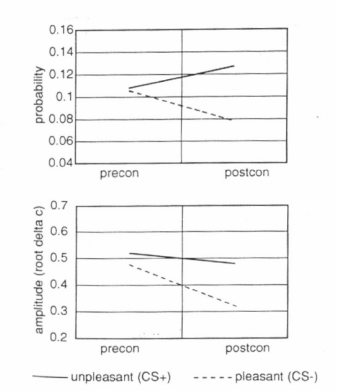


Fig 5: Illustration of SW component measures applied to Cz grand averages. N:negative peak. The post-CS+ condition has a significantly more negative peak and greater area than the other conditions.



SCR findings

Fig. 6 shows a greater amount of elecdrodermal activity for the shock-linked unpleasant stimulus than for the pleasant stimulus.

Overall, the ERP and SCR responses to the unpleasant stimulus indicate that the unmasked(supraliminal) conditioning effect was „carried over“ to the masked (subliminal) postcon phase. Subjects appear to react as if they „expect“ or „anticipate“ a shock when presented whith the shock-linked unpleasent stimulus, even in the absence of perceptual awareness of that stimulus.

3. The elecrophysiological role of Anxiety in Visual Imagery[4]

3.1 Goal & Method

Two groups of student subjects and one group of client subjects were monitored by EEG, EOG (electrooculogram), GSR (galvanic skin response) and FPR (finger pulse response) during free imagery, free imagery recall, dream recall and emergent uncovering psychotherapy. The goal of the investigation was to show that visual imagery in general do not desynchronize alpha, but that the desynchronization depends on the properties of the image.

2.2 Procedure

The student group 1 consisted of 10 volunteer undergraduate male subjects. Stundet group 2 consisted of 6 female and 1 male from the same population. The client group was composed of 5 females and 4 males. All subjects were experienced in emergent uncovering psychotherapy, the ages ranged from 22 to 48 with a mean of 33,6.The EEG electrodes were positioned in the occipital area, with reference to the earlobes. GSR was recorded with silver electrodes fixed to the third and fourth fingers of the subjects left hand.

A 1-min relaxation period preceded each of four experimental conditions to establish a baseline measure. For each of the following conditions the subject signaled the experimenter

[4]Howard Morishige, Joseph Reyher, J. Abn. Psychol. 84 (1975):531-538

at the onset and termination of each visual episode if images by pressing a microswitch with his right hand. After each imagery episode, he was asked to describe in detail what he saw.
Free imagery: The subject was asked to lean back in the chair, close his eyes and report the pictures that came into his mind's eye. This condition lasted 15 min.
Free imagery recall: the subject was asked to close his eyes and visualize, in the original sequence, the visual images the he reported earlier in the free imagery condition.
Dream recall: The subject was asked to close his eyes and visualize the dream in question.
Emergent uncovering: The instructions were the same as the free imagery condition. The subject was asked to reimage hot images, as detected by GSR, as well as those determined by subjective expressions of resistance (opening the eyes, sweating, headache). This condition lasted 30 min.

2.3 Data & Evaluation

Free Imagery	Student 1	Student 2	Client
Alpha	-3.1	-0.1	-2.8
REM	2.6	11.0	3.5
GSR	6.1	2.0	1.3
FPR	3.9	1.2	-0.3

Free Imagery recall	Student 1	Student 2	Client
Alpha	-8.1	-1.9	-7.2
REM	3.4	10.7	2.8
GSR	4.3	1.7	0.8
FPR	2.1	1.5	0.7

The mean difference between the free imagery recall and dream recall conditions is that the pysiological reactions associated with the revisualization of a recalled dream is greater than the activity associated with the revisualization of a comparable period of free imagery.

Dream recall	Student 1	Student 2	Client
Alpha	-10.7	-8.1	-9.4
REM	8.7	14.3	8.5
GSR	4.8	3.0	2.3
FPR	3.8	2.3	-1.2

Anxiety and alpha desychronization

Hot image	Student 1	Student 2	Client
Alpha	-16.0	-14.7	-13.0
REM	15.0	14.8	13.8

A significant decrease in alpha over the relax baseline for all three groups was obtained whenever a visual image associated with a GSR of 2000 Ohms or greated was observed. The uncovering of repressed or anxiety-producing material illustrates that apparantly innocent images often are remote derivates of the same anxiety-producing processes that produce hot images.

2.4 Results

The results showed that visual imagery per se did not desynchronize occipital alpha. However, dream visualisation and images accompanied by an electrophysiological pattern of axienty („hot" images) were associatied with alpha desyncronization. The effort of revisualizations was also found to be an influencing variable, but it was not as desynchronizing as was dream recall. The overall findings are consistent with Freud's conceptualisation of repression in general and his theory of dreams in particular. In comparison with verbal representations, which include free association, spontaneous visual imagery allows more direct expression of the aims and objects of repressed drives, producing anxiety and psychopathology in the process.

4. Biofeedback to enhance psychophysiological effects of imagery[5]

4.1 Goal & Method

[5]Kenneth L. Lichstein, Timothy J. Hoelscher, Behav. Re. Ther. 27 (1989):569-572

The aim of this investigation was to increase arousal by the provision of biofeedback. The ability to generate psychphysiological arousal during imagery could be therapeutically beneficial to individuals receiving emotive imagery therapies.

4.2 Procedure

In a previous study, 62% of randomly selected 95 students failed to attain the clinically derived criterion for significant skin resistance level arousal when fearful imagery was presented. 30 of the subjects whose skin resistance levels proved unreactive were invited to participate in the experiment. There were 3 experimental-groups (feedback, false feedback, no feedback), each with 10 persons. Skin Resistance Level (SRL), EMG and EKG were monitored, the output of the SRL produced a variable loudness tone correlated with SRL for biofeedback.

The experiment consisted of 6 sessions:

Group 1: Feedback

Session 1: The subject received five 1,5 min imagery trials. SRL, EMG and EKG were recorded during the trials. intertrial time was 1 to 5 min to enable the subject's SLR to return to the baseline. No biofeedback was applied.

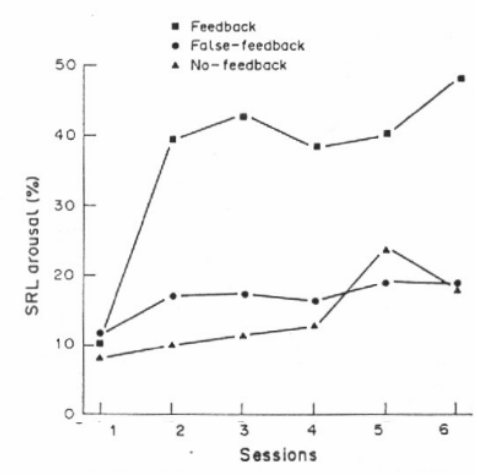
Session 2,3: personal experimentation with thoughts, sensations and emotions to train the biofeedback process without imagery.

Session 4,5: The identical imagery used at session 1 was supported with biofeedback.

Session 6: resembled session1, the difference of the subject's psychophysiological imagery skills after the feedback process was tested.

Groups 2 and 3 resembled the group 1 sessions with a difference in the feedback-method:
Group 2 received a feedback-tone that was manually generated and uncorrelatd with the SCR.
Group 3 received no biofeedback at all.

4.3 Results



The analyses showed significant effects of biofeedback on the imagery-caused arousal of SRL, EKG and EMG-data. For SRL and EMG there were no between group differences in session 1. In sessions 2-6, feedback was significantly greater than false- and no-feedback. Within the feedback group, sessions 2-6 did not differ from each other and all were significantly greater than session 1. No session effects occurred at the 2 control groups. The treatment effects in the feedback group were maintained in session 6 (imagery unassisted by feedback). On the average, SRL feedback effects were 2,5 times greater than in the control groups.

5. Internet Links

http://www.ume.maine.edu/%7Ejmb/jmb10.html	Journal of mind and behaviour
http://freenet.msp.mn.us/ip/health/stockley/new_links.html	new mental health resource
http://www.psychologie.uni-bonn.de/kap/links/li_pt.htm	clinical psychology resources
http://freud.tau.ac.il/~biosee/	clinical psychphysiology
http://www.yorku.ca/dept/psych/lab/grohol.htm	Psychology Web Pointers
http://www.iop.bpmf.ac.uk/home/depts/library/psy/inst.htm	Psychoanalythical Library
http://www.zynet.co.uk/imprint/SPECIAL/absfront.html	Tucson II classified abstracts
http://www.shef.ac.uk/%7Epsysc/InterPsych/inter.html	Interpsych Medical Database