EEG activity and heart rate during recall of emotional events in hypnosis: relationships with hypnotizability and suggestibility

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Abstract

The purpose of the present research was to find physiological and cognitive correlates of hypnosis, imaginative suggestibility and emotional experiences. After the administration of a standard hypnotic induction, the EEG and heart rate (HR) were recorded during self-generated happy and sad emotions using a relaxation condition as a control. Physiological recordings were also obtained during three eyes-open and eyes-closed baseline periods: (1) waking rest; (2) early-rest in hypnosis (just after the hypnotic induction); (3) late-rest hypnosis (at the end of hypnotic condition). EEG was recorded at frontal (F3, F4), central (C3, C4), and posterior sites (middle of O1-P3-T5 and O2-P4-T6 triangles). Using log transform of mean spectral amplitude, eight EEG frequency bands (4–44 Hz) were evaluated. High hypnotizable subjects, as compared to the lows, produced a higher theta1 amplitude (4–6 Hz) across both left- and right-frontal and right-posterior areas. These subjects also produced smaller alpha1 amplitude (8.25–10 Hz) over both left and right frontal recording sites. High suggestible subjects, during resting conditions, disclosed higher theta2 (6.25–8 Hz) and alpha1 amplitudes in eyes-closed as compared to an eyes-open condition than did low suggestible subjects. High suggestible subjects also showed, in hypnosis-rest condition, higher 40-Hz amplitudes (36–44 Hz) and HR activity than did low suggestible subjects. Hypnotizability and not suggestibility was found to moderate emotional processing: high hypnotizable individuals self-reported greater levels of emotional experiences than did low hypnotizables especially in terms of negative emotion. High hypnotizables, during processing of emotional material, also disclosed opposite 40-Hz hemispheric asymmetries over anterior and posterior regions of the scalp. These subjects during happiness showed an increased production of 40-Hz activity in the left frontal and central regions of the scalp, while during sadness they showed an increased activity in the right central and posterior regions. The hemispheric asymmetries for relaxation condition were similar, but less marked, to those

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obtained for happiness. No significant interactions involving both hypnotizability and imaginative suggestibility were found for physiological variables considered in this study. This demonstrates that hypnotizability and suggestibility reflect different underlying psychophysiological activities. © 1998 Published by Elsevier Science B.V. All rights reserved.

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1. Introduction

Two dominant themes in contemporary hypnosis over the last 30 years can be shown: (1) the question of the existence of a hypnotic state (state vs. non-state) and (2) hypnotic susceptibility as a stable individual difference (i.e. trait vs. situational manipulation) (see Fellowes, 1990; Hilgard, 1973; Kirsch and Lynn, 1995; Kihlstrom, 1997). However, upon closer examination, hypnosis research has addressed a variety of dimensions that do not fall easily into these two camps. Recently Kirsch and Lynn (1995) suggested a convergence of position with many of the positions best viewed as lying on a continuum. However, Kihlstrom (1997) points to a number of important distinctions which separate the more cognitive theoretical explanations including the neodissociative one from the more sociocognitive ones. According to Kihlstrom (1997), hypnosis is a complex phenomenon, simultaneously consisting of a social interaction between subject and hypnotist and of a state of altered consciousness involving basic cognitive mechanisms underlying perception, memory and thought. In the present study, we address the question of the relationship of hypnosis and suggestion and the manner in which these heighten emotional experiences.

1.1. State vs. non-state positions

One of the best articulated state positions is the neodissociative approach (Hilgard, 1977, 1992) which suggests that hypnosis reflects the activation of subordinate cognitive control systems operation in a hierarchical order. According to Hilgard’s neodissociation theory, when a hypnotic suggestion becomes operant, the suggestive behavior is characterized by a reduced influence of executive control and volition and by an increased activation of subordinate systems of control whose automatic activity produces the suggested response. The result is a division in consciousness, i.e. the control executive system becoming ignorant of the intentional activities performed by the subordinate system and, therefore, experiences these activities as involuntary. This model assumes that hypnosis alters normal cognitive functioning and that such alteration is reflected in both behavior and experience (e.g. amnesia, analgesia) as well as psychophysiological functions. In line with this view Kihlstrom (1987), in his excellent review on ‘cognitive unconscious’, defines hypnosis phenomena as a category of ‘subconscious declarative knowledge’ and invokes Janet’s concept of dissociative phenomena (Hilgard, 1986) to describe hypnosis. In certain phenomena of hypnosis in which dissociation is operating, the mental representations fully activated by perceptual inputs, are resident in working memory and therefore available to introspection, they appear to be temporarily set aside and seem nevertheless inaccessible to conscious awareness. The alternative position, commonly named the social-psychological approach (Spanos and Coe, 1992), views hypnosis as a social situation in which hypnotic behavior may be described in terms of suggestibility, expectations, and demands present in the hypnotic situation. In particular, a number of researchers (e.g. Barber, 1969; Kirsch, 1997; Weitzenhoffer, 1963, 1980) propose that suggestion, rather than hypnosis per-se, is the basic phenomenon that may describe hypnotic behavior. Recently Kirsch (1997) indicated that hypnotic susceptibility scales are better measures of waking suggestibility than they are of hypnotizability. He proposed a definition of hypnosis as changes in experience following suggestions by reducing the hypnotic induction rituals to being nothing more than a particular set of suggestions, rather than the means to establish a hypnotic
state. He proposed to reinterpret hypnotizability scores as indexes of non-hypnotic imaginative suggestibility.

Assuming that hypnotic phenomena are accurately described by individual differences in imaginative suggestibility than by individual differences in hypnotizability, then we would expect to find, after the administration of an induction, more suggestion-induced differences in physiological responding between high and low suggestible subjects than between high and low hypnotizable ones. Anyway, if suggestibility and hypnotizability refer to similar behavior then they should share similar patterns of physiological activity.

1.2. Hypnotic susceptibility

The second major question directing hypnotic research is that of hypnotic susceptibility (for an overview of hypnotic susceptibility research see Fromm and Nash, 1992). In this line of research various measures of hypnotic susceptibility have evidenced reliable correlation coefficients above 0.60 (Bowers, 1983). Even more impressive is the finding that hypnotic susceptibility has been shown to be as stable a measure of individual differences as measures of I.Q. or various personality inventories with a test-retest correlation of 0.71 when considered over 10-, 15-, and 25-year periods (Morgan et al., 1974; Piccione et al., 1989). Given this stability, it is surprising that there exist few individual difference variables that can reliably predict hypnotizability (Kirsch and Council, 1992; Silva and Kirsch, 1992). Even conceptually similar measures such as dissociative experiences show an orthogonal relationship with hypnotic susceptibility (Faith and Ray, 1994; Ray and Faith, 1995; Ray, 1996). One possibility in predicting hypnotizability may lie in psychophysiological measures as have been shown in other contexts (e.g. Tomarken et al., 1990).

Initial studies on psychophysiological indicators of hypnotic susceptibility (cf. London et al., 1968; Morgan et al., 1974; Nowlis and Rhead, 1968) have reported a positive relationship between the time-percentage occurrence of EEG alpha waves in resting (eyes closed) conditions and hypnotizability. However, Evans (1972) did not find this difference and suggested that previous results were affected by demand characteristics. In his review, Dumas (1977) suggested that the alpha hypnotizability relationship resulted from biased subject selection, a conclusion not supported by Barabasz (1983). In their critical review of alpha and hypnotizability, Perlini and Spanso (1991) concluded that there is little support for an alpha-hypnotizability relationship.

According to Crawford and Gruzelier (1992) the choice of alpha band ranges (e.g. 7–12 Hz or 8–13 Hz) may have influenced findings since recent studies have revealed two alpha bands (slow parietal alpha: 7–10 Hz and fast occipital alpha: 10–13 Hz) that are functionally different (Coppola and Chassy, 1986; Coppola, 1986). The slow alpha activity has been found to be related to a relative cognitive inactivity or low alertness (e.g. Bosel, 1992; Crawford et al., 1995; Gale and Edwards, 1983) and the fast alpha activity to mental workload (e.g. Pfurtscheller and Klimesch, 1991; Sterman et al., 1994) and memory performance (e.g. Klimesch et al., 1990).

The most consistent relationship between EEG activity and hypnotizability exists in the 4–8 Hz theta band (see Crawford and Gruzelier, 1992). Crawford (1990, 1991) found that high hypnotizables generated greater power than low hypnotizables in the high theta (5.5–7.5 Hz), but not the low theta (3.5–5.5 Hz) range from frontal to posterior regions of the scalp. Recently, Crawford et al. (1996) reported that high hypnotizables, in comparison to the lows, showed significantly greater right hemisphere activity compared to the left hemisphere in parietal region in high theta (5.5–7.5 Hz), high alpha (11.5–13.45 Hz), and beta activity (16.5–25 Hz). Vogel et al. (1968) describe two inhibitory processes reflected in the slow EEG activity: `class I inhibition’ and `class II inhibition’. Class I inhibition is characterized by gross inactivation of a global excitatory process such as that which would result in relaxation or drowsiness. Class II inhibition is associated to selective inactivation as present during the performance of automatized behaviors. According to Vogel et al. (1968) class II inhibition is reflected in the EEG frequency which differentiates theta from alpha, designated for normal adults at about
In other studies theta has been associated with continuous concentration of attention and selective attention (e.g. Basar-Eroglu et al., 1992; Bruneau et al., 1993; Schacter, 1977). In the field of hypnosis research, Galbraith et al. (1970) reported the highest significant positive correlation between 5 Hz theta and hypnotizability. The authors interpreted their findings by suggesting that an increase of theta activity in high hypnotizables was reflecting the ability of these subjects to focus attention on relevant stimuli and to shut off the irrelevant ones. In general, a number of subsequent studies have reported a strong relationship between theta (4–8 Hz band) and hypnotizability (e.g. Graffin et al., 1995; Sabourin et al., 1990). Barabasz (1990) reported that high but not low hypnotizable subjects generated more theta power just after a condition of restricted environmental stimulation.

1.3. Hypnosis and suggestion

It is generally assumed that suggestibility is not a unitary phenomenon (Eysenck, 1947, 1991) and the variety of procedures used to measure suggestibility is somewhat diverse. Consequently, the results among studies are often contradictory (see Gheorghiu, 1989 for an overview). Recently a test measuring sensory suggestibility was constructed (Gheorghiu et al., 1993). Sensory suggestibility refers to a variety of imaginal situations characterized by the individual tendency to judge simulated stimuli as real. With the construction of this reliable test, it is now possible to measure sensory suggestibility.

Evans (1989), after a historical and empirical review, concluded that suggestibility and hypnotizability can be considered as the product of different processes and therefore one is not an exhaustive expression of the other. Hilgard (1973, 1991) also concluded that hypnotic behavior cannot be defined simply as a response to suggestion since there are several forms of suggestion including impersonal suggestions, conformity and placebo responses which do not belong to the hypnosis condition, and vice versa, hypnotic phenomena which cover more than specific responses to suggestion.

Further, although there exists a large literature examining psychophysiological concomitants of hypnosis and hypnotic susceptibility (see Crawford et al., 1996; Graffin et al., 1995; Sabourin et al., 1990; for a review see Crawford and Gruzelier, 1992), there are few, if any, studies examining psychophysiological contributions in the area of suggestibility. This may result from the lack of integrative theoretical approaches to direct research in relation to the variety of suggestive phenomena (Gheorghiu, 1989). However, one hypothesis to be tested is that individual differences in sensory suggestibility and hypnotizability are expressions of the same psychophysiological process.

1.4. Attention and emotion

A variety of studies have focused on site specific differences during emotional processing. For example, Davidson et al. (1979, 1990) and Davidson (1992), using alpha activity, found that cortical activation (less alpha activity) in the right frontal site and anterior temporal area correlated with disliked segments of film clips and a relative frontal left hemisphere activation with liked ones. In experiments in which subjects used a mood induction procedure to recall past emotional experiences (sad, happy, depression or sexual emotions) there was an activation of parietal region of the cortex (Tucker et al., 1981; Tucker and Dawson, 1984). Stenberg (1992) found an increased theta activity in the right lateral frontal region during recall of pleasant and unpleasant events. Ray and Cole (1985) engaged subjects in positive and negative emotional tasks which required internal vs. external attentional focus. They found more abundant right temporal beta (16–24 Hz) activity was associated with positive as compared to negative emotional tasks. The role of hemispheric asymmetry in emotional processing is generally accepted but it is still not clear how each hemisphere contributes in the generation of emotional state. This is since a number of other variables such as personality traits or emotion intensity may affect hemispheric asymmetry (see e.g. Davidson et al., 1990; Kline et al., 1994; Tomarken et al., 1990; Tucker et al., 1981; Wexler...
et al., 1992). Recently, Heller (1993) carried out an interesting model of emotion in which the right parietotemporal regions of the cortex not only are specialized for the processing of autonomic and behavioural arousal in emotional states. In the context of this model it is suggested that the right parietotemporal system operates in conjunction with a system localized to the frontal lobes that is involved in the modulation of the emotional valence of experience. Hypnosis is often viewed as a condition of heightened experience and attention (e.g. Crawford, 1982; Crawford et al., 1996; De Pascalis, 1993; Gruzelier and Warren, 1993) in that hypnotically responsive individuals in the waking as well as in hypnosis conditions, both in cognitive task performances and self-report measures, demonstrate more controlled attention, and greater absorption in everyday events (Crawford, 1982; Crawford et al., 1993; Karlin et al., 1979; Tellegen and Atkinson, 1974). The assertion that high hypnotizable persons have a greater ability to control the activity of the attentional system is supported by a growing number of neurophysiological findings. One of the most reliable findings is that there are changes in ERP components (N1, P2, N2 or P3) during hypnosis when high hypnotizables are able to reduce or eliminate the conscious awareness of incoming auditory (Crawford et al., 1996; Jutai et al., 1993), visual (De Pascalis, 1994; Jasiukaitis et al., 1996; Spiegel et al., 1985), olfactory (Barabasz and Lonsdale, 1983; Spiegel and Barabasz, 1988) or somatosensory (Kropotov et al., 1997; De Pascalis and Carboni, 1997; Spiegel et al., 1989; Zachariae and Bjerring, 1994) stimuli.

A robust finding in the hypnosis literature is that high hypnotizables in waking, as well as in hypnosis conditions (e.g. Bower, 1981; Bryant and McConkey, 1989; Crowson et al., 1991; Crawford et al., 1995; De Pascalis et al., 1987, 1989), usually report more intense affect when experiencing positive and negative emotions. Using 40-Hz EEG as a physiological indicator of focused arousal as suggested by Sheer (1975), some evidence has been provided that such greater ability in accessing emotions is due to the greater ability of these subjects to focus their attention to relevant emotional events and to shut off the irrelevant ones. In a previous study carried out in our laboratory high hypnotizable subjects, while they were in hypnosis, experienced greater feeling ratings of self-generated negative events than they did in a waking condition (De Pascalis et al., 1989). These emotional patterns were paralleled by an increased level of 40-Hz activity in hypnosis as compared to waking state.

The purpose of the present research is to bring together the areas of hypnosis, suggestibility, and emotional experiences. Given the current state of research in hypnosis and suggestibility, we suggest three major hypotheses and a number of pilot questions. Firstly, we expect to find greater theta activity in highly hypnotizable persons compared to the low hypnotizable ones. Secondly, emotionality should be experienced more strongly by high as compared with low hypnotically susceptible individuals. And, thirdly, based upon prior hypnosis research on electrocortical processing of emotional material (Crawford et al., 1996; De Pascalis et al., 1987; Heller et al., 1995; Ray and Cole, 1985), we expected greater hemispheric asymmetries during induced emotions in high hypnotizables compared to low hypnotizables. High subjects were expected to show greater EEG asymmetries associated with focused attention i.e. high frequency theta, high alpha, beta and 40-Hz EEG activity. Further, using a more advanced measure of 40-Hz EEG spectral amplitude, we sought to examine EEG differences in high and low sensory suggestible subjects in an attempt to replicate and extend our previous 40-Hz EEG correlates of emotionality. In particular, we expected to find that such asymmetries should be manifested in a reciprocal relationship between frontal and posterior sites with left frontal and right temporo-parieto-occipital sites associated to positive affect and with posterior right site associated with negative one. Assuming that suggestion and hypnosis are part of the same phenomenon, then we expected to find a common physiological substrate between individuals characterized by extreme levels of sensory suggestibility and hypnotizability dimensions.

Past research (Kahneman et al., 1969; Lacey, 1967; Lacey and Lacey, 1970) had demonstrated
that cognitive effort in generating imagery and other internal activity is accompanied by heart rate (HR) increase. However, HR increases have also been found to reflect emotionality. Many studies have found HR modifications during almost every emotional state (for a review see Cacioppo et al., 1993; Levenson, 1992; Palomba et al., 1997). Thus, HR has some claim to be considered as a reasonable index of cognitive and emotional work. Whether HR increases reflect cognitive effort or emotional arousal may be dependent on individual differences and specific experimental factors. Assuming that highly hypnotizable subjects become more emotionally involved in their imagining than lows (Hilgard, 1979; Tellegen and Atkinson, 1974), the last but not least aim of the present study was to evaluate the validity of the suggestion that self-generated emotional events produce a greater HR increase in high than low hypnotizable subjects. A similar HR trend was expected for high and low sensory suggestible subjects.

2. Methods

2.1. Subjects

Twenty right-handed females between the age of 20 and 25 years were selected from a sample of 85 psychology students. The subjects were all volunteers who were tested in small groups of 3–6 persons. They were informed that the experiment involved evaluating their sensibility to perceive sensory stimuli, but were unaware that a standard suggestibility scale was being administered, the SSKG (Gheorghiu et al., 1993). This is a group scale consisting of 10 items designed to measure an individual’s level of suggestibility based on sensory judgement with scores ranging from 0 to 40. A second was held in which subjects were administered individually the Stanford Hypnotic Susceptibility Scale, Form C (SHSS: C; Weitzenhoffer and Hilgard, 1962). The SHSS: C scale was administered by tape-recorder after the experimenter had established rapport with the subject. The experimenter was a woman. The experimenter stopped the tape if extra time was necessary to the subject to comply with task suggestibilities. The hypnotic induction was administered by tape for standardization purposes and because there is evidence of little or no difference between the effects of live versus taped inductions in voluntary students (e.g. Shor and Orne, 1963; Ulett et al., 1971). Following the administration of the SHSS, the subjects were asked to write down two emotionally-meaningful situations in their lives, one of happiness and another of sadness, and one neutral-relaxation control situation (i.e. with no markedly positive or negative emotional valence). Handedness was evaluated with the Italian version of the Edinburgh Inventory Questionnaire (Salmaso and Longoni, 1985). Subjects were also administered the Tellegen Absorption Scale (TAS: Tellegen and Atkinson, 1974) and the Betts’ questionnaire of mental imagery (Sheehan, 1967). The subjects were all women since it is reported that women are significantly more susceptible to hypnosis than men (Bowers, 1971) and that sex is a moderating variable in the relationship between hypnotic susceptibility and hemispheric asymmetry (Gur and Gur, 1974). Moreover, there is experimental evidence for a greater task-induced hemispheric asymmetry in males compared to females (see e.g. Glass et al., 1984; Ray et al., 1976).

Ten high and 10 low hypnotically susceptible females were selected such that each high and low hypnotizable group included half of the subjects with high and half with low level of sensory suggestibility. Subjects were designed as being high hypnotizables (N = 10, mean = 10.1, S.D. = 0.69) when their scores on SHSS: C were 0.9 S.D. above the group mean (N = 60, mean = 6.5, S.D. = 2.33); an equivalent but opposite deviation designated the low hypnotizable subjects (N = 10, mean = 2.9, S.D. = 1.1). In the same way subjects were designed as being high suggestibles (N = 10, mean = 23.0, S.D. = 3.2) when their scores on SSKG were 0.9 S.D. above the group mean (N = 60, mean = 13.8, S.D. = 7.1); an equivalent but opposite deviation designated the low suggestible subjects (N = 10, mean = 5.3, S.D. = 2.2). At the beginning of the experimental psychophysiology session, subjects were administered the State Anxiety Version of the State-Trait Anxiety Inventory (STAI, Spielberger et al., 1970). Subjects who
had reported psychiatric or neurological disorders were excluded from EEG recordings. Since menstrual cycle may affect EEG activity (Glass, 1968), no subjects were experiencing a menstrual period during the time of the EEG recording.

2.2. Procedure

The subjects were shown the experimental setting including the psychophysiological monitoring equipment. Neither the specific experimental hypotheses nor their level of hypnotizability was discussed with the subjects. The experimental session was carried out between 15:00 and 18:30 h. After that electrodes were attached, each subject sat in a comfortable armchair in a sound-attenuated dimly-lit room. During the experimental session the hypnotist and the subject were in touch with another experimenter by means of an intercom system. The hypnotist of this session was a woman, but not the same person who previously assessed the hypnotic susceptibility and suggestibility of all the subjects. After a 2-min relaxation period, the physiological recordings started with two 1.5-min waking resting periods one with eyes closed and with eyes open. After the administration of a tape-recorded hypnotic induction (that included the SHCS; Morgan and Hilgard, 1978), two additional relaxation 1.5-min baselines (eyes open and eyes closed) were taken. After this period the subject was told to keep her eyes closed and to recall from memory one of three emotional events experienced happiness, sadness or neutral relaxation events described previously. The hypnotist emphasized that the emotional memory should be experienced with strong visual imagery and emotional feeling as in the reality. Each emotional task lasted for 2-min. Each period of emotionality was preceded by a 1-min rest period. After these three tasks were completed, a final two 1.5-min baselines (eyes open and eyes closed) were completed. The order of baselines and emotional tasks were counterbalanced across subjects.

Subjects were told if they were unable to perform any of the tasks to inform the experimenter. In those cases in which the subject had difficulties performing the task, she was given extra time. The subject signalled the start of the task by raising her right index finger. At the end of each emotional task the subject rated along a 10-point scale the vividness of visual imagery (i.e. 1 'no image at all', to 10 'perfectly clear and vivid as in the reality') and level of emotional feeling (i.e. 1 'no emotion at all', to 10 'perfectly identical feeling as in reality') and relaxation (i.e. 1 'not relaxed at all', to 10 'relaxed as in reality').

2.3. EEG recordings

EEG recordings were made using silver-silver chloride cup electrodes (Ag-AgCl) attached by collodion, on F3 and F4 (anterior sites), on C3 and C4 (central sites), and in the middle of O1-P3-T5 and of O2-P4-T6 triangles (posterior sites). These anterior and posterior recording sites were chosen according to Sheer (1989) in terms of regulation of arousal. Raw EEG signals were obtained by using an eight-channel EEG machine ('ERA-9'–OTE. Biomedica Italiana). Time constants were set at 0.3 s and filters at 75 Hz. EEG signals were recorded on tape by an 8-channel digital recorder (OTE-Biomedica Italiana, 0–80 Hz bandwidth).

The EEG was acquired in digital form, using an IBM PC-AT computer, by sampling at 128 Hz per channel with a 12-bit interface (Metrabyte Dash-16). For each condition, 20 epochs of 4 s (512 points per epoch per channel) were recorded on 3,5" microdisks. Forty-Hz EEG, for each electrode, was obtained off-line from the digitized raw EEG by filtering the EEG in the 36–44 Hz band and then correcting the filtered signal for 60 Hz EMG (56–64 Hz bandwidth) contamination. The correction consisted in subtracting from the filtered 40-Hz EEG scores the predicted EEG values, as obtained by linear regression of filtered 40-Hz EEG on filtered 60-Hz EMG (for more details see Raghavan et al. (1986) and Sheer (1975)).

Eye movements (EOG) were recorded with Ag-AgCl electrodes in a bipolar arrangement, with the superior orbit referenced to the outer canthus of the right eye. All electrode impedances
were less than 7 kΩ. EEG epochs were excluded from analysis when the eye movements produced a slow potential variation greater than 30–40 μV. The EEG was processed by Fast Fourier Transform (FFT) over 4 s epoch. FFT was implemented by using a Keithley Asyst-4.0 software system. Thus, 512 point transforms were accomplished creating a resolution of 0.25 Hz in the resulting spectra. To reduce discontinuities at the window edges a Blackman window was applied to the acquired EEG data before computing the spectrum.

Mean EEG spectral amplitudes were obtained in the following frequency bands: theta1 (4–6 Hz), theta2 (6.25–8 Hz), alpha1 (8.25–10 Hz), alpha2 (10.25–13 Hz), beta1 (13.25–16 Hz), beta2 (16.25–20 Hz), beta3 (20.25–35.75 Hz), corrected 40-Hz EEG (36–44 Hz). A log transform of spectral amplitude data was used as database for statistical analysis.

2.5. Statistical data analyses

2.5.1. EEG bands

For each EEG band a repeated measures analysis of variance (ANOVA) was performed across resting and emotion conditions. The GLM procedure of the Statistical Analysis System (SAS) was used with the following design: 2 Hypnotizability (high, low) × 2 Suggestibility (high, low) × 2 Hemisphere (left, right) × 3 Intrahemispheric Location (frontal, central, posterior) × 3 Trial (positive, negative, neutral). A similar analysis was also performed across eyes open/closed resting conditions.

2.5.2. Heart rate

A repeated ANOVA was performed for R-R intervals across emotion conditions according to the following design: 2 Hypnotizability (high, low) × 3 Trial. A similar analysis was performed across three resting baselines by considering the eye-condition factor.

An ANOVA was also performed for self-rating scores of visual imagery and emotional feeling. For EEG, R-R time, and self-rating scores significant effects were assessed using the Greenhouse-Geisser epsilon (Vasey and Thayer, 1987). A rejection region with at least a value of $P < 0.05$ was selected and used throughout. Multiple comparisons of the means were carried out by Tukey’s HSD test (Kirk, 1968, p. 88). Comparisons addressing hypnotizability and suggestibility with hemisphere functioning are emphasized.

3. Results

3.1. Self-report measures

No significant differences for state anxiety were found between hypnotizability groups or between high and low suggestible subjects ($t = 0.65$ and $t = 0.78$, $P > 0.05$, respectively).

The ANOVA for visual-imagery ratings demonstrated a main effect for Hypnotizability ($F_{1,16} = 10.5$, $MSe = 157.7$, $P < 0.005$) that indicated a higher level of visual imagery for the high hypo-
tizables compared to the low hypnotizables across all emotional task conditions (highs: 7.3, 7.8, and 8.1; lows: 4.2, 5.0, and 6.1; respectively for neutral, positive and negative emotion conditions).

ANOVA's involving emotional self-report ratings showed the following effects: (1) Hypnotizability ($F_{1,16} = 6.63$, MSe = 170.0, $P < 0.02$); (2) Trial ($F_{2,32} = 9.5$, MSe = 1.8, $P < 0.001$); (3) Hypnotizability x Trial ($F_{2,32} = 3.44$, MSe = 1.8, $P < 0.05$). The first effect indicated that high hypnotizables experienced higher levels of emotionality compared to the low hypnotizables (7.4 vs. 5.3, respectively for high vs. low hypnotizables). The second effect indicated that high hypnotizables experienced more pronounced negative emotional feelings compared to positive emotionality and relaxation. The low hypnotizables, in contrast, did not evidence differences between positive and negative emotions, but both emotional ratings were higher than relaxation ratings (highs: 8.2 vs. 7.1 and 7.0; lows: 6.1 vs. 6.0 and 3.7; respectively for negative vs. positive and relaxation feelings).

In order to evaluate the relationships between the personality dimensions, a correlation coefficient was calculated for the entire subject pool with complete data ($N = 60$). Hypnotizability was significantly related with sensory suggestibility ($r = 0.447$, $P = 0.0003$), with vividness of mental imagery ($r = -0.294$, $P = 0.0225$), and with absorption ($r = 0.270$, $P = 0.0369$). Absorption was also found related to Bett’s vividness of visual imagery ($r = -0.323$, $P = 0.0118$). The other correlation coefficients between personality variables were not significant. The negative sign in this case indicates that absorption increases with vividness of visual imagery, since the level of imagery was scored in the way that at higher scores were corresponding lower levels of vividness.

3.2. EEG bands

3.2.1. Resting conditions

There were significant site effects for alpha2, beta1 and beta3 amplitudes (alpha2: $F_{2,32} = 15.01$, MSe = 0.786, $P < 0.0001$; beta1: $F_{2,32} = 11.01$, MSe = 0.197, $P < 0.0002$; beta3: $F_{2,32} = 6.10$, MSe = 0.312, $P < 0.01$) that indicated greater amplitudes over posterior sites compared to frontal and central sites. Common to alpha2, beta1, beta2 and beta3 activity was a significant effect for the eyes open/closed-condition (alpha2: $F_{1,16} = 49.37$, MSe = 2.12, $P < 0.0001$; beta1: $F_{1,16} = 5.58$, MSe = 0.309, $P = 0.03$; beta2: $F_{1,16} = 9.13$, MSe = 0.341, $P = 0.0081$; beta3: $F_{1,16} = 8.19$, MSe = 0.407, $P < 0.01$). This effect indicated that alpha2, beta1 and beta2 amplitudes were higher in eyes-closed condition compared to eyes-open condition, while an opposite trend was found for beta3 amplitude.

3.2.1.1. Theta1

The following effects were found for theta1 amplitude: (1) Eye-condition ($F_{1,16} = 18.7$, MSe = 0.286, $P < 0.0005$); (2) Location ($F_{2,32} = 77.9$, MSe = 0.139, $P < 0.0001$); (3) Eye-condition x Location ($F_{2,32} = 37.6$, MSe = 0.07, $P < 0.0001$); (4) Location x Hemisphere ($F_{2,32} = 68.6$, MSe = 0.02, $P < 0.0001$); (5) Hypnotizability x Hemisphere x Location x Trial ($F_{4,64} = 3.7$, MSe = 0.004, $P = 0.009$). The first effect indicated that there was a greater theta1 amplitude in eyes-open compared to an eyes-closed condition (1.56 vs. 0.983, for eyes-open vs. eyes-closed condition). The second effect indicated that there was a monotone decrease of amplitude from frontal to central and posterior leads. The third effect showed that this decrease was more pronounced in eyes-open compared to the eyes-closed condition (eyes-open: 1.484, 1.085 and 0.879; eyes-closed: 1.012, 0.925 and 0.914; for frontal, central and posterior leads, respectively). The fourth and fifth effects disclosed that during all three baseline conditions, high hypnotizable subjects showed greater theta1 amplitude over left frontal compared to the right hemisphere and in the posterior areas, an opposite effect across the first two conditions. During the initial baseline and the first hypnosis baseline there was greater theta1 amplitude in the right hemisphere compared to the left in posterior recording sites. The highly hypnotizable subjects in comparison to the lows demonstrated more theta1 activity in the left and right frontal areas and in the right posterior area. The low hypnotizables did not show significant hemisphere differences over posterior sites. However, they showed greater amplitude over left frontal sites compared to the right sites.
across all conditions (see Fig. 1). No effects involving sensory suggestibility were found.

3.2.1.2. Theta2. Effects for Location, Eye-condition, and Eye-condition × Location were significant (F2,32 = 27.47, MSe = 0.205, P < 0.0001; F1,16 = 4.97, MSe = 0.823, P = 0.04; and F2,32 = 23.73, MSe = 0.065, P < 0.0001). The Location effect disclosed that there was a greater theta2 amplitude over frontal scalp area as compared to central and posterior sites (1.35, 1.12 and 1.06, respectively). The other effects indicated that in eyes-closed compared to eyes-open condition there was a significantly greater production of theta2 activity over posterior scalp sites (frontal: 1.34 vs. 1.36; central: 1.06 vs. 1.17; parietal: 0.9 vs. 1.23, respectively for eyes-open vs. eyes-closed conditions). Finally, the Suggestibility × Eye-condition × Trial interaction was also significant (F2,32 = 3.82, MSe = 0.083, P = 0.03). This effect indicated that highly suggestible subjects, compared to the lows, during waking-baseline and hypnotic-baseline conditions produced more theta2 in waking eyes-closed than in eyes-open condition. In hypnotosis, with eyes-closed conditions, highly suggestible subjects produced more theta2 than the lows (see Fig. 2a).

3.2.1.3. Alpha1. The alpha1 amplitude displayed a number of significant main and interaction effects: (1) Eye-condition (F1,16 = 27.29, MSe = 3.69, P < 0.0001); (2) Suggestibility × Eye-condition × Trial (F2,32 = 4.63, MSe = 0.150, P = 0.02); (3) Hemisphere × Location (F2,32 = 37.13, MSe = 0.040, P < 0.0001); (4) Hypnotizability × Hemisphere × Trial (F2,32 = 3.21, MSe = 0.009, P < 0.05); (5) Hypnotizability × Hemisphere × Location × Trial (F2,32 = 3.20, MSe = 0.004, P = 0.02). The first effect indicated that there was more alpha1 in eyes-closed than in eyes-open condition; the second effect indicated that the difference in alpha1 amplitude between eye conditions was more pronounced for highly suggestible subjects across waking and hypnosis-baseline conditions (see Fig. 2b). The third and fourth effects indicated that highly hypnotizable subjects had more alpha1 activity in the left hemisphere over frontal region during a waking-rest, the hypnosis-rest1 and even more hypnosis-rest2. This hemispheric trend demonstrated a mono-
tonic increase of frontal alpha1 from waking to hypnosis conditions with the increase being more pronounced over the left frontal site. Over posterior sites there were, for high hypnotizables, more alpha1 in the right hemisphere, but this difference disappeared in the hypnosis-baseline2 due to a monotone increase of alpha1 in the left hemisphere from waking to hypnosis1 and hypnosis2 conditions. The hemispheric trend did not change significantly across baseline conditions for low hypnotizable subjects. Comparisons of the means between hypnotizability groups evidenced that high subjects had smaller alpha1 amplitude compared to the lows over both left and right frontal recording sites ($P < 0.01$) (see Fig. 3). These subjects, however, in waking-rest and hypnosis-rest conditions displayed a relative right hemisphere activation (i.e. lower alpha1 amplitude) over frontal sites and a relative left-hemisphere activation over posterior sites. Low hypnotizable subjects in waking-rest and hypnosis-rest conditions also displayed a relative right hemisphere activation over frontal sites (see Fig. 3).

3.2.1.4. 40-Hz. The following significant effects were found: (1) Suggestibility $\times$ Trial $(F_{2,32} = 3.60, MSe = 1.098, P = 0.039)$; (2) Suggestibility $\times$ Hemisphere $(F_{1,16} = 6.76, MSe = 0.063, P = 0.02)$. The first effect showed that 40-Hz amplitude in highly suggestible subjects progressively increased from waking to hypnosis1 and hypnosis2 conditions. In low suggestible subjects, in contrast, there were no differences in 40-Hz amplitude across baseline conditions (see Fig. 4). The second effect displayed a right-hemisphere activation for highly suggestible subjects while, in contrast, low suggestible ones displayed a hemisphere balancing (high suggestibles: 0.70 vs. 0.81; low suggestibles: 0.59 vs. 0.57; for left vs. right hemisphere, respectively).

3.2.2. Emotion conditions

For theta1, theta2, alpha1, beta1, beta2, and beta3 there were no significant effects involving Hypnotizability, Suggestibility and Trial. Common to these EEG bands were the significant effects for Location and Hemisphere $\times$ Location. These effects indicated that there were higher amplitudes over posterior recording sites and that these amplitudes were greater over left-frontal scalp sites and over right-posterior scalp sites.

3.2.2.1. Alpha2. A main effect for Hypnotizability was evidenced $(F_{1,16} = 5.19, MSe = 4.09, P = 0.037)$. This effect indicated that across emotion conditions highly hypnotizable individuals had a greater alpha2 amplitude than low hypnotizable individuals. The Location and Hemisphere $\times$ Location factors were also significant $(F_{2,32} =$
3.2.2.2. 40-Hz. A number of significant effects were evidenced for 40-Hz amplitude: (1) Hemisphere × Location (F2,32 = 10.09, MSe = 0.083, P = 0.0004); (2) Hypnotizability × Hemisphere × Location (F2,32 = 3.72, MSe = 0.083, P = 0.035); (3) Hypnotizability × Hemisphere × Trial (F2,32 = 4.00, MSe = 0.147, P = 0.045); (4) Hemisphere × Location × Trial (F4,64 = 4.51, MSe = 0.052, P = 0.014); (5) Hypnotizability × Hemisphere × Location × Trial (F4,64 = 3.05, MSe = 0.052, P < 0.05). The first and second effects indicated that high hypnotizables had a significantly greater 40-Hz amplitude over the left compared to the right frontal site, no hemispheric differences over central sites and a right hemisphere prevalence over posterior sites; low hypnotizables displayed a left hemisphere prevalence over frontal sites and no hemisphere differences across central and posterior sites (see Fig. 5).

The third effect indicated that high hypnotizables had a differential hemispheric asymmetry across emotion and neutral-relaxation conditions and that this hemispheric trend was different from that displayed by low hypnotizable subjects. The fourth and fifth effects disclosed for highly hypnotizable subjects: (a) in the happiness emotion condition a left-hemisphere prevalence over
frontal and central scalp sites, and a right-hemisphere activation for posterior sites; (b) in the sadness emotion, as compared to the other conditions, there was a pronounced increase of 40-Hz in the right-hemisphere at frontal, central and posterior sites which showed more power in the left frontal site and right central and right posterior sites; (c) in the neutral-relaxation condition a left hemisphere activation at frontal sites and no hemispheric differences at central and posterior sites which showed more power in the left frontal site and right central and right posterior sites;
sites were found. The poor hypnotizables displayed, for happiness and neutral-relaxation conditions, similar hemispheric trends to that found for high subjects across frontal and posterior sites. The lows, in contrast with the highs, displayed across frontal and posterior sites a left hemisphere activation for the negative emotion condition. These hemispheric trends are shown in Fig. 6.

### 3.3. Heart rate

The ANOVA for HR scores across resting conditions evidenced a significant effect for Suggestibility × Trial ($F_{2,32} = 3.74$, MSe = 1642.7, $P = 0.04$). This effect indicated that high suggestible subjects significantly increased their heart rate from waking-rest to hypnosis-rest conditions; low suggestible subjects, in contrast, displayed a monotonic heart rate decrease from waking rest to hypnosis rest conditions (high suggestibles: 80.6, 82.3, and 81.8; low suggestibles: 77.5, 75.5, and 74.0 bpm; respectively for waking rest, first hypnosis rest, and last hypnosis rest).

The ANOVA across emotion and control conditions evidenced a main effect for Trial ($F_{2,32} = 8.93$, MSe = 398.4, $P = 0.0008$). This effect indicated that there was a monotonic increase of heart rate from the relaxation-control to positive and negative emotion conditions (77.5, 79.4, and 80.6 bpm, respectively). No main or interaction effects were found for Hypnotizability on HR scores.

### 4. Discussion

Given the current state of research in hypnosis and suggestibility, we examined three major hypotheses. In terms of the first hypothesis, we expected to see a greater theta activity in high than in low hypnotizable subjects. Indeed, as it can be seen in Fig. 1, this was the case for theta1 ($4–6$ Hz) and alpha1 ($8.25–10$ Hz) activities, as measured across resting conditions. In particular, high hypnotizable subjects during waking and hypnosis conditions had greater amplitudes in the left than right hemisphere at frontal regions. The opposite hemispheric trend was observed for these subjects across posterior sites during waking and the first hypnosis condition. In the later hypnosis condition there was an increased activity for both theta1 and alpha1 over left temporo-parieto-occipital region with no hemispheric differentiation. The low hypnotizable subjects also produced more theta1 and alpha1 over the left as compared to the right frontal region, but they did not show differences in asymmetry between waking and hypnosis conditions (see Figs. 1 and 3). For theta2 ($6.25–8$ Hz) spectral amplitude we failed to find significant effects involving hypnotizability in resting conditions. Moreover, specific EEG patterns in resting conditions for theta2 and alpha1 ($8.25–10$ Hz) spectral amplitudes differentiate high and low suggestible persons (see Fig. 2).

Thus, results from the present study demonstrate that there are distinctive EEG patterns among resting baselines that characterize high and low hypnotizable subjects and differentiate them from high and low suggestible ones. Second, we expected emotionality to be experienced more strongly by high as compared to low hypnotically susceptible individuals. In terms of self-report, high hypnotizable individuals did report greater levels of emotional experiences than low susceptible individuals. Further, high hypnotizable individuals reported a greater experiencing of negative as compared to positive affect whereas low susceptible individuals did not show this differentiation. Third, in terms of electrocortical processing of emotional material, we hypothesize opposite frontal and temporo-parieto-occipital EEG differences in emotionality. As can be seen in Fig. 6 in terms of 40 Hz this was clearly the case for high hypnotizable individuals in terms of sadness and for low and high hypnotizable individuals in terms of happiness. In terms of pilot work, we sought to examine differences between subjects showing high and low levels of imaginative suggestibility. The only differences found between high and low suggestibility groups was in the gamma band in terms of resting conditions and for alpha and theta in terms of eyes open/closed conditions. Since this is the first study to examine EEG differences in this group, future work is required to fully understand these results. Another purpose of the present study was to repli-
cate and extend our previous 40-Hz EEG correlates of emotionality using a more advanced measure of 40-Hz EEG spectral amplitude.

4.1. Psychophysiological differences during rest in waking and hypnosis

The theta1 finding is consistent with previous hypnosis research (e.g. Galbraith et al., 1970; Graffin et al., 1995; Sabourin and Cutcomb, 1980; Sabourin et al., 1990; Tebecis et al., 1975). Indeed, as with the present study, Graffin et al. (1995) found the strongest theta (4–8 Hz) differences between susceptibility groups in the more frontal areas of the cortex. Previous research has evidenced that increased frontal midline theta, especially at 6 Hz, has been associated with attentional readiness or attentive performance (in resting condition) of cognitive tasks (Bruneau et al., 1993; Ishihara and Yoshii, 1972; Lang et al., 1988; Mizuki et al., 1980). Moreover, looking at the Galbraith et al. (1970) findings, the highest correlated theta frequency with hypnotizability was at 5 Hz which is corresponding to the center frequency of our theta1 band. As in the Galbraith et al. study, our theta1 findings may be seen as reflecting a class II inhibition process i.e. that high hypnotizable individuals might manifest a heightened state of attentional readiness and focalization of attention. In the present study we failed to find theta2 differences between high and low hypnotizable subjects as, indeed, it was found in the recent study of Crawford et al. (1996). We think that the apparent conflicting findings may lie in the sometimes incorrect assumption that low theta is associated with class I inhibition and high theta with class II inhibition, since we cannot exactly know the band edges which define the high and low theta activities. It may be reasonable to think that these edges are dependent from a number of factors such as personality, sampling, and situation-specific variables.

The alpha1 activity has been found to be associated with decreased cortical activity or with poor sustained attentional abilities (e.g. Bosel, 1992; Gale and Edwards, 1983; Klimesch et al., 1990). If we assume that an increase in theta1 activity reflects an increase in focused attention and that an increase in alpha1 reflects an aspecific effect of relaxation, then the increased theta1 and alpha1 amplitudes found over left temporo-parieto-occipital site in highly hypnotizable subjects, indicate that these subjects, in resting hypnotic condition, were not only more relaxed, but also more facilitated in processing relevant stimuli than they did in a waking condition. Moreover, the finding that high hypnotizables, in comparison with lows, displayed higher theta1 and lower alpha1 amplitudes over left and right frontal regions, is indicating that highs were actively more involved in the hypnosis condition than did the lows. Finally, the alpha1 trend observed across waking and hypnosis conditions over frontal and temporo-parieto-occipital regions of the left hemisphere is consistent with the Gruzelier neurophysiological model of hypnosis wherein the central inhibitory processes, particularly of the left hemisphere, are considered as the main indicators characterizing hypnosis (Gruzelier et al., 1984; Gruzelier, 1988; Gruzelier and Warren, 1993).

The HR data failed to evidence significant differences among resting conditions between high and low hypnotizable subjects. This result does not confirm the expected finding, i.e. that hypnosis induction, being composed of relaxation suggestions, produces a decrease in HR (see e.g. Sarbin and Slagle, 1979). Gray et al. (1970) and Bauer and McCanne (1980) obtained findings in line with this prediction: they observed a decrease in HR during a rest period after the hypnotic induction as compared to a rest period before the induction. However, the present result appears in agreement with the Lamas and del Valle-Inclán (1994) findings supporting that the induction procedure does not produce HR deceleration in high hypnotizable subjects.

4.2. EEG differences during emotions in hypnosis

During the emotional conditions, high hypnotizable subjects, compared to the lows, reported greater ability in experiencing positive and negative emotions, more alpha2 activity and more pronounced emotion-related 40-Hz EEG hemispheric shifts. Specifically, in terms of 40-Hz am-
plitude high hypnotizables showed three main findings (see Fig. 6). Firstly, in the happiness condition an increased activity in the frontal left hemisphere that produced a marked hemispheric asymmetry in favor of the left compared to the right hemisphere; a similar but less pronounced asymmetry in favor of the left hemisphere was also found across central sites, while an opposite hemispheric asymmetry was evidenced in the posterior region. This pattern of findings is consistent with previous research showing more left frontal (cf. Davidson, 1992) and right posterior (cf. Tucker, 1981) cortical involvement in the processing of positive emotionality. Secondly, in the sadness condition, compared to the other conditions, there was an increased activity over the right hemisphere that produced a hemispheric balancing in the frontal region and a right hemisphere activation in the central and even more in the posterior regions. These results are consistent with the predictions of the Pribram (1981) anterio-posterior neurophysiological model of emotions. Thirdly, the relaxation condition produced more activity in the left than in the right frontal region, along with more equal hemispheric activity in the central and posterior regions.

Overall findings in terms of 40-Hz activity parallels those of previous research from our lab. One major EEG difference between positive and negative emotional experience was an increased production of 40-Hz activity in the left frontal region for happiness and a significant increase in the right posterior regions for sadness. These results support prior research of self-generated emotional states that demonstrate, using alpha, activation of parietal region for positive and negative emotions (Collet and Duclaux, 1987; Harman and Ray, 1977; Karlin et al., 1979; Meyers and Smith, 1987; Smith et al., 1987, 1989; Tucker et al., 1981; Tucker and Dawson, 1984). These results also support the validity of the Heller (1993) model indicating that parietotemporal regions play a critical role in the experience of emotion. Our observations are parallel to those of Stenberg (1992) who found the frontal lateral region of the brain mainly engaged in emotional processing. Similar 40-Hz hemispheric trends were reported in our previous studies in which 40-Hz density was the dependent variable (De Pascalis et al., 1987, 1989). In our previous studies, 40-Hz density increased in the right hemisphere during negative emotions. The current study found an increased activity in the left and even more in the right posterior sites by displaying a hemispheric asymmetry in favor of the right hemisphere. Starting from the assumption that 40-Hz EEG rhythm is the physiological expression of 'focused arousal' (e.g. Sheer, 1989; Tiitinen et al., 1993), our 40-Hz EEG findings during emotional states are consistent with the dual-attentional model of Kinsbourne (1982) and of Pribram (1981) wherein the left hemisphere is more involved to maintain selective or focal attention and the right to maintain 'sustained' attention in order to form a continuous synthesis of the incoming information. During positive emotions, as compared to a relaxation condition, the frontal and central regions in the left hemisphere are more engaged to extract information from the recollecting material and the posterior-right hemisphere to form a connotational synthesis of the ongoing processed stimuli. That is, it is the posterior area that gives color to the emotional experience. The recollection of a negative emotion, with respect to a relaxation condition, requires an engagement of both right and left frontal areas and mainly of the right central and posterior areas of the cortex.

In terms of HR activity it was found that HR increased during positive and even more during negative emotional events as compared to a relaxation condition. The HR activity failed to evidence, among emotion conditions, different trends between high and low hypnotizable subjects. This result confirms findings from other studies using facial configuration or relived emotion tasks. The HR increases for sadness, fear and anger (Ekman et al., 1983; Levenson et al., 1991) and happiness (Levenson et al., 1990). The HR activity has been used in hypnosis research as a physiological measure of attentional demands. It has been found to increase with stressful active suggestions and to decrease with relaxation ones (see e.g. Barber, 1965; Sarbin and Slagle, 1979). The HR changes should be more pronounced in highly hypnotizable subjects since they are more engaged than the lows in the suggested tasks, as indeed it was
the case in the study of Sabourin et al. (1990). Our HR changes were sensitive to the emotional valence of the recollected material but failed to evidence differences in trends between high and low hypnotizable subjects. This lacking result may lay in the fact that attentional demands and emotional valence have an additive effect on HR increase (e.g. Cook et al., 1991; Hawk et al., 1992). This effect may have been sufficient to produce an HR increase also in the low hypnotizable subjects.

4.3. Suggestibility

The HR increase during hypnosis resting conditions as compared to a waking resting condition differentiate suggestible from non-suggestible subjects. In terms of EEG, theta2, alpha1, and 40-Hz EEG activities were sensitive to individual differences in suggestibility, but only between eyes open and closed conditions. Common to theta2 and alpha1 was the tendency for highly suggestible persons to display a significantly greater amount of these activities in resting eyes-closed as compared to resting eyes-open conditions. In general, high suggestible individuals compared to low suggestible ones showed a differential increase of theta2 in the last eye-closed baseline condition. In terms of alpha, high suggestible individuals showed more alpha1 in the eyes closed condition (see Fig. 2). The 40-Hz EEG in highly suggestible subjects also displayed a monotonic increase from waking to the first and last hypnosis-rest conditions (see Fig. 4). These results to do not form a consistent picture but can be understood as related to the greater reactivity of highly suggestible subjects to the hypnosis task per-se. The validity of this interpretation is also supported by the more pronounced heart rate increase found for these subjects in the hypnosis-rest conditions as compared to the initial waking condition. The lack of relationship between sensory suggestibility and absorption scores as well as a lack of EEG theta differentiation would suggest that individual differences in the capacity to be absorbed in imaginative activity is separate from that of suggestibility. Since no significant interactional effects involving both hypnotizability and suggestibility were found, for each of the variables considered in this study we maintained that these two dimensions are expressions of different underlying psychophysiological activities.

Overall, the present study replicates a variety of EEG research, especially theta and 40 Hz activity, in relation to hypnosis. As in previous studies, high and low hypnotically susceptible individuals differed in EEG theta and in emotional processing as reflected in both self-report and 40 Hz activity. The present study also supported previous theoretical speculations suggesting frontal/posterior differences in emotional processing. Finally, it gives psychophysiological support to the theoretical position that suggestibility and hypnosis reflect different physiological mechanisms, but it also indicates that it might be worthwhile to take into account suggestibility in future research.

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