Hypnotizability Dependent Autonomic Modulation during a Low Attentional Task

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Abstract

Hypnotizability-dependent changes in heart rate and blood pressure in the time domain were studied during low attentional tasks in subjects with high or low hypnotic susceptibility watching a relaxing and an alerting movie. All participants reported relaxation during the former, while only part of them was stressed by the latter. During relaxation hypnotizability did not modulate mean heart rate and blood pressure, but affected the variability of the latter, which indirectly indicates differences in the autonomic pattern associated with the low attentional relaxing movie with respect to simple relaxation and highlighted the hypnotizability-related role of the emotional content associated with a relaxation response. In line with previous studies the results suggested a role for hypnotizability in the control of the vascular resistance.

1. Introduction

Hypnotic susceptibility is a cognitive trait responsible for the possibility to accept suggestions and modulate perception and behaviour accordingly [1]. It can be measured through scales and has its anatomo-functional basis in the supervisory attentional system, located in frontal and cingulate cerebral areas . Differences between subjects with high (Highs) and low (Lows) level of hypnotizability have been reported, in various tasks, even in the absence of any hypnotic induction and /or specific suggestions [2-5]. In the autonomic domain, our previous studies showed that during simple relaxation, that is relaxation without any specific instruction [6], only Lows decreased their mean heart rate and showed an increased HF spectral component of heart rate variability, in spite of the similar relaxation reported by the two groups. Since EEG spectral analysis revealed an increased gamma power in Highs and a decreased one in Lows, relaxation was considered as a cognitive task modulated by hypnotizability with Highs performing an active cognitive strategy, and Lows responding with the disengagement from any intentional cognitive activity [7].

When not hypnotized Highs receive emotion-laden suggestions, they report a subjective experience corresponding to the suggestion received, i.e fear, and exhibit EEG correlates of activation, but do not show the expected autonomic response, which suggests the possible occurrence of an active buffering of the autonomic output [8]. However, results on hypnotizability related autonomic control are not univocal since other studies have shown that a pre-eminent sympathetic tone is present in Highs and that medium hypnotizable subjects respond with greater decreases in parasympathetic activity than both Highs and Lows, during emotional stress tasks [9].

The autonomic response to stimulation with different emotional content (positive-negative) and different level of arousal (high-low) has been studied through the use of video clips which allowed identifying autonomic activation patterns specific for various emotional experiences [10-12]. In the present study we used such video clips to evaluate possible hypnotizability-related autonomic responses during cognitive tasks with pleasant or unpleasant content. Thus, Highs and Lows watched video clips in the absence of any specific instruction other than concentrating on the movie. The low attentional load of the movies allowed avoiding possible superimposition between the effects of cognitive load and of the emotional content of the task.

2. Methods

Subjects. After their written informed consent following the rules of the Declaration of Helsinki, normal drug-free volunteers (age 19-30) were divided in 2 groups- 20 Highs (10 females) and 26 Lows (15 females)- according to the Stanford Hypnotic Susceptibility Scale, form C [13].

Experimental procedure. Subjects participated in 2 experimental sessions (30 min each) for two low attentional tasks consisting of concentrating on a relaxing

movie presenting natural scenes associated with soft music (Session R, 46 subjects) or on the triller Shining, by S. Kubrik (Session A, 35 subjects) which was supposed to be arousing. The experimental sessions took place in the morning (9.00-12.00) and were separated by at least 3 days. At the beginning and at the end of each session the participants scored their relaxation (score 0-10) and, finally, were interviewed about the attention paid to the movie (score 0-10). ECG, respirogram and blood pressure (BP) were recorded and, for off line analysis, sessions were divided into 6 consecutive intervals (I1,... I6), 5-minute each.

Data acquisition. ECG was recorded through Red DotTM Ag/AgCl disposable electrodes placed according to the standard DI, while the respirogram (RESP) was obtained through a piezoelectric dc-coupled transducer (Pro-Tech Instruments) wrapped around the chest. ECG was acquired at 1KHz sampling rate (National Instrument A/D converter) and the RR interval series (tachogram) was extracted using a QRS complex detection algorithm based on a threshold derivative method. Blood pressure was monitored through a photopletismograph (Psylab) with a sensor placed on the third phalanx of the middle finger of the left hand and acquired though the same converter used for ECG.

Data analysis. Time domain analysis of RR and blood pressure were performed through mean and standard deviation (SD) values and through the classical sd2 and sd1 (higher and lower dispersion) dimensions of the Poincaré plot (PP) [14-18], the former being a measure of the Low and Very Low variability (mainly related to sympathetic variability) and the latter an index of the fast variability associated with parasympathetic activity. The mean respiratory frequency (RF) and amplitude (RA) were also evaluated.

Statistical analysis. For session R separate repeated measures ANOVAs were performed on the interview scores following a 2x2x2 design, with Group (Highs, Lows) and Gender (females, males) as Between groups factors and Times (before, after the movie) as Within Group factor. For each autonomic parameter analysis was conducted following a 2 Groups x 2 Genders x 6 Intervals (I1,...I6) design, with Group and Gender as Between groups factors and Intervals as Within Group factor, for session R, and following a 2 Groups x 2 Genders x 5 Intervals (I1,...I5) design for session A due to numerous missing values in the last interval (I6) of some of the subjects. Furthermore, for session A subjects reporting an increased alertness were grouped and analysed separately from those reporting no change or even relaxation.

3. Results

Session R (Table 1.). Interview scores. All subjects felt significantly more relaxed ($F(1,42)=97.197$, $p<0.0001$) after the movie than before (mean$\pm$SE: before, 5.87$\pm$0.26; after, 8.26+0.18). Females (7.93$\pm$0.31) reported significantly higher attention to the movie ($F(1,42)=5.408$, $p<0.025$) than males (6.87$\pm$0.34) .

RR and RESP analysis. No significant main effects and interactions were found for mean RR and sd1. SD increased throughout the session, although not significantly ($F(4,210)=3.334$, $p=0.059$), while sd2 showed a significant increase across intervals ($F(5,210)=4.033$, $p<0.030$). A trend toward a Gender effect, with lower mean RR in females than in males, was observed ($F(1,42)=3.874$, $p=0.056$). No significant change was observed in RF, while RA showed a significant Interval x Gender x Group interaction ($F(5,210)=4.629$, $p<0.009$) corresponding to significant decreases across intervals only in the females belonging to the Highs group ($F(5,45)=2.369$, $p=0.054$).

BP analysis. No significant main effects were found for BP mean value. SD showed a significant increase across intervals ($F(5,210)=3.969$,$p<0.011$) and a significant Interval x Gender x Group interaction ($F(5,210)=2.979$, $p<0.013$). The latter was sustained by increases of SD across Intervals in Highs, both males and females, ($F(5,90)=3.231$, $p<0.043$) and in the males of the Lows group (Interval x Gender; ($F(5,120)=4.450$, $p<0.014$). Analysis yielded significant Gender x Group ($F(1,42)=5.982$, $p<0.019$) and Interval x Gender x Group interactions ($F(5,210)=3.559$, $p<0.021$) for sd1, with a significant increase across intervals in Highs. A Gender effect was also found within Highs ($F(1,18)=6.862$, $p<0.017$) with values in females (1.80$\pm$0.21) higher than in males (1.04$\pm$0.21). Significant Interval effect ($F(5,210)=5.107$, $p<0.003$) and Interval x Gender x Group interaction ($F(5,210)=2.574$, $p<0.028$) were found for sd2. In particular, sd2 increased across Intervals in Highs ($F(5,90)=3.562$, $p<0.031$), while, within Lows, it increased across intervals only in males ($F(5,50)=4.755$, $p<0.011$).

Session A (Table 1.). Interview scores. Twenty subjects out of 35 reported a significantly increased arousal after watching the movie ($F(1,16)=40.213$, $p<0.0001$). Among the others, a significant Time x Group interaction (($F(1,9)=14.778$, $p<0.04$) was found, with Highs significantly more relaxed after the movie than before ($F(1,4)=74.462$, $p<0.001$), while no changes occurred in Lows .

Alerted subjects (Session A-a).

RR and RESP analysis. No significant Interval effect was observed for both mean RR and SD. Analysis of sd1 ($F(4,64)=3.295$, $p<0.016$) yielded significant increases across intervals; sd2 showed tendency to increase across time, in spite of the lack of significant Interval effect or interactions. Both SD ($F(1,16)=10.351$, $p<0.005$) and sd2 ($F(1,16)=5.396$, $p<0.034$) were significantly higher in

males than in females during later Intervals. RF and RA did not change across time and did not show any Group effect and interaction.

BP analysis. Mean BP value increased significantly across Intervals ($F(4,60)=4.017$, $p<0.006$), while no significant change occurred in SD, sd1, sd2.

Non alerted subjects (Session A-n).

RR and RESP analysis. No significant effect and interaction were observed for mean RR, SD, sd2, sd1, RF and RA.

BP analysis. Significantly higher values of mean BP were found in females than in males ($F(1,11)=5.089$, $p<0.04$). sd1 exhibited a significant Interval x Gender x Group interaction ($F(4,44)=2.875$, $p<0.034$), with higher values in females than in males among Highs during later intervals ($F(1,5)=8.388$, $p<0.034$) and no differences among Lows.

Table 1. Behaviour of RR and BP in sessions R and A. H=Highs, L=Lows, F=females, and M=males.

	Session R		Session A- a		Session A-n	
	RR	BPmean	RR	BPmean	RR	BPmean
mean value				⬆		
SD		⬆ H ML	⬆			
sd2	⬆	⬆ H ML	⬆			
sd1		⬆ H	⬆			⬆ FH

4. Discussion and conclusions

The present findings show that during a low attentional, relaxing task both Highs and Lows do not modify their mean heart rate, in spite of an increase in sd2, indicating modifications of the slow HRV components. This is at variance with what previously found during simple relaxation sessions [7] when no attentional performance was required and the High Frequency, parasympathetic component of RR variability, was responsible for the slight RR increases observed in Lows across time.

Hypnotizability related differences emerge in mean blood pressure whose changes in variability across time indicate that, during the relaxing movie, the variability expressed by sd2 (mainly related to sympathetic activity) increased in both groups, although only in males among Lows, while the parasympathetic variability increased only in Highs, which might be in line with the hypothesized favourable role of hypnotic susceptibility [19] in cardiovascular health. The results concerning the participants not aroused by the alerting movie (Session A-n) were similar to those obtained during the relaxing movie. It is noticeable that, among these participants, Highs reported an increased relaxation in spite of the arousing movie, while in Lows it was simply not effective. However, the autonomic changes of Highs during Session A-n were limited to females whose subjective autonomic monitoring seems to be more reliable than the males one. This is at variance with Session R in which Highs autonomic changes were independent of gender. All the participants reporting a decreased relaxation during the alerting movie (Session A-a) showed increases in both the sympathetic and parasympathetic variability of RR with no change in its mean value, which confirms the results obtained during the guided imagery of an unpleasant situation [8], mental stress [20,21] and experimental pain [22]. At variance, mean blood pressure increased. This might indicate a hypnotizability-dependent different interaction between the sympathetic and the endotelial control of vascular resistance during different tasks. In fact, the endothelial control did not change during painful stimulation and mental computation in Highs [20-22], while the arousing movie, which increased mean blood pressure in the absence of changes in heart rate, actually induced changes in the peripheral resistance also in Highs.

The present findings show differences in the hypnotizability-related modulation of heart rate and mean blood pressure variability, which is in line with other authors' results reporting hemodynamic responses to stress involving mainly the cardiac output or peripheral resistances [23] and prompts further investigation on the possibly different effects of various cognitive tasks at cardiac and vascular level. In line with previous studies [20-22], the present results suggest, for hypnotizability, a greater role in the control of the vascular resistance than in heart rate modulation. In addition, they highlight the hypnotizability-related effect of the emotional content associated with a relaxation response.

A limitation of the study is due to the low number of subjects really aroused by the arousing task, which makes the suppression of the gender differences in the mean blood pressure control observed during the arousing task unreliable.

Finally, we would like to remark that the concurrent increases in the sympathetic and parasympathetic activities observed during the relaxing task as well as during the successfully activating one support the view of a wide modulability of the autonomic space not limited to balance mechanisms [24].

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