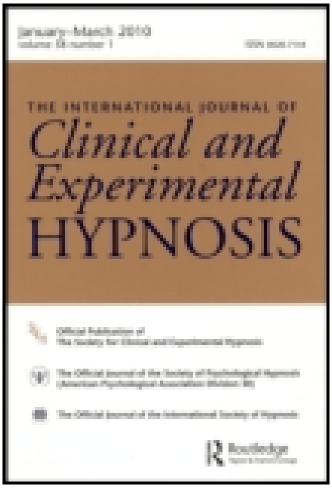

International Journal of Clinical and Experimental Hypnosis
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/nhyp20

The Effects of Hypnosis on Heart Rate Variability

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Published online: 21 Feb 2013.

Intl. Journal of Clinical and Experimental Hypnosis, 61(2): 162–171, 2013

ISSN: 0020-7144 print / 1744-5183 online
DOI: 10.1080/00207144.2013.753826

Routledge
Taylor & Francis Group

THE EFFECTS OF HYPNOSIS ON HEART RATE VARIABILITY

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Abstract: Uslu et al. (2012) suggested that hypnotic status can modulate cerebral blood flow. The authors investigated the effects of hypnosis on heart rate variability (HRV). In women, HRV decreased during hypnosis. Posthypnotic values were higher compared to prehypnotic and hypnotic values. Women had highest HRV parameters in the posthypnotic condition. It appears that hypnosis can produce cardiac and cognitive activations. Hypnotherapy may be useful in some cardiac clinical conditions characterized by an autonomic imbalance or some cardiac arrhythmias.

Temporal fluctuations in cardiac cycles are mainly determined by the activity of sympathetic and parasympathetic systems innervating the heart. Heart rate variability (HRV) is defined as fluctuations of the sinus rhythm that are affected by internal and external factors of body (Kristal-Boneh, Raifel, Froom, & Ribak, 1995). Furthermore, these fluctuations in heart rate can be determined with a straightforward and noninvasive technique called HRV analyzing the interaction between sympathetic and parasympathetic nervous systems that provides information about the autonomic nervous system.

Nasal cycle is a phenomenon of the alternating congestion-decongestion response in both nostrils (Shannahoff-Khalsa, Boyle, & Buebel, 1991). It manifests as greater or lesser airflow in one nostril compared to the other, with a pattern of alternating dominance ranging from 25 minutes to 8 hours, with the peak interval between 1.5–4 hours. Nasal cycle is regulated by the autonomic nervous system, such that unilateral sympathetic activity in one nostril mucosa causes vasoconstriction and decongestion, while synchronous parasympathetic activity in the other nostril causes vasodilatation and congestion.

Manuscript submitted June 1, 2012; final revision accepted June 27, 2012.
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Breathing solely out of one nostril or the other is referred to as unilateral forced nostril breathing (UFNB). It has been reported that UFNB may affect cognitive ability. UFNB through the left nostril is associated with enhanced spatial abilities, whereas breathing through the right nostril is associated with enhanced verbal abilities (Jella & Shannahoff-Khalsa, 1993; Klein, Pilson, Prosser, & Shannahoff-Khalsa, 1986).

Diamond, Davis, and Howe (2008) have investigated the relationships between hypnotic depth and some HRV parameters. They found a significant linear relationship between hypnotic depth and the high-frequency (HF) component of HRV. They have suggested that the reactivity of the parasympathetic branch of the autonomic nervous system reflected in HRV could become part of a real-time, quantitative measure of hypnotic depth.

One of the recent studies suggested that the neural mechanisms of hypnotic conditions remain considerably unknown but that hypnosis has a genuine effect on brain functioning (Uslu et al., 2012). A measure of the autonomic nervous system (ANS) response to hypnosis can be obtained from HRV (Diamond et al., 2008). According to the literature, hypnosis has been generally considered a condition that is characterized by a decreased sympathetic tone and an increased parasympathetic activity, or a physiological state that is comparable to relaxation response (DeBenedittis, Cigada, Bianchi, Signorini, & Cerutti, 1994). In addition, the nature of underlying mental activity during hypnosis can be studied by using heart rate to measure actual, underlying effort (Sadler & Woody, 2006). Furthermore, autonomic cardiac tone is significantly modified during hypnosis by shifting the balance of the sympatho-vagal interaction toward an enhanced parasympathetic modulation, accompanied by a reduction of the sympathetic tone and a decreased short-range similarity but without a concomitant change in heart rate (Aubert, Verheyden, Beckers, Tack, & Vandenberghe, 2009). In this study, we aimed to investigate the effects of hypnosis on cardiac health by assessing prehypnotic, during hypnosis, and posthypnotic changes on heart rate.

Method

Subjects

Twenty-five healthy adult subjects (13 women, 12 men, $M_{\text{age}} = 35.2$, $SD = 6.3$) participated in this study. In addition, exclusion criteria were health problems, such as psychiatric, respiratory, metabolic, cardiac, or ANS diseases that might change the heart rate. The Ethical Committee of the Faculty of Medicine of the University of Fatih approved this study.

Hypnotic Conditions

In Condition I, the subjects were alert and sitting in a comfortable armchair in a quiet room. After resting 10 minutes, an electrocardiography (ECG) monitored for 5 minutes prior to a hypnotic induction.

Condition II (hypnotic state) commenced after inducing hypnosis, using a hypnotic procedure. The subjects were guided by the hypnotist to respond to suggestions (Green, Barabasz, Barrett, & Montgomery, 2005). Subjects were considered hypnotized when roving eye movements were observed and if the subject responded by a hand movement that he or she felt hypnotized.

In Condition III (hypnotic imagination), the participants were under hypnosis and invited to imagine pleasant life experiences. Imagery could be initiated by the subjects and is defined as a dynamic psychophysiologic process in the absence of external stimuli. This process is an alteration in perception, sensation, emotion, thought, or behavior through imagination and/or suggestion (Menzies & Taylor, 2004).

In Condition IV, subjects were monitored for 5 minutes after the completion of hypnosis.

The Recording ECG

Subjects rested for 10 minutes without recording ECG in order to stabilize autonomic parameters and then the hypnotic induction was started. The room was darkened to encourage relaxation and noise was reduced to a minimum.

ECG was recorded using PowerLab 26T (ADInstruments, Australia), a device used for multimodal monitoring of biosignals. According to the standard Einthoven Triangle, three self-adhesive ECG electrodes were applies to the right wrist and right and left legs, respectively. The digital signals were then transferred to a laptop and analyzed using LabChart® software (MLS310/7 HRV Module). A full continuous ECG could be viewed and saved for later analysis, and software-based filters were used to exclude movement artifacts and ectopic beats prior to HRV analyses. In addition, the subjects' were documented with a video camera for detailed analysis after recording ECG (Sony DCR-SR290).

Statistical Analyses

Measured values are given as a mean and standard deviation. Statistical analysis was performed using SPSS for Windows (version 16.0) statistical program (SPSS, Inc., Chicago, IL). A Friedman test of multiple comparisons was used to compare four conditions. A p value less than .05 was considered significant.

Results

Males

The standard deviation of the NN intervals (SDNN) and the standard deviation of the averages of NN intervals in all 5-minute segments of the entire recording (SDANN) decreased from Condition I to Conditions II and III, but it was higher in Condition IV compared to Condition II (see Table 1). However, these changes were not statistically significant, $\chi^2 = 3.8$ and 1.1, respectively.

Square root of the mean of the sum of the squares of differences between adjacent NN interval (RMSSD) and the percent of difference between adjacent NN intervals that are greater than 50 ms (pNN50) decreased from Condition I to II and III, but in Condition IV it was approximately similar to Condition II. However, these changes were not statistically significant, $\chi^2 = 1.1$ and 0.7, respectively.

Very low frequency (VLF; < 0.003–0.04 Hz), low frequency power (LF; 0.04–0.15 Hz), and high frequency power (HF; 0.15–0.4 Hz) decreased from Condition I to Condition II but were approximately similar or higher in Condition III compared to Condition II. On the other hand, VLF was the lowest value in Condition IV and also LF and HF was higher in Condition IV compared to Conditions II and III. However, these changes were not statistically significant, $\chi^2 = 7.5$, 5.5, and 3.1, respectively.

The ratio of low-high frequency power (LF/HF) decreased from Condition I to II and III, but in Condition IV it was approximately similar to Condition II, $\chi^2 = 3.3$.

Generally, all parameters of HRV increasingly decreased from Condition I to Conditions II and III but in Condition IV increased

Table 1
Means and Standard Deviations (SD) of the Different HRV Parameters in Healthy Men During Hypnotic Conditions

	Condition I		Condition II		Condition III		Condition IV			
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	χ^2	*p*
SDNN	49.32	16.93	46.31	9.52	43.14	9.33	47.85	18.69	3.8	*ns*
SDANN	34.40	25.22	31.84	15.0	30.74	16.11	35.73	25.58	1.1	*ns*
RMSSD	34.34	25.17	31.82	14.99	30.69	16.08	31.69	25.53	1.1	*ns*
pNN50	11.47	15.44	10.93	13.83	9.95	13.66	10.56	13.72	0.7	*ns*
VLF	10.07	4.52	7.37	3.86	7.55	3.62	6.83	4.27	7.5	*ns*
LF	8.21	5.02	6.25	2.09	6.34	2.85	7.38	6.09	5.5	*ns*
HF	6.74	1.21	4.39	4.71	4.97	5.83	5.39	9.29	3.1	*ns*
LF/HF	3.20	2.33	2.85	2.22	2.44	2.04	2.88	2.92	3.3	*ns*

back compared to previous conditions in men (see Table 1). Moreover, the effects of hypnotic conditions in healthy men were not statistically significant on all of HRV parameters.

Females

SDNN, which was approximately similar in Conditions I and II, also decreased in Condition III but it was the highest in Condition IV. The effects of hypnosis on SDNN were statistically significant, $\chi^2 = 8.72$, $p = .03$.

SDANN and RMSSD decreased from Conditions I to II and were the same in Conditions II and III. In addition, they were the highest value in Condition IV. However, the effects of hypnosis on SDANN and RMSSD were statistically significant, $\chi^2 = 10.4$, $p = .02$ and $\chi^2 = 10.39$, $p = .02$, respectively.

The pNN50 decreased from Condition I to Conditions II and III but was the highest in Condition IV. The effects of hypnosis on pNN50 were statistically significant, $\chi^2 = 9.37$, $p = .03$.

In contrast to previous HRV parameters, VLF increased from Condition I to Condition II and decreased in Condition III but increased to the similar value of Condition II again. The effects of hypnosis on VLF were not statistically significant, $\chi^2 = 1.89$.

HF increased from Condition I to Conditions II and III and decreased in Condition IV, which was approximately similar to Condition II. Anyway, the effects of hypnosis on VLF were not statistically significant like VLF, $\chi^2 = 2.62$.

LF and LF/HF decreased from Condition I to Condition II then increased in Condition III; they were highest in Condition IV. Eventually, the effects of hypnosis on LF and LF/HF were statistically significant, $\chi^2 = 16.85$, $p = .001$ and $\chi^2 = 12.23$, $p = .007$, respectively.

In general, HRV parameters, except VLF and HF, were unsteady in Conditions I, II, and III. Also, in Condition IV, all of HRV parameters were the highest value compared to the other conditions in women (see Table 2). Therefore, in healthy women, the effects of hypnotic conditions on HRV were statistically significant.

Discussion

In the present study, all HRV parameters changed during and after hypnosis compared to the prehypnotic condition in both men and women. The changes in women were significant, but not in men.

In women, all HRV parameters except VLF in the prehypnotic condition decreased during hypnosis (Conditions II and III). Also, posthypnotic values were higher compared to prehypnotic and

Table 2
*Means and Standard Deviations (*SD*) of the Different HRV Parameters in Healthy Women During Hypnotic Conditions*

	Condition I		Condition II		Condition III		Condition IV			
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	χ^2	*p*
SDNN	50.07	11.91	50.51	16.62	46.99	17.70	55.28	20.48	8.72	.03
SDANN	37.16	13.18	36.44	21.86	36.45	24.49	39.80	26.36	10.40	.02
RMSSD	37.11	13.16	36.41	21.84	36.41	24.45	39.75	26.32	10.39	.02
pNN50	16.90	13.52	14.89	17.90	14.17	19.35	17.30	17.15	9.37	.03
VLF	9.03	6.89	12.76	12.60	8.32	7.82	12.65	14.94	1.89	*ns*
LF	5.27	2.42	4.29	3.12	4.94	4.25	8.05	5.36	16.85	.001
HF	6.15	4.94	7.72	1.21	7.96	1.34	7.77	1.11	2.62	*ns*
LF/HF	1.27	0.80	0.95	0.55	1.08	0.69	1.82	1.10	12.23	.007

hypnotic values. That is to say, women had the highest HRV parameters in the posthypnotic condition.

A hypnotized person sees, feels, smells and otherwise perceives in accordance with the hypnotist's suggestions. Therefore, it can be stated that hypnosis can result in metabolic, cardiac, and cognitive activations. Uslu et al. (2012) compared cerebral blood flow in normal waking (alert, relaxed mental imagery) and hypnotic states. In that study, flow velocity in the middle cerebral artery was increased during hypnosis from 5 minutes before hypnotic induction and decreased during hypnotic imagination. According to that study, only highly hypnotizable persons' overall cerebral blood flow increased. However, it suggested that hypnosis requires cognitive effort and so hypnotic status can modulate cerebral blood flow.

Cardeña, Milz, Pascual-Marqui, and Kochi (2012) evaluated depth reports and EEG activity during both voluntary and hypnotically induced left-arm lifting. The hypnotic condition was associated with higher activity in fast EEG frequencies in anterior regions and slow EEG frequencies in central-parietal regions, all left-sided. Hypnotic depth was correlated with left hemisphere increased anterior slow EEG and decreased central fast EEG activity.

Peter, Schiebler, Piesbergen, and Hagl (2012) reported that during hypnotic arm levitation, the total muscle activity was lower than while holding it up voluntarily. Therefore, it can be stated that it is possible to reduce strain and to objectively measure muscle activity in an uplifted arm through hypnotic arm levitation.

Our results suggest that hypnosis causes an increase in cardiac effort or activity. It has been shown that the cognitive effort or activity increases during hypnosis (Sadler & Woody, 2006). These results show that both heart and brain but not skeletal muscles are active in hypnosis.

Some HRV parameters, such as decreased SDNN and increased LF/HF ratio, are associated with an increased cardiac mortality in almost all clinical conditions characterized by an autonomic imbalance (Durmaz et al., 2009). Therefore, hypnotherapy can be used in some cardiac clinical conditions characterized by an autonomic imbalance or some cardiac rhythm disturbances.

The LF component is modulated by both the sympathetic and parasympathetic nervous systems. The HF component is generally defined as a marker of vagal modulation. The LF/HF ratio reflects the global sympatho-vagal balance and can be used as a measure of this balance. In a normal adult in resting conditions, the ratio is generally between 1 and 2 (Sztajzel, 2004).

Nasal cycle is a phenomenon of the alternating congestion-decongestion response in both nostrils (Shannahoff-Khalsa et al., 1991). It manifests as greater or lesser airflow in one nostril compared to the other, with a pattern of alternating dominance ranging from 25 minutes to 8 hours, with the peak interval between 1.5 and 4 hours. Nasal cycle is regulated by the autonomic nervous system, such that unilateral sympathetic activity in one nostril mucosa causes vasoconstriction and decongestion, while synchronous parasympathetic activity in the other nostril causes vasodilatation and congestion.

Breathing solely out of one nostril or the other is referred to as unilateral forced nostril breathing (UFNB). It has been reported that UNFB may affect cognitive ability. UNFB through the left nostril is associated with enhanced spatial abilities, whereas breathing through the right nostril is associated with enhanced verbal abilities (Jella & Shannahoff-Khalsa, 1993; Klein et al., 1986). The cognitive and cardiac effects of hypnosis may be due to its modulator effects on nostril breathing dominance or nasal cycle.

Dane, Caliskan, Karasen, and Oztasan (2002) investigated the effects of UFNB on systolic and diastolic blood pressures and heart rate. In men, both the right and left UFNB significantly increased the systolic blood pressure and heart rate but had no effect on the diastolic blood pressure. In women, the right UFNB increased, but the left UFNB slightly decreased the systolic and diastolic blood pressures. Also Chen, Brown, and Schmid (2004) reported that there was a tendency for left UFNB to produce a greater decrease in arterial blood pressure in subjects with higher baseline blood pressure levels. Dane (2004) suggested that the effects of UFNB on the autonomic nervous system were sex related. Also, research has established some relationships between nostril dominance and some psychiatric disease such as schizophrenia (Yildirim et al., 2010) and affective disorders (Ozan et al., 2012).

It can be stated that the cardiac effects of hypnosis, like UFNB, are also sex specific. These results suggest that hypnosis may be helpful in cardiac autonomic disturbances, especially in women.

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Die Effekte von Hypnose auf die Variabilität der Herzfrequenz

Ramazan Yüksel, Osman Ozcan und Senol Dane

Abstrakt: Uslu et al. (2012) gingen davon aus, daß der hypnotische Zustand den cerebralen Blutfluß modulieren kann. Wir untersuchten die Effekte von Hypnose auf die Variabilität der Herzfrequenz (HRV). Bei Frauen ging die Herzratenvariabilität unter Hypnose zurück. Posthypnotische Werte waren höher im Vergleich zu den prähypnotischen und perhypnotischen Werten. Frauen hatten die höchsten Werte unter posthypnotischen Bedingungen. Es scheint, daß Hypnose kardiale und kognitive Aktivierung hervorrufen kann. Hypnotherapie könnte bei gewissen kardialen klinischen Erkrankungen, die durch autonome Imbalance oder Arrhythmien gekennzeichnet sind, hilfreich sein.

Stephanie Reigel, MD

Les effets de l'hypnose sur la variabilité de la fréquence cardiaque

Ramazan Yüksel, Osman Ozcan et Senol Dane

Résumé: Les recherches d'Uslu *et al.* (2012) semblent indiquer que l'état hypnotique peut moduler le débit sanguin vers le cerveau. Nous avons analysé les effets de l'hypnose sur la variabilité de la fréquence cardiaque (VFC). Chez les femmes, la VFC diminuait durant l'hypnose. Les valeurs post-hypnotiques étaient plus élevées que les valeurs pré-hypnotiques ou hypnotiques. Les paramètres de VFC des participantes étaient les plus élevés en état post-hypnotique. Il semble que l'hypnose peut produire une activation cardiaque et cognitive. L'hypnothérapie peut être utile dans le cas de certains états cliniques cardiaques caractérisés par une ataxie vasomotrice ou certaines arythmies cardiaques.

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Los Efectos de la Hipnosis en la Variabilidad del Ritmo Cardiaco

Ramazan Yüksel, Osman Ozcan, y Senol Dane

Resumen: Uslu et al. (2012) sugirieron que el estado hipnótico puede modular el flujo de sangre cerebral. Nosotros investigamos los efectos de la hipnosis en la variabilidad del ritmo cardiaco (HRV). En mujeres, HRV decremento durante hipnosis. Los valores post hipnóticos fueron más altos comparados con los valores pre hipnóticos e hipnóticos. Las mujeres tuvieron los

parámetros más altos de HRV en la condición post hipnótica. Parece ser que la hipnosis puede producir activaciones cardiacas y cognitivas. La hipnoterapia podría ser útil en algunas condiciones cardiacas clínicas caracterizadas por un desequilibrio autonómico o en algunas arritmias.

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