AUTOMATIC SLEEP APNEA DETECTION AND ITS APPLICATION IN PATIENTS OF THE SIESTA DATABASE – ADAPTATION NIGHT EFFECTS

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Introduction: The first-night effect (FNE) is a well-reported phenomenon in sleep research. It is considered to result from the subject's adaptation to the unfamiliar environment of the sleep laboratory and the technical equipment required for polysomnography (PSG). This might include the physical discomfort induced by electrodes and cables, as well as the psychologically stressful situation of being the object of study. The aim of the present study is to investigate differences in the apnea/hypopnea index (AHI) during two consecutive nights in the sleep laboratory. The results of this study are based on data recorded in the SIESTA project. A new apnea/hypopnea detection software, which was developed recently for the Somnolyzer 24x7, is introduced.

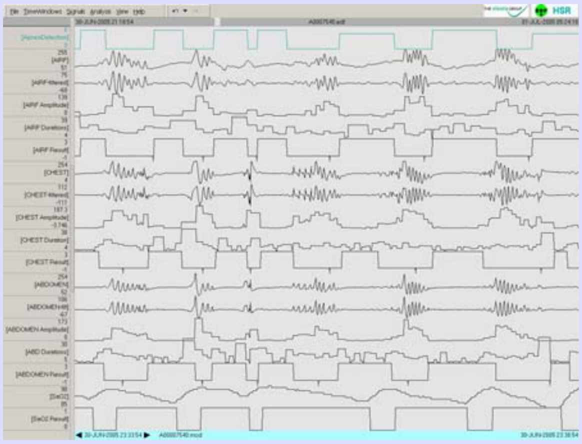


Figure 1: Desaturation, Apnea & Hypopnea detection example

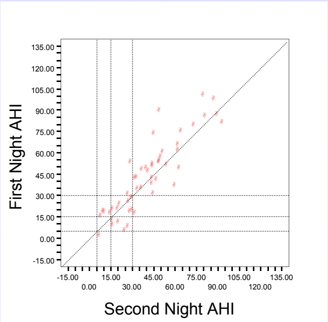
Method: The detection algorithm is based on 4 polysomnographic signals: oxygen saturation (SaO_2), nasal airflow, movement of the chest wall and of the abdomen. Peaks and troughs of the SaO_2 signal are determined in order to extract intervals of oxygen desaturation. A different technique is used to detect changes in nasal airflow and the effort signals. Baseline drifts are subtracted from these signals by bandpass filtering. Every single breath is then extracted. Using also the duration information of individual breaths, intervals with reduced airflow are detected and assigned to three classes: an amplitude decrease of more than 30% (possible hyopnea), more than 50% (hypopnea) and more than 80% (apnea). The chest and abdomen movement channels are treated similarly. Final classification of respiratory events is accomplished with a decision tree. Based on detected oxygen desaturations and decreases in airflow, chest and abdomen signals, intervals are then classified as being either hypopneas, obstructive, mixed or central apneas (see figure 1).

Data: In the present analysis 51 subjects (44 males and 7 females) recorded in 2 consecutive nights were included. Subjects' mean age was 51+/-10 years. Differences between AHIs obtained in the first and in the second night were statistically compared by means of a paired t-test.

		1st Night	2nd Night	1st-2nd Night		
		Mean ± SD	Mean ± SD	Change value	t-value	P (df=47)
Total sleep period (min)	APNEA	464 ± 37	476 ± 28	-12.3	-2.25	0.029
	HC	442 ± 33	450 ± 41	- 8.2	-1.32	
Total sleep time (min)	APNEA	395 ± 54	428 ± 40	-32.7	-4.30	**0.000**
	HC	364 ± 61	400 ± 45	-35.1	-3.61	**0.001**
Sleep efficiency (%)	APNEA	80 ± 10	86 ± 7	-6.0	[illegible]	**0.000**
	HC	77 ± 13	84 ± 7	-7.6	[illegible]	**0.000**
Sleep onset latency (min)	APNEA	26 ± 31	16 ± 10	9.6	2.18	0.034
	HC	25 ± 26	20 ± 22	5.5	1.37	
REM latency (min)	APNEA	119 ± 70	85 ± 54	33.2	[illegible]	**0.001**
	HC	114 ± 55	82 ± 32	31.4	[illegible]	**0.000**
Number of sleep cycles	APNEA	3.4 ± 1.0	3.9 ± 1.0	-0.5	-3.43	**0.001**
	HC	3.5 ± 1.1	4.0 ± 0.9	-0.5	-3.05	**0.004**
Wake within TSP (min)	APNEA	66 ± 39	45 ± 25	21.4	3.28	**0.002**
	HC	76 ± 53	48 ± 29	28.0	3.66	**0.001**
Wake after final awakening (min)	APNEA	7 ± 11	6 ± 16	0.2	0.11	
	HC	10± 20	5 ± 10	5.1	2.42	0.020
Frequency of awakenings	APNEA	36 ± 24	29 ± 19	6.8	2.23	0.030
	HC	25 ± 12	22 ± 9	2.3	1.54	
Frequency of stage shifts	APNEA	214 ± 71	221 ± 76	-7.1	-0.73	
	HC	139 ± 33	150 ± 35	-11.5	-2.20	0.033
S1 (min)	APNEA	77 ± 42	75 ± 50	2.1	0.30	
	HC	44 ± 22	43 ± 20	1.7	0.73	
S1 (% TST)	APNEA	20 ± 11	17 ± 10	2.5	1.44	
	HC	12 ± 7	11 ± 5	1.7	2.82	**0.007**
S2 (min)	APNEA	219 ± 56	225 ± 45	- 5.9	-0.66	
	HC	211 ± 50	223 ± 45	-12.4	-1.56	
S2 (% TST)	APNEA	55 ± 11	52 ± 10	2.4	1.39	
	HC	57 ± 8	55 ± 8	2.0	1.63	
S3 (min)	APNEA	23 ± 19	30 ± 20	-7.4	-2.60	0.012
	HC	28 ± 16	31 ± 14	-0.2	-1.02	
S3 (% TST)	APNEA	6 ± 5	7 ± 5	-1.2	-1.74	
	HC	8 ± 4	8 ± 4	-0.2	-0.30	
S4 (min)	APNEA	7 ± 12	14 ± 17	- 6.5	-2.82	**0.007**
	HC	13 ± 15	21 ± 20	-7.7	-3.32	**0.002**
S4 (%TST)	APNEA	2 ± 3	3 ± 4	-1.4	-2.61	0.012
	HC	4 ± 4	5 ± 5	-1.7	-2.82	**0.007**
REM (min)	APNEA	69 ± 24	84 ± 21	-15.1	[illegible]	**0.000**
	HC	68 ± 24	82 ± 23	-13.6	[illegible]	**0.001**
REM (%TST)	APNEA	17 ± 5	20 ± 5	-2.4	-2.49	0.016
	HC	19 ± 6	20 ± 5	-1.9	-2.04	0.047
Movement time (min)	APNEA	2 ± 3	3 ± 3	-0.6	-1.41	
	HC	1 ± 1	1 ± 2	-0.4	-1.28	

Table 1: Comparison of the first-night effects in R&K derived variables between apnea patients and age- and sex-matched healthy controls (n=2x48).

Results: The AHI per TST was 42.07 in the first and 40.62 in the second night, with a higher variance in the first night. Samples showed a highly significant correlation of 0.889. The paired t-test did not reveal a significant difference between the two nights (t=0.869; p=0.389). In 5 recordings a critical AHI value of 15 was not reached in the first, but in the second night. One patient did not show an AHI of more than 15 in either night.



2nd \ 1st	Healthy AHI<5	Mild 5-15	Moderate 15-30	Severe >30
Healthy AHI<5				
Mild 5-15	1		4	
Moderate 15-30		5	7	2
Severe >30			1	31

Figure 2: Scatterplot of AHI results for 51 patients. Given are the boundaries for mild (5<AHI≤15), moderate (15<AHI≤30) and severe (AHI>30) apnea.

Table 2: The absolute numbers counted from scatterplot in figure 2.

Conclusion: Despite the fact that different parameters like sleep efficiency, REM latency or time spent in REM sleep demonstrated significant first-night effects in apnea patients (similar to healthy controls; cmp. table 1), the AHI did not change significantly. The reason for this might be that the AHI is an index relative to sleep duration. Moreover, the reduction of time spent in REM has just a small effect, as, in comparison with light sleep stages, only few apneas can be observed during REM sleep. Thus, we confirm previous reports that in patients with high AHI measured already in the first night, sleep apnea might be diagnosed correctly without a second PSG night.

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