Behavioral characteristics predisposing to hyperventilation complaints: "Emphasis on exhaling" and "time pressure"

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SAMENVATTING. Gedragskenmerken die voorbeschikken tot hyperventilatieklachten. *Bij de behandeling van patiënten met het hyperventilatiesyndroom (HVS) treden bijzonderheden in gedrag en ademhalingspatroon aan het licht, die ook wel eens een rol zouden kunnen spelen in de etiologie van het syndroom. In deze studie worden twee tendensen onderzocht: nadruk op uitademing en tijdsdruk. Ze worden geoperationaliseerd in de "Behavioral Questionnaire Exhaling" (BQE) die werd ingevuld door 75 HVS patiënten en 80 niet-HVS'ers. Met behulp van de methode van lineaire discriminant-analyse bleek het mogelijk een duidelijk onderscheid te maken tussen de twee groepen voor wat betreft de acht items over ademhalingsgewoonten. In het totaal werd 87% van de proefpersonen correct geclassificeerd (HVS: 85%), niet-HVS: 89%). De zes items betreffende tijdsdruk differentieerden weliswaar, maar in mindere mate. Van de proefpersonen werd 72% correct geclassificeerd (HVS: 81%, niet-HVS: 64%). Deze resultaten verlenen empirische steun aan de hypothese dat specifiek gedrag en ademhalingstendenties van HVS-patiënten de instabiliteit van het ademhalingssysteem kunnen vergroten, en zodoende hyperventilatie als stress response kunnen faciliteren. Diagnose en behandeling van het HVS kunnen in effectiviteit toenemen wanneer deze kenmerken in acht worden genomen.*

Although the definition and diagnosis of Hyperventilation Syndrome (HVS) has become fairly well established, its etiology is still unclear. Pfeffer (1978) concludes his review of the syndrome as follows: "The main controversy over the etiology of HVS is whether the hyperventilation is a response to anxiety or a bad breathing habit with secondary production of anxiety. However, whichever view should prove to be correct, by the time the patient presents for help the vicious circle (hyperventilation-symptoms-anxiety-hyperventilation) has usually become established." Brashear (1983), in a recent review, agrees that the establishment of this vicious circle is the important fact of HVS, regardless of the causes. In other words, the issue of causation can only be resolved by studying the development of HVS in the lifetime of individuals in a prospective study. Retrospectively, a detailed medical history may provide some clues. Lazarus (1969) for instance found that a significant event often is associated with the very first episode of HVS: personal loss, frightening event, physical trauma. In this way, however, it is not known which persons respond with hyperventilation to such life events. Another approach would be to search for dispositional characteristics in the patient, which do not form part of the clinical picture in the way that anxiety does. Lum (1976) noted a tendency towards perfectionism and obsession, for instance. In this paper two other characteristics of HVS patients will be studied.

In treating patients with HVS, peculiarities in behavior and breathing pattern were observed which may play a role in the genesis of the syndrome. Our treatment consists mainly of techniques for teaching a normal, regular respiratory pattern. Two tendencies, not presented as complaints, but seemingly habitually present, were an emphasis on exhaling (Balfoort et al., 1979) and time pressure, being the tendency to do things very quickly (Van Dixhoorn, 1980). The tendency to exhale is shown, for instance, in an inability for breath-holding after inspiration, in forceful (sighing) or long (speaking) exhalations and post-exhalatory pauses.

Diaphragmatic descent (Kimura et al., 1973) and sideways expansion of the lower ribcage (Kapandji, 1974) is hindered by the constricting event of expiratory muscle activity (the intercostal muscles of the lower lateral costal margin are mainly expiratory (Taylor, 1960)). Consequently, *in*halation becomes uneven, more difficult and more upper-thoracic. The patient complaints about shortness of breath and the inability to inhale enough, but he does not notice the tendency to exhale too strongly or quickly, which he considers natural.

The second tendency is to do things very quickly. The HVS patient is often impatient and it is troubling for him to wait and to do things slowly and attentively. The patient often images he is doing many things simultaneously and he is rushing ahead of events in his mind. This speed and impatience feels quite natural, and restraining himself seemingly creates more stress than rushing on (Lange, 1977). He may complain that he is unable to do what he likes anymore, but not that he al-

ways wanted too much in too short time.
These peculiarities and their possible dispositional nature become manifest during treatment. Teaching a slow and regular costo-abdominal rhythm involves a re-education of the breathing pattern, implying a re-appraisal and (re)learning of a relaxed kind of breathing. The patient gradually becomes aware of respiratory movement in abdomen, lower back and pelvic region. A successful treatment session typically ends with feelings of being unusually lazy, sleepy or quiet. Although the technique of respiration has become adequate, the sensations may be so strange as to even induce fear. Therefore, the explanation is given that the treatment is directed towards changing the basic pattern of breathing, which requires some time. But ultimately hyperventilation will be prevented. The treatment is *not* meant as a *direct* remedy for the attacks and complaints. In order to underline this purpose a questionnaire is constructed, called Behavioral Questionnaire Exhaling (BQE) comprising behavioral and psychological characteristics, to be filled out by the patient. For this investigation two kinds of items are selected from BQE, viz. Emphasis on Exhaling (EE) and Time Pressure (TP) respectively. The purpose is to test the hypotheses that 'Emphasis on Exhaling' and 'Time Pressure' have qualities to differentiate HVS patients from non-HVS (normal persons).
The research questions are:
1) Has 'Emphasis on Exhaling' the ability to differentiate HVS and non-HVS? If so, to what extent?
2) Has 'Time Pressure' the ability to differentiate HVS from non-HVS? If so, to what extent?

Material and methods

Subjects

Eligible for this study were HVS patients who in 1981-1983 underwent breathing and relaxation therapy in the Biofeedback department of St. Johannes de Deo Hospital, Haarlem, or the Breathing Therapy Practice, Amersfoort, The Netherlands. The diagnosis HVS was made on the basis of the complaints pattern by (a) the referring medical doctor, and (b) the therapist. Exclusion criteria were (1) patients in whom a somatic disorder was responsible for the complaints and (2) patients in whom no irregularity in respiration was found at all. Doubtful cases were decided by applying the hyperventilation provocation test or left out of the study. Seventy-five patients were found eligible for the study (22 men, 53 women; mean age 36.6 years, SD 9.8 years).
The reference group (non-HVS) consisted of persons who for professional reasons attended lessons on breathing therapy, mainly physiotherapists or yoga teachers. Questionnaires utilizable for statistical analysis were obtained from 80 persons (28 men, 52 women; mean age 31.9 yr, SD 11.8 yr). The same groups have been reported on elsewhere (Van Dixhoorn et al., 1984).

Procedure

The patients (HVS) completed the questionnaire at the end of the first interview as part of the intake procedure in the presence of the therapist. The non-HVS persons completed the questionnaire during a short pause in the lessons.

Questionnaire

Behavioral Questionnaire Exhaling (BQE) consists of 40 items of which the 14 items concerning 'Emphasis on Exhaling' and 'Time Pressure' are of relevance here. The items are to be answered on a three point scale (1=yes, 2=?, 3=no). The items do not refer to actual complaints, but to behavioral tendencies. Many are phrased as: "Are you in the habit of ...", "Do you usually ...", "Are you a person who ...". Thus, as far as seriousness or frequency was deemed important, this was expressed in the formulation of the question.
Examples of the operationalisation of the tendencies at issue are: "Do you sometimes notice that you 'forget' to inhale?", "Are you in the habit of speaking quickly?" (respiratory tendencies); "Do you usually want things to be done immediately?", "Are you in the habit of thinking ahead of events?" (behavioral tendencies).

Methods of analysis

The method of Linear Analysis of Discriminance is used to discriminate optimally between two or more categories of subjects. In the present study there are two categories: HVS and non-HVS. By means of this method predictor variables are selected which have discriminating values as regards HVS and non-HVS. The mathematical objective is to weigh and combine variables linearly in such a manner that the two categories are distinguished from one another statistically in an optimal way. The method selects the predictor variables stepwise and determines the coefficients for each variable selected. The procedure is as follows: a single variable is to be selected which has the highest value on the selection criterion. The first variable selected is then paired with each of the remaining variables one at a time. The combination which has the highest value on the selection criterion is selected, and so on. This process continues untill all variables or combinations of variables which meet the criterion have been selected. A variable which has been selected might later be removed, because other variables or combinations of variables may have greater discriminating power. Similarly, a variable which is excluded might be re-entered at a later step in the selection procedure. The criteria used for inclusion and exclusion are $F \geq 1.00$ and $F \leq 0.95$ respectively. In this analysis Wilks lambda

Table 1 Response frequencies on 'Emphasis on exhaling' of HVS and non-HVS.

Item formulation	HVS (n = 75) (%)	non HVS (n = 80) (%)	Difference (%)	Significance*
Do you frequently have a tight sensation around the stomach and ribs?	57	5	52	$P << 0.001$
Do you sometimes notice that you 'forget' to inhale?	68	21	47	$p << 0.001$
Do you sigh a lot, blowing out the air in your lungs?	61	15	46	$p << 0.001$
Are you in the habit of speaking quickly, getting a lot of words in a single breath?	73	31	42	$p << 0.001$
Does it happen that a long time passes without breathing after you exhaled?	51	20	31	$p << 0.001$
Do you sometimes lose your voice?	17	4	13	$0.01 < p < 0.05$
Is your voice often thin?	24	13	11	ns
Are you in the habit of holding in your stomach?	41	34	7	ns

* Tested with χ^2 for contingencies.

(λ) is used. This test takes into consideration the difference between the centroids (i.e. means) and the cohesion (i.e. homogeneity) within groups (Colley, 1971; Van der Geer, 1971; Tatsuoka, 1971).

Results

In operational terms the first research question was as follows: Has the tendency 'Emphasis on Exhaling' the ability to differentiate HVS and non-HVS? If so, to what extent?

Regarding EE the response frequencies are given in Table I. The items are ordered descendingly, according to the difference between HVS and non-HVS. The differences on the first five items are highly significant. Most HVS patients (68%) sometimes forget to inhale, whereas few non-HVS (21%) do. Also 73% HVS patients used to speak quickly, in contrast to 31% of non-HVS.

The habit of frequent sighing, specifically while breathing out, is noticed by many HVS (61%) patients but hardly by non-HVS (15%). A frequent, tight sensation around the stomach and ribs, indicating the constricting expiratory tension, is noticed by 57% of HVS and very few non-HVS (5%) indeed. A post-exhalatory pause, as indicated by the question whether it happens that a long time passes without breathing after one exhaled occurs in half of HVS patients and in one-fifth of non-HVS.

On three items of EE the two groups do not differ discernably: losing voice, thin voice and the tendency of holding the stomach in. This may indicate that the tendency to exhale, as a respiratory habit, is mainly located around the lower ribs and diaphragm, whereas the more culturally determined wish to present a flat abdomen has not so much to do with that: it applies to HVS and non-HVS equallky and is located below the diaphragm. The conclusion is justified that the majority of HVS exhibit an emphasis on exhaling, whereas in non-HVS a minority does.

Table 2 Classification matrix of HVS vs non-HVS, on the basis of discriminant analysis: Emphasis on exhaling.

Criterion	Assignment		On the basis of discriminant analysis	
	HVS	non HVS	HVS	non HVS
HVS (n = 75)	a	b	64	11
non-HVS (n = 80)	c	d	9	71
	Classification rates (%)		Statistical double cross-validation (%)	
correct classification	87		85	
sensitivity a/a+b	85		81	
specificity d/c+d	89		89	
true positive prediction a/a+c	88		87	
true negative prediction d/d+b	87		84	

The differentiating abilities of the items on EE jointly are tested by the method of a stepwise linear analysis of discriminance. For this tendency the differentiation is highly significant (Wilks $\lambda = 0.377$, $\chi = 132.6$, $df = 6$, $<< 0.0001$). The classification rates are given in Tabel II. Inspection of this table learns that 135 of the 155 subjects (87%) are correctly classified.
The stability of the discriminant function was investigated by means of a statistical double cross-validation, i.e. both HVS and non-HVS were divided randomly into two groups, as far as possible of equal size (I and II). The discriminant function coefficients of group I were estimated and the subjects of group II were then classified on the basis of these coefficients. An identical procedure was used for group II, but in the reversed order.
The percentages of correct classification were 90 and 87 for the two groups respectively. Consequently, the conclusion is justified that the differentiating ability of the respiratory habit 'Emphasis on Exhaling' is very stable.
The sensitivity and specificity are almost equal for EE (85% and 89% resp.): it means that few HVS patients do not have EE and that even less non-HVS do have it. For more detailed information, see Table II). So, it is concluded that 'Emphasis on Exhaling' is closely associated with HVS.

The second research question was: "Has the tendency 'Time Pressure' the ability to differentiate HVS from non-HVS, and if so, to what extent"?
In Table III the items on behavioral tendencies are presented.

On these items the differences between the two groups are on the average smaller, compared to the items on EE, mainly because HVS and non-HVS share these habits. The majority of HVS (87%) prefers to be doing several things simultaneously, whereas more than a half (58%) of non-HVS agree to that too. About the same percentage of HVS vs non-HVS usually wants to act immediately (HVS: 81%, non-HVS: 54%) and has always been quick and impatient (HVS: 71%, non-HVS: 44%). Almost all HVS (93%) are in the habit of thinking ahead of events, but this applies also to many non-HVS (69%), indicating that TP does not necessarily manifest itself in the overt behavior only, but also concerns mental activity. In concordance with this finding it is not surprising that waiting is difficult for many HVS (68%), but also for half of non-HVS (50%). Two third of HVS and non-HVS stated not to take things easily. It is concluded that almost all HVS patients exhibit TP whereas many of non-HVS also do.
The differentiating abilities of the items on TP jointly are tested by the method of a stepwise linear analysis of discriminance. The results are highly significant (Wilks $\lambda = 0.816$; $\chi^2 = 28.2$, $df = 4$, $p << 0.0001$). The classification rates are given in Table IV. It can be seen that 122 out of 155 subjects (72%) are correctly classified. Statistical double cross-validation resulted in respectively 62 and 69 percentages of correct classification.
The differentiating ability of TP is therefore stable, but to a lesser degree than that of EE.
Sensitivity is much higher than Specificity (81% and 64% resp.) which means that most HVS can be recognized by their behavioral tendency but many of non-HVS too. It might be concluded that 'Time Pressure' is allied substantially to HVS, although not exclusively.

Discussion

In this study the hypothesis is confirmed that HVS patients are characterized by behavioral tendencies, which may increase the instability of the respiratory

Table 3 Response frequencies on 'time pressure' of HVS and non-HVS.

Item formulation	HVS (n = 75) (%)	non HVS (n = 80) (%)	Difference (%)	Significance*
Would you prefer to be doing several things at once?	87	58	29	$p << 0.001$
Do you usually want things to be done immediately?	81	54	27	$p << 0.001$
Have you always been quick and impatient by nature?	71	44	27	$0.001 < p. < 0.01$
Are you in the habit of thinking ahead of events?	93	69	24	$p < 0.001$
Do you find waiting difficult?	68	50	18	$0.01 < p < 0.05$
Were you always a person who took things easily? (percentage of negative answer is given)	67	68	1	ns

* Tested with χ^2 for contingencies.

system and thus facilitate hyperventilating as a stress response. Despite the plausibility of this rationale, the original question summarized by Pfeffer (1978) (see also introduction) remains unanswered. The design of this study has limitations which do not allow for the evidence to be conclusive. In order to prove the existence of dispositional traits, a prospective study is necessary wherein these characteristics should be found in non-HVS persons as risk factors for later occurrence of HVS. Further, this empirical study is based on self-report only. A replication would be necessary in which beside self-report other methods of measurement are added (e.g. observations and physiological respiratory variables).

Of the eight questions concerning respiratory habits of BQE, four express the tendency to exhale most clearly, namely: forgetting to inhale, sighing while inhaling, speaking many words on a single breath, long pause after exhalation. Taking as a criterion that at least two of them have to be endorsed, 77% of HVS are used to exhale, in contrast to 21% of non-HVS. 'Time Pressure' is expressed especially in the items: doing several things simultaneously, doing things immediately, being impatient and quick, thinking ahead of events. Taking as criterion that all four have to be endorsed, 63% of HVS is under high time pressure, whereas 20% of non-HVS is.

The idea of traits predisposing to HVS becomes more plausible when two conditions are met. First, they should be present well before the first HVS episode and second, they should destabilize respiration. This view is also expressed by Garssen (1980) who concludes that a specific over-responsivity of the respiratory system is more plausible than to consider HVS as part of a general stress response. He found only a small degree of hyperventilation in normal subjects under stress. Furthermore, there are no reasons to assume that HVS patients experience more stressful life events than non-HVS or that they react with elevated stress responses. Therefore, investigations should be concentrated on specific mechanisms to account for this 'symptom specificity' (Garssen, 1980). The present study provides useful indications.

In clinical practice, a disposition to HVS can be ascertained. It means that a patient recognizes certain tendencies, without labeling them in terms of complaints or discomfort. Of importance is, that specific characteristics of behaving and breathing exist, which although they feel natural to the person, do foster hyperventilation. In other words, the HVS patient promotes his own complaints, but does not realize it. This idea has implications for treatment and can also be verified in therapy (Lange, 1977; Grossman, 1984; Bonn et al., 1984). Treatment should be two-fold: reducing complaints, and re-eductng the use of the body.

Table 4 Classification matrix of HVS vs non HVS, on the basis of discriminant analysis: time pressure.

Criterion	Assignment		On the basis of discriminant analysis	
	HVS	non HVS	HVS	non HVS
HVS (n = 75)	a	b	61	14
non-HVS (n = 80)	c	d	29	51
	Classification rates (%)		Statistical double cross-validation (%)	
correct classification	72		66	
sensitivity a/a+b	81		79	
specificity d/c+d	64		54	
true positive prediction a/a+c	68		62	
true negative prediction d/d+b	79		73	

Another argument pro 'disposition is derived from research on Type A behavior. The meaning of Time Pressure is almost identical to 'Speed and Impatience' in the Jenkins Activity Survey (Jenkins et al., 1974). The similarity of HVS patients to Type A has been noticed by Lum (1976): "most happy when driving themselves hard", "constantly under the stress of having to meet deadlines, or rushing to be on time". It is plausible that 'Speed and Impatience' also affects respiratory behavior, in the sense of speeding up respiratory rhythm (Van Doornen, 1980), or that it promotes upper-thoracic breathing (Friedman et al., 1960). Also, this characteristic in itself does not elicit negative feelings (Wadden et al., 1983).

According to Brashear (1983) realiable diagnosis is facilitated if the physician is alert for subtle clues, including respiratory behavior. This view is supported by the present study, but frequent heaving, sighing and overbreathing are not the only signals. The presence of an emphasis on exhaling (whether through self-report or observation ascertained) is an argument pro HVS, just as its absence is an argument contra. The presence of 'Time Pressure' is not of significance, but its absence makes HVS highly improbable.

A useful tool for the physician is the Nijmegen Questionnaire, consisting of 16 items on complaints of HVS (Van Dixhoorn, 1984). The positive and negative predictive power of this check list is quite high (94% and 92% resp.). Its predictive value will to all probability increase if information on dispositions is added.

Summary

In treating patients with hyperventilation syndrome (HVS) peculiarities in behavior and breathing pattern

occur which may play a part in the etiology of the syndrome. In this study two tendencies were scrutinized: 'Emphasis on Exhaling' and 'Time Pressure'. They were operationalized in Behavioral Questionnaire Exhaling (BQE), which was completed by 75 HVS patients and 80 non-VHS. From the method of linear analysis of discriminance it appeared that the eight items representing the breathing habit were able to highly differentiate HVS from non-HVS. In total 87% of the subjects were classified correctly (HVS: 85%, non-HVS: 89%). The six items describing time pressure had differential qualities but to a lesser degree. Of the subjects 72% were classified correctly (HVS: 81%, non;HVS: 64%). These data provide empirical support for the hypothesis that specific behavior and respiratory tendencies of HVS patients may increase the instability of the respiratory system, and thus facilitate hyperventilation as a stress response. Diagnosis and treatment of the syndrome will gain effectiveness when these traits are taken into account.

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