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Can biased symptom perception explain false-alarm choking sensations?

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ABSTRACT

Background. Breathlessness in asthma often cannot be explained with objective variables indicating airways obstruction. The hypothesis that unrealistic breathlessness results from false interpretation of sensations was tested.

Methods. Sixty-four children and adolescents with asthma, aged 9–18 years, were randomly assigned to: (1) standardized physical exercise for induction of general symptoms; (2) equipment causing itching through skin irritation; or (3) physical exercise combined with equipment causing itching through skin irritation. Pre-test and post-test measures were: lung function; breathlessness; general symptoms; itching; state anxiety; and worry.

Results. Lung function decreased within normal parameters (3·8%, 1·1%, 2·6%, respectively) and did not differ significantly between conditions. Breathlessness increased significantly after exercise, particularly in condition 3. Breathlessness correlated with general symptoms and worrying, but not with changes in lung function, age, or asthma severity.

Conclusion. Biased symptom perception can explain unrealistic breathlessness. Prerequisites are situational cues triggering selective perception and ambiguous sensations associated with the anticipated (feared) physical state. Excessive breathlessness may often warrant objective confirmation by means of lung-function testing.

INTRODUCTION

Human beings are by nature vulnerable to a biased perception of physical symptoms. They are unaware of most vegetative functions and are poor perceivers of physiological changes (Gannon & Haynes, 1986). At the same time, their information processing is equipped to extensively elaborate on information that is connotated with harm, including the signals of a potential fatal disease (Pennebaker & Skelton, 1981; Rietveld & Prins, 1998). If the initial encoding of internal signals in terms of a match with representations in memory falls short, additional information is sampled and processed to constitute a mental display in line with the predictions generated by recall schemata (Lacroix *et al*. 1991). Conscious monitoring of possibly relevant information may contribute to unconsciously operating selective perceptual mechanisms. The incorporation of information that is associated with disease, but not necessarily causally related to pathophysiology, may often be adaptive regarding early symptom perception. However, it makes patients with a chronic disease vulnerable to biased symptom perception (Rietveld & Prins, 1998). There is no empirical support for the lay assumption that symptom perceptual accuracy increases with the acquisition of experiential knowledge with the symptoms of a disease (Pennebaker, 1982). The influence of biased information processing could often explain unrealistic symptoms in chronic diseases with actual or perceived life-threatening complications. The ambiguity of physical signals underlying symptoms may contribute to the likelihood of biased symptom perception.

Breathlessness is not a specific symptom of any physiological state, or specific for any disorder, although it may cause extreme suffering and distress. There are four arguments showing

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the feeble status of breathlessness as a clear symptom.

1. Which afferent signals underly breathlessness is not clear. Patients who actually suffocated were often remarkably free from breathlessness (Barnes, 1994). Signal detection experiments with detection of externally applied resistive loads to breathing confirmed that patients with asthma were often very inaccurate, even children with relatively healthy airways (Rietveld, 1998). In clinical practice, patients with asthma may consider themselves symptom-free during asthma attacks, or conversely suffer from breathlessness without any airways obstruction (Wolkove *et al.* 1992; Burdon *et al.* 1994; Rietveld, 1997).

Contemporary research has proposed three different mechanisms to explain breathlessness: (*a*) afferent signals from the respiratory muscles during intense labour; (*b*) high levels of arterial carbon dioxide (hypercapnia); or eventually (*c*) hypoxia (Banzett *et al.* 1990). Nonetheless, the origin of breathlessness remains the subject of debate (Adams *et al.* 1985; Skevington *et al.* 1997).

2. Breathlessness is not a specific, uniform symptom. Breathlessness is usually assessed with a single item scale, but factor analysis has shown that there are five distinct factors involved: awareness of respiratory difficulty; panic/fear; hyperventilation; fatigue; and irritability (Brooks *et al*, 1989; Simon *et al.* 1990). The unique contribution of one concomitant could dominate the expression of breathlessness, irrespective of the presence of other concomitants.

3. Patients with asthma commonly make false interpretations with regard to sensations and symptoms associated with asthma (Dirks & Schraa, 1983). They are likely to attribute irritability, fatigue or increased heart rate to asthma (compare Easterling & Leventhal, 1989).

4. External information can contribute to breathlessness. After repeated exposure to co-occurring situational cues and symptoms of asthma, these cues could become triggers of selective symptom perception and thereby enhance the likelihood of biased perception (Rietveld & Brosschot, 1999). Children with asthma used false lung function information and false respiratory sounds in their symptom perception and reported high breathlessness (Rietveld *et al.* 1996, 1997). Consequently, situational cues in combination with ambiguous sensations could enhance breathlessness through biased symptom perception.

This study tested the hypothesis that breathlessness in asthma, not explained by a reduction in lung function, is caused by false interpretation of general symptoms in terms of asthma.

To test this proposition, general symptoms were induced with physical exercise and an elastic band with itching powder to induce itching through skin irritation. These sensations were selected because they are associated with asthma, but are independent of airways obstruction. Patients with asthma are aware of the risk of physical exercise triggering bronchoconstriction towards a full blown asthma attack. This implies that a physical exercise task induces uncertainty with respect to asthmatic state, irrespective of actual exercise-induced airways obstruction (Rietveld *et al.* 1996).

METHOD

Participants

The sample consisted of 64 children and adolescents with asthma, aged 9–18 years (mean = 13·2; S.D. = 2·3), 34 boys and 30 girls. The inclusion criteria included a recent diagnosis of asthma by a physician, and prescribed asthma medication. The experiment was conducted in line with the criteria of the ethical board of the Faculty of Psychology. All parents signed informed consent. The participants were financially rewarded. The severity of asthma was divided into four classes according to the consensus of British lung physicians (British Thoracic Society, 1993). Asthma severity ranged from if needed bronchodilator medication (class 1), to high doses of inhaled corticosteroids (class 4). The participants were instructed not to use bronchodilator medication on the morning of the test. There were no normal controls in the experiment because former studies with a similar test design have consistently shown that they are not responsive to the experimental manipulation of breathlessness (Rietveld *et al.* 1996, 1997).

Experimental procedure

After checking inclusion criteria, the pre-test measures consisted of lung function, breathlessness, general symptoms, itching, state anxiety

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and worry. The experimenter assigned the participants in random order to one of three experimental conditions with the independent variables 'general symptoms', 'itching through skin irritation' or 'general symptoms + itching through skin irritation'. Condition 1 comprised standardized physical exercise for induction of general symptoms. Condition 2 comprised the induction of itching through skin irritation via an elastic band with itching powder. Condition 3 comprised physical exercise combined with itching through skin irritation. Post-test assessments were similar to pre-test. The participants were debriefed about the application of itching powder in Conditions 2 and 3.

Technical procedures

Induction of general symptoms through physical exercise

The participants in experimental Conditions 1 and 3 ran outdoors over a course of 80 m until a heartbeat of 180 bpm was signalled by a control device, strapped around the chest of each participant (Polar Edge, Polar Electro, Nieuwegein, The Netherlands). This was a mild task, intended to induce general symptoms, as well as uncertainty about asthmatic state, rather than actual airways obstruction. The participants were instructed to run fast until asked to stop.

Induction of itching through skin irritation

Skin irritation or eczema is a secondary problem in a subgroup of patients with asthma. It was hypothesized that itching would cause unpleasant sensations and/or irritability in all participants. The elastic band strapping the heartbeat device was treated with sticky powder, causing itching in the experimental Conditions 2 and 3.

Measures

Assessment of lung function

The degree of airways obstruction was measured pre-test and post-test by lung-function testing with a spirometer (Spirosense, Tamaraco systems, Lode BV, Groningen, The Netherlands). The Forced Expiratory Volume in 1 s (FEV1) was expressed as a percentage predicted for a child or adolescent of similar sex, age, height and weight.

Assessment of breathlessness

Breathlessness was defined as laboured breathing, shortness of breath, or tightness of the chest. Breathlessness was measured pre-test and post-test with a self-report 10-point Likert-type scale, ranging from 0 (no breathlessness) to 9 (very severe breathlessness). The scale has been used extensively in previous studies. A mean rise in breathlessness of 2·5 or 4·3 scale points coincided with a reduction in lung function of 30% and 29% during exercise-induced and histamine-induced airways obstruction, respectively (Rietveld *et al*. 1996, 1997).

Assessment of general symptoms

General symptoms were measured pre-test and post-test with 17 items, based on asthma symptom questionnaires (Brooks *et al*. 1989). The symptoms were: sighing, fatigue, muscle pain, heart pounding, dry mouth, dizziness, chest pain, warm sensations, pain in the loin, ear buzzing, nasal congestion, saliva or sputum, cough, pain in the limbs, headache and muscle cramps. These items were presented in a Likert-type format with 10 scale points, ranging from 0 (not at all) to 9 (very severely). The mean scores were computed, ranging from 0 to 153 points.

Assessment of itching through skin irritation

Itching was measured to assess the impact of manipulation in Conditions 2 and 3. To this end, two items were added in the same format as in state anxiety (see paragraph *Assessment of state anxiety*). The score ranged from 2 to 6 points.

Assessment of state anxiety

State anxiety was measured pre-test and post-test with a Dutch version of the subscale 'state anxiety' of the Spielberger Trait and State Anxiety Inventory (Spielberger, 1983; Bakker *et al*. 1989). The scale consisted of 20 statements and the participants had to mark one of three response options 'never', 'sometimes', or 'yes', corresponding with scores 1, 2 or 3. The total score ranged from 20 to 60 points.

Assessment of worry

Worrying was measured to test the influence of this emotional state on self-reported breathlessness. Two items were added in the same

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format as in state anxiety (see the preceding paragraph). The total score ranged from 2 to 6 points.

Statistics

A 3 (Condition) by 2 (Test) analysis of variance with Condition as between factor and Test as a within factor was conducted on all dependent measures. The significance level was set at 0·05. Tukey's honestly significant difference (HSD) test was used to specify the Condition effect.

Correlations were computed between relevant variables by means of Pearson's correlation coefficient.

RESULTS

There was one boy with a post-exercise reduction in lung function of $> 15\%$ and his data were excluded from testing, this left 63 participants for analysis.

The one-way analysis of variance showed that itching during pre-test was significantly higher in Condition 1 *versus* Conditions 2 and 3, $F(2, 60) = 11{\cdot}25$, $P < 0{\cdot}001$. Pre-test worrying was significantly higher in Condition 1 *versus* Condition 2, $F(2, 60) = 6{\cdot}65$, $P = 0{\cdot}003$. The other pre-test variables were not significantly different between Conditions ($P > 0{\cdot}05$; Table 1).

Table 1. *Means and standard deviations of pre-test* (1) *and post-test* (2) *variables over all conditions*

	Condition 1 ($N = 22$)		Condition 2 ($N = 20$)		Condition 3 ($N = 22$)	
	Mean	(S.D.)	Mean	(S.D.)	Mean	(S.D.)
FEV1						
(1)	93·00	(9·04)	90·30	(10·14)	92·05	(8·68)
(2)	89·27	(10·76)	89·20	(9·52)	88·73	(9·06)
Breath						
(1)	0·77	(0·97)	0·85	(0·93)	0·68	(0·72)
(2)	2·81	(1·60)	0·95	(0·76)	3·77	(1·88)
Anxiety						
(1)	31·68	(8·11)	29·70	(3·13)	27·45	(2·22)
(2)	28·41	(7·19)	29·25	(3·46)	30·82	(3·94)
Worry						
(1)	4·09	(0·81)	3·30	(0·73)	3·68	(0·78)
(2)	2·67	(0·58)	2·40	(0·50)	3·14	(0·94)
G. symp.						
(1)	14·91	(18·25)	11·50	(5·00)	10·32	(2·93)
(2)	22·23	(7·83)	16·95	(6·00)	24·27	(6·31)
Itching						
(1)	3·18	(0·59)	2·65	(0·67)	2·45	(0·51)
(2)	2·95	(0·72)	3·15	(1·27)	4·18	(0·96)

Lung function

There was no clinically relevant decrease in lung function during the experiment, 3·8% and 2·6% after physical exercise (Conditions 1 and 3), and 1·1% after induction of itching (Condition 2). The Test effect was significant, but the Condition effect was not, $F(1, 60) = 47{\cdot}66$, $P < 0{\cdot}001$, and $F(2, 60) = 0{\cdot}11$, $P = 0{\cdot}90$, respectively. There was no significant Test × Condition interaction effect.

Breathlessness

Breathlessness did not increase after induction of itching in Condition 2, but there was an impressive increase in breathlessness after physical exercise (Condition 1). However, the highest breathlessness occurred when itching was combined with exercise (Condition 3). The Test effect, Condition effect, and Test × Condition interaction effect were all significant, $F(1, 60) = 112{\cdot}92$, $P < 0{\cdot}001$, $F(2, 60) = 165{\cdot}25$, $P < 0{\cdot}001$, and $F(2, 60) = 26{\cdot}20$, $P < 0{\cdot}001$. The Tukey HSD test showed that post-test breathlessness differed significantly between all three Conditions.

General symptoms

General symptoms increased significantly during testing in all Conditions, particularly after physical exercise combined with itching in Condition 3. The Test effect was significant, but the Condition effect was not, $F(1, 60) = 277{\cdot}02$, $P < 0{\cdot}001$, and $F(2, 60) = 2{\cdot}33$, $P = 0{\cdot}11$, respectively. The Test × Condition interaction effect was significant, $F(2, 60) = 15{\cdot}93$, $P < 0{\cdot}001$. Tukey HSD test showed that post-test general symptoms differed significantly between all three Conditions.

Itching

Itching increased during the experiment, and particularly when itching was combined with exercise in Condition 3. The Test effect was significant, but the Condition effect was not, $F(1, 60) = 18{\cdot}96$, $P < 0{\cdot}001$, and $F(2, 60) = 2{\cdot}66$, $P = 0{\cdot}078$, respectively. The Test × Condition interaction effect was significant, $F(2, 60) = 16{\cdot}88$, $P < 0{\cdot}001$. Tukey HSD test showed that post-test itching differed significantly between Conditions 1 and 2 and 1 and 3.

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State anxiety

State anxiety remained fairly stable throughout the experiment. The Test effect, Condition effect, and Test × Condition interaction effect were not significant, $F(1, 60) = 0{\cdot}41$, $P = 0{\cdot}52$, $F(2, 60) = 1{\cdot}05$, $P = 0{\cdot}356$, and $F(2, 60) = 3{\cdot}82$, $P = 0{\cdot}027$, respectively.

Worry

Worrying decreased significantly during the experiment, and was significantly lower after induction of itching in Condition 2. The Test effect, Condition effect, and Test × Condition interaction effect were all significant, $F(1, 60) = 75{\cdot}89$, $P < 0{\cdot}001$, $F(2, 60) = 6{\cdot}88$, $P = 0{\cdot}002$, and $F(2, 60) = 4{\cdot}60$, $P = 0{\cdot}014$, respectively. Tukey HSD test showed that post-test worrying differed significantly between Conditions 2 and 3.

The significant correlations were as follows: pre-test and post-test lung function (0·95); pre-test and post-test general symptoms (0·55); pre-test lung function and severity of asthma (−0·56); post-test lung function and severity of asthma (0·53); post-test breahtlessness and post-test general symptoms (0·54); post-test breathlessness and post-test worry (0·42), $N = 63$; $P < 0{\cdot}01$.

DISCUSSION

The data supported the hypothesis that excessive breathlessness results from a biased perception of general sensations and symptoms. The lung function of the participants diminished within normal parameters in all three Conditions, whereas breathlessness differed widely. Breathlessness did not increase when the only intervention was induction of itching, which shows that itching was not interpreted in terms of asthma. In contrast, when itching was combined with physical exercise, this led to the highest increase in breathlessness.

These results confirmed that breathlessness, mediated by situational cues, fluctuates with degrees of general sensations and symptoms. A reduction in lung function, indicative of airways obstruction, is not essential. Pre-requisites are situational cues triggering selective perceptual mechanisms and ambiguous sensations connotated with the anticipated (feared) physical state of exercise-induced asthma.

Breathlessness did not correlate with lung function, severity of asthma or age, but breathlessness during post-test correlated significantly with general symptoms and worrying.

Ambiguous sensations after exercise were fatigue, muscle cramps, heart pounding, dry mouth and sighing. The combination of these sensations and symptoms with induced itching in Condition 3 coincided with the highest breathlessness. The current proposition is that ambiguous sensations and symptoms are integrated in the symptom perception process and become imminent as asthma symptoms. It is doubtful that patients are aware of their perceptual bias themselves.

The lung function data suggested that the study attracted mainly youngsters who were not very susceptible to exercise-induced airways obstruction. Hence, it is likely that support for the hypothesis would have even been stronger with a sample representative with regard to susceptibility to exercise-induced asthma (Silverman & Anderson, 1972). Similarly, the current participants scored low on anxiety, which probably was another limitation for testing the hypothesis. Emotional arousal interferes with perceptual accuracy and makes individuals vulnerable to a biased perception of sensory information (Rietveld & Prins, 1998; Spinhoven *et al*. 1997; Wilson & Jones, 1991). Anxious participants would probably have been more likely to a biased perception of signals in line with a feared physical state. Moreover, emotional breathing patterns could induce breathlessness through hyper-inflated airways, irrespective of actual airways obstruction (Lougheed *et al*. 1993). However, the current results suggested a strong relationship between breathlessness with worry, but not with state anxiety.

The complexity of inter-relationships underlying symptom perception in chronic disease warrants research into the linking of perceptual and emotional factors. Whether correctly or falsely perceived, conscious awareness of breathing problems by anxious or worried patients would constitute a sequence of emotional arousal and ensuing biased symptom perception (McNally, 1990). Ambiguous physical signals and contextual cues that mediate in biased symptom perception would be incorporated in recall schemata towards a firm biased perceptual mechanism. Situational variables

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associated with initial attacks of breathlessness would develop into powerful triggers of this biased perceptual sequence (Woods *et al.* 1997).

Although breathlessness is usually measured as a single construct, the results of this study suggest the importance of parallel assessment of related sensations and symptoms. Future research is necessary to test the extent of the biased perception of symptoms in other subject groups, particularly in panic-prone patients.

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