

**Internal sensations as a source of fear:  
Exploring a link between hypoxia and flight phobia**

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### **Abstract**

Although flight phobia is very common in the general population, knowledge of the underlying mechanisms is limited. The aim of the current study is to determine whether hypoxia is selectively associated with flight anxiety. We wanted to explore levels of oxygen saturation (SpO<sub>2</sub>) and the associated subjective somatic sensations in flight phobics and controls. The data collected in this study were obtained from 103 participants: 54 had flight phobia, 49 were controls. SpO<sub>2</sub> as well as a subjective report of somatic sensations and anxiety were measured during short haul flights, both at ground level and at cruising altitude.

Results indicated that both flight phobics and controls showed a comparable clinical significant decrease in SpO<sub>2</sub> from sea level to cruising altitude. Next, at ground level the flight phobic group reported more somatic sensations, most likely due to the elevated levels of anxiety at that point. However, at cruising altitude the flight phobic group still reported more somatic sensations while the level of anxiety was no longer significantly different from controls. This finding points to altered symptom perception in flight phobia and stresses the importance of somatic sensations in this particular phobia.

Keywords: fear of flying, flight phobia, theoretical perspectives, conditioning theory, hypoxia, somatic sensations

### **Internal sensations as a source of fear:**

#### **Exploring a link between hypoxia and flight phobia**

Estimates of the prevalence of fear of flying run as high as 10 – 40 % of the general population (Van Gerwen, Spinhoven, Diekstra, & Van Dyck, 1997). This remarkably high number of people suffering from this particular anxiety includes individuals who have stopped taking flights because of their fear, but also individuals who still travel by airplane although they use a wide range of strategies to cope with their anxiety such as medication or alcohol (Van Gerwen, et al., 1997). Considering the high prevalence and the observation that flying is becoming ever more a part of everyday life it is surprising that only a few studies have been conducted on the underlying mechanisms of fear of flying. The few studies that have looked at underlying reasons for fear of flying have shown that fear of flying is most often driven by a fear of a crash or airplane emergency, and in that sense it can be diagnosed as a simple phobia of the situational type (APA, 2000). However, fear of flying is not a unitary fear, because it is also often associated other basic fears, as agoraphobia or claustrophobia and even panic disorder (McNally & Louro, 1992; Wilhelm & Roth, 1997). In this study only participants diagnosed with flight phobia, who indicated that their fear was not primarily due to another anxiety problem were included, because we wanted to study flight phobia as a primary simple phobia.

As is the case for most phobias (Merckelbach, de Jong, Muris, & van den Hout, 1996), the most common explanation for flight phobia is classical conditioning. Based on this account, fear of flying is conditioned through the association of an aversive, possibly traumatic event (UCS) that inherently produces fear (UCR) with a formerly neutral stimulus (CS) such as flying. However, the high prevalence of flight phobia in the general population cannot be explained by the low incidence of aircraft-related incidents. This pertains to a more general remark on conditioning theory that not all individuals with anxiety have experienced a traumatic event, and inversely that not all individuals who have experienced a traumatic event subsequently develop

conditioned anxiety (Rachman, 2004). Alternatively, neoconditioning theories propose that there are other pathways to anxiety next to direct conditioning, such as modeling (Bandura, Blanchar, & Ritter, 1969) and transmission of verbal information (Rachman, 1977). Wilhelm & Roth (1997) have looked into these three pathways applied to flight phobia. They used a structured interview to assess fear of flying and flight history among sixty-six participants with fear of flying and twenty-one controls. As to the specific pathways to fear of flying, none of the participants with fear of flying indicated information or modeling as the cause of their fear. Most of them indicated that the reason for their fear was possible unpleasant flight experiences, such as accidents, emergencies, mechanical failures and severe turbulence. However, only half of them reported having experienced such events. Moreover, this number was not significantly different from controls, indicating that experiencing such events do not necessarily lead to fear of flying. So it seems that experiencing such external unpleasant, aversive events while flying cannot exclusively account for the conditioning of flight phobia and that other conditioning events may play a role in the development of flight anxiety. A possibility worth considering here is an internal aversive sensations being responsible for the fear conditioning. There are several sources of somatic sensations when flying, such as hypoxia, acceleration, mechanical vibrations and the effects of motion on the vestibular system (Jaffee, 2005; Silverman & Gendreau, 2009).

We will focus on hypoxia, which is an oxygen deficiency at a cellular level caused by abnormalities in uptake, transport or use of oxygen in the blood, reflected in low oxygen saturation. Oxygen saturation, or  $SpO_2$ <sup>1</sup>, is expressed in a percentage, with 98-100% as normal values at sea level. Hypoxia is one of the most important physical consequences of high altitude exposure. When the altitude increases there are decreases in air pressure and air density, these lead to a decrease in the partial pressure of oxygen equivalent to breathing 15.1% oxygen at sea level (Coker et al., 2002). Commercial aircraft cabins are pressurized to below 10000 ft.

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<sup>1</sup>  $SpO_2$  is the common abbreviation of oxygen saturation level in the blood.

(usually at 8000 ft.), because pressurization to sea level is not cost effective (Hocking, 1998, 2001). Hyperventilation is the first compensatory mechanism to altitude hypoxia: to compensate for the reduced oxygen saturation, ventilation will increase, paradoxically accompanied by the subjective sensation of breathlessness known as dyspnea (Mortazavi, Eisenberg, Langleben, Ernst, & Schiff, 2003; Roth et al., 2002). However, not only the possibility of full blown hyperventilation is of importance here, but also other symptoms of hypoxia such as increased breathing with dyspnea, increased heart rate, lightheadedness, slurred speech, a feeling of unreality and palpitations (Harding & Mills, 1983). The link between altitude and anxiety or panic has already been studied as a part of acute mountain sickness syndrome. For example, it has been shown that even at low altitudes, individuals with anxiety disorders show respiratory problems (Papp et al., 1997; Wilhelm et al., 2001). In their review, Roth et al. (2002) argue that initial phases of adjustment to high altitude are accompanied by somatic distress and anxiety, especially in those who suffer from anxiety disorders or are prone to them.

An important finding is that more than 50% of aircraft passengers show hypoxia. In their study, Humphreys, Deyermond, Bali, Stevenson, & Fee (2005) measured the oxygen saturation of 84 passengers on a short and long haul flight. They found that more than half of the passengers had hypoxia above clinical value, meaning a SpO<sub>2</sub> of 94% or lower. This is a value at which physicians would administer supplemental oxygen in hospitalized patients. Harding & Mills (1983) argue that a degree of hypoxia will occur in all passengers travelling at altitudes above 10,000 ft; some passengers remain fit and well while others experience significant symptoms and aversive bodily sensations. It is striking that most of the somatic symptoms triggered by hypoxia (such as breathlessness, palpitations, dizziness, etc.) are almost identical to the physical correlates of anxiety. The following hypothesis can be construed: because of travelling at high altitude, oxygen saturation decreases and hypoxia takes place. Some

individuals may experience these physical sensations more pronounced than others. In these individuals an association of flying with aversive internal bodily sensations would lead to flight anxiety. Flying then becomes a conditioned stimulus (CS) through the association with these fear-related sensations (UCS), and will eventually evoke a conditioned response (CR): fear, and as a possible consequence avoidance behaviour leading to flight phobia (Vanden Bogaerde & De Raedt, 2008; 2011).

The aim of the current study is to explore whether hypoxia is selectively associated with flight phobia. Next to exploring oxygen saturation levels, we also wanted to determine the subjective bodily sensations that are associated with hypoxia. More specifically, a significant difference is expected in the subjective experience of somatic sensations between passengers with and without flight phobia. More specifically, we expected that the flight phobic group would experience more somatic sensations at high altitude associated with a decrease in oxygen saturation.

## **Method**

### **Participants**

The data collected in this study were obtained from a total of 106 participants. Three participants were excluded from further analyses because they had an SpO<sub>2</sub> lower than 94% at ground level. Of the total 103 participants 54 participants were flight phobic, 49 were controls. In the flight phobic group 29 were female (53.7%) and 25 were male (46.3%). The average age of this group was 40.22 years, ranging from 19 to 65 years (women: 39.9 SD=10.584 and men: 40.6 SD=12.84). The control group consisted of 29 males (59.2%) and 18 females (36.7%). The average age of the participants in this group was 41.85 years, ranging from 21 to 67 years old (women: 39.7 SD=12.399 and men: 43.2 SD=10.76). The average age in the two groups was not significantly different ( $t(98) = .704, p=.483$ ). None of the subjects indicated having heart or lung problems.

The flight phobic participants were recruited from a treatment programme for fear of flying. The treatment programme is a two-day group cognitive-behavioural programme with exposure as the core intervention. The treatment programme is based on a standardized treatment manual. Each treatment session group consisted of six participants coached by two clinical psychologists/behaviour therapists. Before the start of the two-day programme there was a diagnostic phase, where participants were asked to fill out a number of questionnaires concerning fear of flying (see below). Also participants had an individual one-hour diagnostic interview with a clinical psychologist to properly assess flight phobia: participants in the clinical group were assessed with the subdivisions of the MINI – Mini International Neuropsychiatric Interview (Sheehan et al., 1998) pertaining to anxiety. These subdivisions of the MINI structured interview are based on the DSM-IV criteria for diagnosing anxiety disorders. Also participants' flight history was clarified with the use of a semi-structured interview. Individuals who met the criteria of a concurrent panic disorder or any other anxiety disorder that was primary to the flight phobia were excluded from the treatment programme and thus also from this study, as were individuals with a posttraumatic stress disorder related to an aircraft emergency. These strict exclusion criteria were set to ensure that the sample consisted of individuals with a flight phobia (simple phobia), so possible results would not be attributable to another anxiety problem. The first day of the group programme consisted primarily of providing information on the technical and aerodynamic aspects of flying, after which psycho-education is given on anxiety and the role of avoidance. The first day lasted about approximately 8 hours. Four days later, the second day of the program took place. Here, the participants underwent extended exposure, taking two flights (return) coached by a clinical psychologist/certified behaviour therapist (one therapist per two patients). These therapeutic flights were regular commercial flights in Europe with flying time varying between one and two hours per flight, usually on an aircraft type AVRO-RJ100. The second day lasted approximately 10 hours in total.

The control participants were recruited among the passengers on the same flights as the therapeutic flights. Other passengers on these flights were informed about the fear of flying programme and the ongoing study, they were then asked to participate. Only two passengers declined participation. Furthermore, these control participants were selected using specific questions from the MINI that exclude the presence of flight phobia or panic disorder: individuals were asked whether they had a persistent and exaggerated fear of flying and whether they had experienced panic attacks (using the DSM IV criteria). If individuals answered 'yes' to either of these questions they were excluded from the study.

All participants had flown before, but there was a difference in the distribution of the number of flights taken and time since the last flight between the control and the flight phobic group (Table 1). In the flight phobic group a large majority (57.4%) reported having taken between 10 to 50 single flights, and 43.5% indicated having taken their last flight more than 5 years ago. In the control group 32.7% reported having taken more than 100 flights, with 51.1% having taken their last flight taken less than one month ago. Age when taking the first flight was significantly different ( $t(63)=8.173, p<.05$ ), with flight phobics taking their first flight on average at 14.94 years old ( $SD= 8.084$ ) and controls at 20.26 years old ( $SD=9.071$ ).

## Materials

**Oxygen Saturation.** Percentage oxygen saturation ( $SpO_2$ ) was recorded using the OxiPen® manufactured by the EnviteC (Wismar, Germany). This Oxipen has a fingerclip sensor (EnviteC F 3227) that is applied to the first finger. This non-invasive pulse oximeter measures the colour difference in the blood caused by oxygen saturation: when blood is de-oxygenated (oxygen saturation reduces) it loses its reddish colour due to the optical properties of haemoglobin molecules.

**Flight anxiety.** The Flight Anxiety Situations Questionnaire (FAS) (Van Gerwen, Spinhoven, Van Dyck, & Diekstra, 1999) was used as a primary measure. Each item is rated on a five-point Likert type scale, ranging from 1 (no anxiety) to 5 (overwhelming anxiety). The



questionnaire assesses the intensity of anxiety experienced in different flight, or flight-related, situations. The FAS consists of three subscales. First, the Anticipatory Flight Anxiety Scale, which contains 12 items that pertain to the anxiety experienced when anticipating a flight. Next, the In-Flight Anxiety Scale contains 10 items pertaining to the anxiety experienced at particular events during a flight. And last, the Generalized Flight Anxiety Scale which contains 7 items that refer to the anxiety when confronted with stimuli associated with flying and airplanes in general, regardless of personal involvement in a flight situation. The FAS has been shown to be a reliable and stable measure of fear of flying with Cronbach's  $\alpha$  above .88 and test-retest correlations above .90 (Van Gerwen, et al., 1999). To operationalize the anxiety experienced during the flight we used a Visual Analogue Scale (VAS) of 10 cm on which participants were asked to indicate their current level of anxiety or fear. Participants indicated their level of anxiety by placing a cross on the scale; and scores were assigned by measuring the position of the cross, ranging from 0 (not at all) to 100 (extremely).

**Somatic sensations.** The Flight Anxiety Modality Questionnaire (FAM) (Van Gerwen, et al., 1999) is an 18-item self report questionnaire, designed to measure the specific modality of anxiety symptoms in flight situations. Each item is rated on a five-point Likert type scale, ranging from 1 (not at all) to 5 (very intensely). The FAM consists of two subscales: the Somatic Modality Scale, which assesses the physical symptoms during a flight, and the Cognitive Modality Scale, relating to the presence of distressing cognitions during a flight. The FAM has been shown to be a reliable and stable measure of these two modalities of fear of flying with Cronbach's  $\alpha$  above .89 and test-retest correlations above .79 (Van Gerwen, et al., 1999). For the operationalisation of somatic sensations we used the Somatic Modality Scale, since we were interested in the bodily sensations experienced during a flight.

## **Procedure**

Before participating in the study, all participants were explained what the procedure entails and were asked to sign the informed consent. Flight phobic participants filled out the

diagnostical questionnaire when enrolling for the treatment programme. Participants in the control group completed the questionnaires between the measurements at sea level and those at cruising altitude.

On the day of the actual flight oxygen saturation, level of somatic sensations and level of anxiety were measured twice. First, all measures were taken at sea/ground level, this was done directly after boarding the airplane, when participants were seated but before taxi and take-off. First oxygen saturation (SpO<sub>2</sub>) was measured. Then participants were asked to indicate how anxious they are (VAS) and what somatic sensations (FAM Somatic) they experienced at that moment. This was done sequentially in all participants, but within a 5 minute timeframe. The second measurement was done 40 minutes later for the measurements at cruising altitude (10000ft.). The same procedure was used: first oxygen saturation was measured after which participants were asked to indicate their level of anxiety and somatic sensations.

## Results

### Flight Anxiety

In order to verify that the two groups differed significantly in flight anxiety, independent samples t-tests were conducted on all scales of the diagnostical questionnaires FAS and FAM. A Bonferoni correction in the 0.05 significance level was made to correct for multiple t-tests ( $\alpha$  / number of tests). The results showed that the two groups differed on all scales (see Table 2): flight phobics scored significantly higher on all subscales.

### Oxygen Saturation

Oxygen Saturation (SpO<sub>2</sub>) was analyzed with a mixed ANOVA with Group (controls / flight phobics) as between subject variable and Altitude (ground level / cruising altitude) as within subject variable. Results indicated a significant main effect for Altitude,  $F(1,95) = 218.10$ ,  $p < .001$ ,  $\eta^2 = .69$ , but no significant main effect for Group,  $F(1, 95) = .02$ ,  $p = .877$ . The Group x

Altitude interaction was also non-significant,  $F(1, 95) = .0001, p = .98$ . The oxygen saturation levels in both groups dropped from 98% at ground level to 92% at cruising altitude on average. In the total group 65% had a SpO<sub>2</sub> of 94% and lower at cruising altitude, in the control group this was the case for 67% and in the flight phobic group this was 63%. A Pearson Chi-Square test indicated that there was no significant difference between these two proportions,  $\chi^2(1) = .23, p = .63$ .

### **Subjective somatic sensations and anxiety**

Subjective somatic sensations and anxiety were analyzed with mixed ANOVA's with Group (controls / flight phobics) as between subject variable and Altitude (ground level / cruising altitude) as within subject variable. Results for the subjective reports of somatic symptoms as measured by the FAM Somatic scale indicated a significant main effect for Altitude,  $F(1, 87) = 22.31, p < .001, \eta^2 = .20$ , a significant main effect for Group,  $F(1, 87) = 30.53, p < .001, \eta^2 = .26$ , and the Group x Altitude interaction was also significant,  $F(1, 87) = 20.985, p < .001, \eta^2 = .19$ . Closer inspection of the results indicated that overall flight phobic participants reported more somatic sensations than controls did, both at ground level,  $t(49.13) = 6.50, p < .001, d = 1.29$ , and cruising altitude,  $t(51.62) = 5.02, p < .001, d = 1.00$ . Moreover, controls did not report more somatic sensations at cruising altitude than at ground level,  $t(42) = .348, p = .730$  and flight phobic participants actually reported less somatic sensations at cruising altitude relative to ground level. This decrease in somatic sensations in the flight phobic group was significant,  $t(45) = 4.91, p < .001, d = .52$ . This unexpected finding is most likely explained by the results of the analyses of reported anxiety during the flight. The mixed ANOVA for the anxiety VAS scale revealed a significant main effect for Group,  $F(1, 84) = 7.28, p < .05, \eta^2 = .08$ , a non-significant main effect for Altitude,  $F(1, 84) = .583, p = .447$  and a significant Group x Altitude effect,  $F(1, 84) = 4.77, p < .05, \eta^2 = .05$ . In order to have a closer look at the group differences a number of independent samples t-tests were done, showing that that anxiety levels differed significantly between flight anxious participants and controls at ground level,  $t(48.36) = 4.13, p < .001, d = .81$ ,

but not anymore at cruising altitude,  $t(89) = .47, p = .64$ . The follow-up tests showed that in the flight phobic group the experienced anxiety decreased significantly,  $t(41) = 2.173, p < .05, d = .46$ , analogous to the findings of somatic sensations. Again, for the control group no significant difference was found,  $t(43) = .97, p = .34$ .

In order to further investigate which variables were associated with somatic sensations at cruising altitude, a correlation matrix was computed separately for both groups. Because in the separate groups the data were no longer normally distributed, we used bivariate non-linear correlations (Spearman's Rho) (Table 3). In both groups there is no significant correlation between levels of anxiety and oxygen saturation. In the control group somatic sensations were significantly associated with level of anxiety and oxygen saturation, while in the flight phobic group there was only a significant correlation with anxiety. Moreover, the correlation between somatic sensations and anxiety was significantly larger in the flight phobic group than in the control group,  $z = 1.72, p < .05$ .

## Discussion

When flying at altitude, changes in the partial pressure of oxygen make it harder to breathe, resulting in a lower blood oxygen saturation. This is a condition called hypoxia that results in symptoms like heart racing, breathlessness and dizziness. Because of the resemblance between these symptoms and the bodily correlates of anxiety, we hypothesized a possible association between hypoxia and fear of flying. The results of this study showed no significant difference in levels of oxygen saturation between flight phobics and controls: the flight phobic group as well as the control group showed a significant decrease in oxygen saturation. The results here were comparable to those of Humphreys and colleagues (2005): about 60% of the sample had a SpO<sub>2</sub> of 94% or lower. The authors have pointed out that this is a value at which one would be given supplemental oxygen when administered to the hospital. Other authors disagree and state that it is a normal reaction of SpO<sub>2</sub> to fall to 85-91% of what is the

value at sea level and that there is only a real concern when an individuals' SpO<sub>2</sub> is lower than 95% at sea level (Coker, et al., 2002). In any case, even if a SpO<sub>2</sub> of 94% or lower poses no significant health risk, it does not mean that these lower saturation levels cannot produce a number of aversive somatic sensations. A general remark here is that there are no data available on what type and intensity of somatic sensations oxygen saturation levels produce in normal (non patient) populations in the context of aviation. Although a direct relation between hypoxia and fear of flying was not found, the current study is the first the our knowledge to examine the possibility of such a relationship.

Next to exploring oxygen saturation levels, the current study also aimed to determine the subjective bodily sensations that are possibly associated with hypoxia. More specifically, a significant difference was expected in the subjective experience of somatic sensations between passengers with and without flight phobia: flight phobic subjects would show increase in somatic sensations associated with a decrease in oxygen saturation. The results of the current study show a significant difference in the reports of somatic sensations between both groups: while reports of somatic sensations in the control group did not differ significantly from ground level to cruising altitude, the flight phobic group reported less somatic sensations at cruising altitude compared to sea level. We would have expected to observe an increase in the reports of somatic sensations at cruising altitude because of the lower oxygen saturation levels, but this unexpected finding might be due to a treatment effect. Because the level of anxiety decreased it's physical correlates also decreased resulting in decreased reports of somatic sensations. Alternatively, these results might also reflect a high level of anticipatory anxiety, with fear being at its highest just before take-off. However, Wilhelm & Roth (1997) found no significant difference between the fear experienced at take –off compared to other stages of flight (except for landing). Moreover, the difference found here shows an effect size (Cohen's *d*) of .460, which is a moderate effect, but presumably indicating a larger decrease than can be explained anticipatory anxiety alone.

In any case, when looking exclusively at the reports of somatic sensations at cruising altitude, it is clear that flight phobics report more somatic sensations than controls while there is no significant difference in anxiety and oxygen saturation. At ground level the flight phobic group reported more somatic sensations and this could be due to the elevated levels of anxiety they reported: both somatic sensations and anxiety are significantly higher than controls at that point. However, at cruising altitude this is no longer the case: while the flight phobic group still reports more somatic sensations, the level of anxiety is no longer significantly different from controls. So these elevated reports of sensations can no longer be explained by anxiety. In her comprehensive cognitive-perceptual model of symptom perception, Cioffi (1991) states that symptom reporting should be seen as a multifaceted process which involves objective bodily states as well as the psychological appraisal of these states which is influenced by attentional and interpretation processes. At cruising altitude it is clear that there is no significant difference in objective bodily states with respect to the oxygen saturation, the implication being that the elevated symptom reporting in the flight phobic group stems from the psychological appraisal of these symptoms. This might be indicative of a higher sensitivity or increased attention for these sensations in the flight phobic group – or in other words an increased interoceptive awareness. Importantly, enhanced interoceptive awareness has been found in subjects with fear of flying: when presented at random with respiratory loads that made it a little harder to breathe, subjects with fear of flying were more accurate in detecting these respiratory loads in comparison to controls. Individuals with fear of flying also reported significantly more somatic sensations than controls after performing the detection task. Moreover, the level of somatic sensations and accuracy were positively correlated: the more accurate subjects were in detecting the task, the more sensations they reported (Vanden Bogaerde, Derom, & De Raedt, 2011).

When exploring the reports of the somatic sensations more closely we found no significant correlation between levels of anxiety and oxygen saturation in either group. However, in the control group somatic sensations were significantly associated with level of anxiety and oxygen

saturation, while in the flight phobic group there was only a significant correlation with anxiety. Moreover, the correlation between somatic sensations and anxiety was significantly larger in the flight phobic group than in the control group. Most likely, in the flight phobic group the sensations are so prominent that they wash out possible sensations associated with hypoxia.

The use of a clinical group of flight phobics who are being treated can be seen as a flaw in this study, maybe a non-therapeutic group would yield clearer results. However it would not be ethical to do such a study with flight phobics without providing them with treatment. In order to disentangle the influence of anxiety and its physical correlates on one hand and oxygen saturation on the other, the study should be carried out in a hypobaric chamber where hypoxia can be experimentally induced. Muhm and coworkers (2007) implemented such a hypobaric chamber study: they found that the SpO<sub>2</sub> decreased as the altitude increased, with an average decline of 4.4%. They also found that the frequency of reported discomfort increased with increasing altitude. It would be interesting to design such an experiment with flight phobics where hypoxia can be experimentally induced and somatic sensations can be measured. Additionally it would also be interesting to measure the somatic sensations in a more objective way, with the use of somatic markers like online registration of heart rate and ventilation. Wilhelm & Roth (1998) recorded multiple physiological anxiety measures in flight phobics and controls during a flight. They found that fearful flyers show an increased skin conductance variability. And although minute ventilation did not differ from the control group, fearful flyers did show more pauses in their breathing pattern.

Pertaining to the more general model of flight phobia presented here, where flight phobia can be conditioned through the association of flying with aversive internal bodily sensations as opposed to an externally threatening situation, it should be noted that studies on the underlying mechanisms of fear of flying are very scarce. Furthermore, this is the first study on the relation between the flying environment, the sensations it can induce and flight anxiety. Flying remains

an unnatural situation for humans and this could lead to a facilitated conditioning of anxiety (Wilhelm & Roth, 1997).

In conclusion, the results of this explorative study can be summed up as following: first, both flight phobics and controls showed a comparable decrease in oxygen saturation from sea level to cruising altitude. So there seems to no direct link between hypoxia and fear of flying. Second, with respect to the subjective reports of somatic sensations, we found a significant difference between flight phobics and controls, while there was no significant difference in oxygen saturation or levels of anxiety at cruising altitude. So despite similar levels of oxygen saturation and anxiety, flight phobics still reported more somatic sensations. Because there is no significant difference in objective bodily states with respect to the oxygen saturation, the implication is that the elevated symptom reporting in the flight phobic group most likely stems from the psychological appraisal of these symptoms. This first exploration into a possible link between hypoxia and flight phobia was a starting point that marked findings with respect to subjective symptom reporting. More research with different research designs needs to be done to clarify what psychological processes influence symptom perception in flight phobia.

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Table1: Percentages of participants reporting the number of flights taken and time since last flight.

	Flight phobics	Controls
Number of flights	%	%
< 5	20.4	4.5
5 – 10	14.8	4.5
10 – 50	57.4	34.1
50-100	7.4	20.5
>100	0	36.4
Time since last flight	%	%
< 1 month	0	51.1
1 – 6 months ago	21.7	33.3
6 – 12 months ago	21.7	6.7
1 – 5 years ago	13.0	8.9
>5 years ago	43.5	0

Table 2: FAS and FAM scores of flight phobic and control group.

		Flight Phobics		Controls		<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>				
FAS	Anticipation	42.61	12.15	12.77	2.57	17.61	58.42	<.001	3.32
	In Flight	41.37	7.97	13.23	3.53	23.45	75.18	<.001	4.94
	Generalized	14.26	5.54	7.21	.78	9.23	55.39	<.001	1.73
	Total	109.85	23.81	36.45	6.29	21.80	61.38	<.001	4.10
FAM	Somatic	30.15	14.54	12.11	2.37	8.98	56.29	<.001	1.68
	Cognitive	27.78	8.66	8.02	2.43	16.04	62.59	<.001	3.02

Table 3: Correlation matrix with bivariate non-linear correlations (Spearman's Rho) between somatic sensations, subjective level of anxiety and oxygen saturation.

Group		Somatic sensations (FAM Somatic)	Subjective level of anxiety (VAS)
Flight phobic	Subjective level of anxiety (VAS)	.595**	
	Oxygen saturation SpO <sub>2</sub>	-.065	.057
Control	Subjective level of anxiety (VAS)	.323*	
	Oxygen saturation SpO <sub>2</sub>	.355*	.245

\* Correlation is significant at the 0.05 level (2-tailed)

\*\* Correlation is significant at the 0.01 level (2-tailed)