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# Physiological reactivity to phobic stimuli in people with fear of flying

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**Abstract**

**Objective:** The nature of the relationship between physiological and subjective responses in phobic subjects remains unclear. Phobics have been thought to be characterized by a heightened physiological response (physiological perspective) or by a heightened perception of a normal physiological response (psychological perspective). **Method:** In this study, we examined subjective measures of anxiety, heart rate (HR), and cardiac autonomic responses to flight-related stimuli in 127 people who applied for fear-of-flying therapy at a specialized treatment center and in 36 controls without aviophobia. **Results:** In keeping with the psychological perspective, we found a large increase in subjective distress ($\eta^2$=.43) during exposure to flight-related stimuli in the phobics and no change in subjective distress in the controls, whereas the physiological responses of both groups were indiscriminate. However, in keeping with the physiological perspective, we found that, within the group of phobics, increases in subjective fear during exposure were moderately strong coupled to HR ($r$=.208, $P$=.022) and cardiac vagal ($r$=.199, $P$=.028) reactivity. In contrast to predictions by the psychological perspective, anxiety sensitivity did not modulate this coupling. **Conclusion:** We conclude that subjective fear responses and autonomic responses are only loosely coupled during mildly threatening exposure to flight-related stimuli. More ecologically valid exposure to phobic stimuli may be needed to test the predictions from the physiological and psychological perspectives.


*Keywords:* Flight phobia; Aviophobics; Respiratory sinus arrhythmia (RSA); Pre-ejection period (PEP); Anxiety sensitivity

## Introduction

The prevalence of people with varying degrees of fear of flying is estimated at 7–40% of the general population in industrialized countries [1,2]. Curtis [3] reports a lifetime prevalence of 13.2% of people who are impaired by fear of flying, while Depla [4] mentions that 6.9% of all people experience serious interference in daily life and social functioning due to fear of flying. In view of recent events like the 9/11 bombing this percentage is not expected to decrease. Although distinguished by their fear of flying from other types of phobics, flying phobics are a heterogeneous group. Fear of flying can be the manifestation of one or more other phobias, such as claustrophobia or social phobia. It can also be the effect of generalization of one or more natural environment phobias, such as fear of heights, falling, storms, water, instability, etc. Fear of losing control and a high need to have control over a situation is often associated with fear of flying [1,5–7].

As much as eight out of 10 symptoms experienced by individuals with specific phobias during exposure to a phobic stimulus might be related to bodily sensations [8,9]. This applies in full to aviophobia where physiological sensation is one of the major symptoms reported. Physiological discomfort is used prominently in the diagnosis of fear of flying, and it is often invoked as one of the main measures of treatment effectiveness [10]. In spite of the importance of physiological sensations in fear of flying, many studies on aviophobics evaluate these sensations exclusively by verbal report. This

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might be problematic, as the relationship between self-reported feelings of anxiety and actual physiological reactivity has proven to be complex [11–21].

Two distinct theoretical perspectives have been proposed. In the physiological perspective, a historical extension of the original formulation by James [22] and Lange [23], exaggerated subjective arousal is thought to arise from exaggerated physiological arousal during exposure to anxiety-related stimuli. Increased sympathetic and decreased parasympathetic nervous system activity is sensed through afferent feedback from the affected organs (sweat glands, heart, lungs) and causes anxiety [24–29]. In the psychological perspective, the primary deficit in phobics is not exaggerated physiological arousal, but a tendency to focus attention on bodily sensations and/or overinterpret these signals as danger signals. In this perspective, and combining both viewpoints, anxiety sensitivity is seen as a key moderator between the experience of bodily sensations and anxiety [30,31]. Anxiety sensitivity is the fear of anxiety-related bodily sensations, based on the belief that the sensations have harmful somatic, psychological, or social consequences [32]. Individuals with high anxiety sensitivity are prone to interpret normal bodily sensations in a threatening manner, whereas those with low anxiety sensitivity experience these sensations as unpleasant but nonthreatening. Anxiety sensitivity is believed to be a dispositional variable distinguishable from trait anxiety [33].

To study the divergent predictions as derived from the physiological and psychological perspective, simultaneous assessment of subjective and physiological responses during exposure to phobic stimuli is needed. To date, surprisingly few studies have simultaneously assessed the changes in subjective fear levels during exposure to simulated or real flights in aviophobics together with physiological reactivity. These studies usually recorded increases in heart rate (HR) and respiration rate or decreases in HR variability (HRV), a measure of cardiac parasympathetic control, as the main physiological outcome variables. Using HR, for example, Beckham [34] found high levels of synchrony over time between physiological arousal and subjective anxiety during flight exposure. Synchrony over time even exhibited prognostic value for positive treatment outcome in their study. Contrasting results were obtained in a randomized double-blind placebo design by Wilhelm and Roth [35]. They tested the effect of alprazolam (a benzodiazepine) during two flights in women suffering from fear of flying. During the first flight, alprazolam significantly reduced anxiety compared to placebo, whereas HR was in fact higher. On the second flight, without alprazolam, women who had been on alprazolam had both higher levels of self-reported anxiety and higher levels of HR, whereas the women who had been on a placebo had lower levels of self-reported anxiety together with a nearly significant decrease of HR. Bornas et al. [36] compared four groups of psychology students, selected for low or high scores on a fear-of-flying questionnaire and either low or high HRV levels during a baseline measurement. Low HRV fearful flyers reported higher levels of anxiety than any other group when confronted with flight-related pictures and sound, while high HRV fearful flyers did not report higher levels of anxiety than controls. Finally, Ekeberg et al. [37,38] used catecholamines rather than HR or RSA as their main variable to index physiological reactivity in flight phobics. They too reported only low correlations between the psychological and physiological response to flight phobia stress [21]. Taken together, the extant studies suggest that subjective report and physiological reactivity are often not in synchrony.

In the present study, we reexamine the relationship between subjective and physiological reactivity in individuals with fear of flying when confronted with flight-related stimuli. We first compared phobics to nonphobic controls to test whether the physiological reactivity of the phobics, in parallel to their larger subjective reactivity, was larger than that of nonphobic controls. Secondly, we assessed the concordance between self-reported anxiety and physiological markers of anxiety within a relatively large group of people who applied for fear of flying therapy at a specialized treatment center. Thirdly, we investigated whether the association of self-reported anxiety and physiological markers of anxiety was moderated by individual differences in anxiety sensitivity. The physiological perspective predicts a higher reactivity in phobics than in nonphobics to flight-related stimuli and, within the group of phobics, a significant correlation between physiological reactivity and the amount of self-reported fear. The psychological perspective predicts a weaker concordance between subjective and physiological arousal, which may be limited to individuals who score high on anxiety sensitivity. We extend the work in previous studies, which focused on HR and measures of parasympathetic activity, by adding the pre-ejection period (PEP), a measure of sympathetic nervous system activity. Our focus on cardiac parameters reflects two major considerations: measurements needed to be as noninvasive as possible and they needed to respond to changes in psychological state over a time scale of a few minutes. The PEP and respiratory sinus arrhythmia (RSA, a measure of parasympathetic control) measures are uniquely qualified to meet both demands [39,40].

## Method

### *Participants*

Participants were phobics who applied for therapy at the VALK Foundation during the research period and nonpaid volunteers without fear of flying who acted as a control sample. The VALK Foundation is a facility that specializes in treating flying phobics. It is a joint enterprise of the Department of Clinical, Health and Neuropsychology at Leiden University, KLM Royal Dutch Airlines, Transavia