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Psychological and Physiological Response during the Treatment of Fear of Flying

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1 Introduction

1.1 Motivation of this study

Flying like a bird has always been a dream of mankind and is still fascinating. Daedalos and Ikarus of the antique mythology stand for the temptation of being able to fly. Leonardo DaVinci experimented years, but could not find a way allowing human beings to fly. The Wright brothers in 1903 were the first ones who succeeded in flying with an airplane, and only since 1958 it has been possible to fly non-stop over the Atlantic. Although flying has become a reality with technical support, the dream of flying like a bird by oneself does not work.

The former exclusive position of airline business has changed; traveling by air has become a commodity affordable by the general public, and the globalization of the world demands more flexibility from people, including a higher degree of mobility. Mobility stands for life quality, which is important for professional as well as for leisure reasons. However, increased mobility has also aggravated the problem for people suffering from fear of flying.

Studies investigating autonomic response and psychological response during a professional treatment program, which includes real flights and a control group, are very rare. There are numerous laboratory studies in connection with anxiety and evoked fear reactions, but the onset of fear is not comparable to real exposure studies.

1.2 Fear of flying as a common problem

Fear of flying is common, it ranks high on the list of fears afflicting people today and with which people have to cope (van Gerwen, Diekstra, Arondeus, & Wolfger, 2004). Fear of flying seems to be a heterogeneous problem of diverse nature and ethnology. The problem concerns not only the individuals but also corresponding economic sectors like civilian and military airlines, tourism, and business travel. Common coping mechanisms of passengers like consumption of alcohol or taking pharmaceuticals are helpful only in the short term. The growing relevance of fear of flying results in more people being forced to find treatment (Reinecker, 1993) and consequently the choice of treatment programs is increasing worldwide. Since the 1980s, Austrian Airlines has arranged treatment seminars where people learn to manage efficiently to get rid of their fears or learn to cope with them.

1.2.1 Safety factor of flying

Although statistics demonstrate that flying has become safer during the last decades, knowledge about the mathematical risk does not affect fear of flying (McLean in Bor & Van Gerwen, 2003). Facts regarding safety are therefore not decisive whether a person is afflicted with the problem or not. Despite the increasing number of passengers (see Figure 1), the number of fatalities and fatal accidents are not increasing as shown in Figure 2. The survival rate after a crash is even 95.7%, according to analyses of the U.S. National Transportation Safety Board (2001, p. 6) analyzing airline accidents involving U.S. air carrier flights (cargo and passengers) from 1983 through 2000.

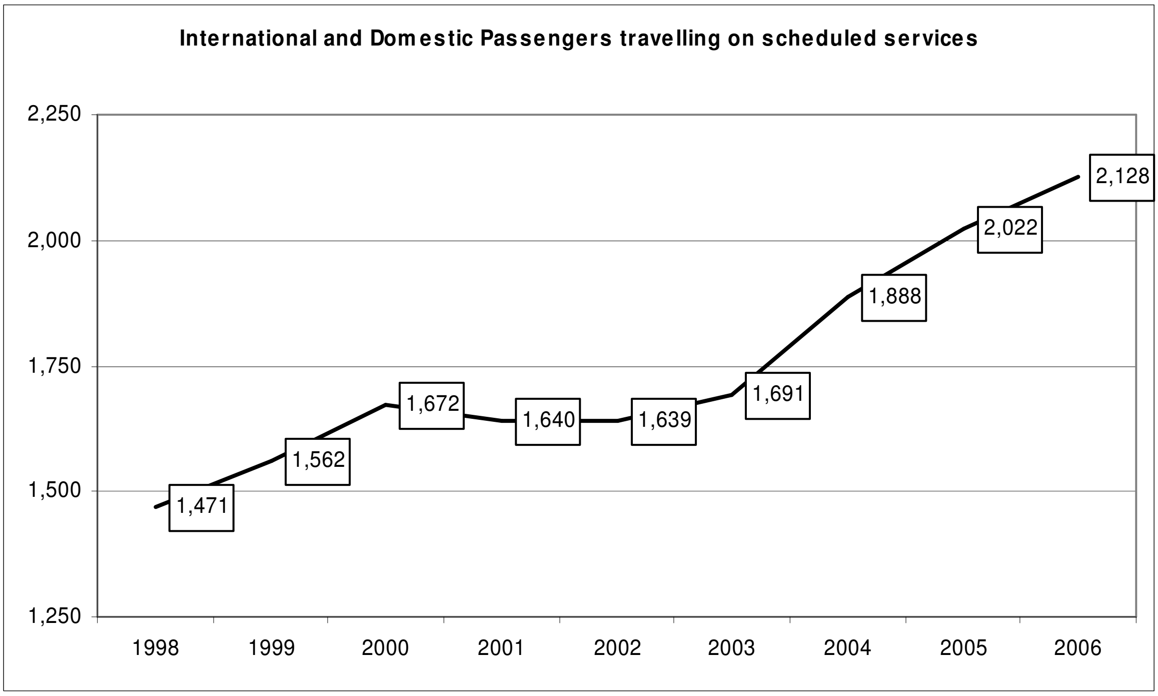


Figure 1. Number of Passengers (in millions) per year. International and domestic scheduled services of airlines of International Civil Aviation Organization Contracting States (International Civil Aviation Organization, ICAO, 2007, Appendix 1, p. 1).

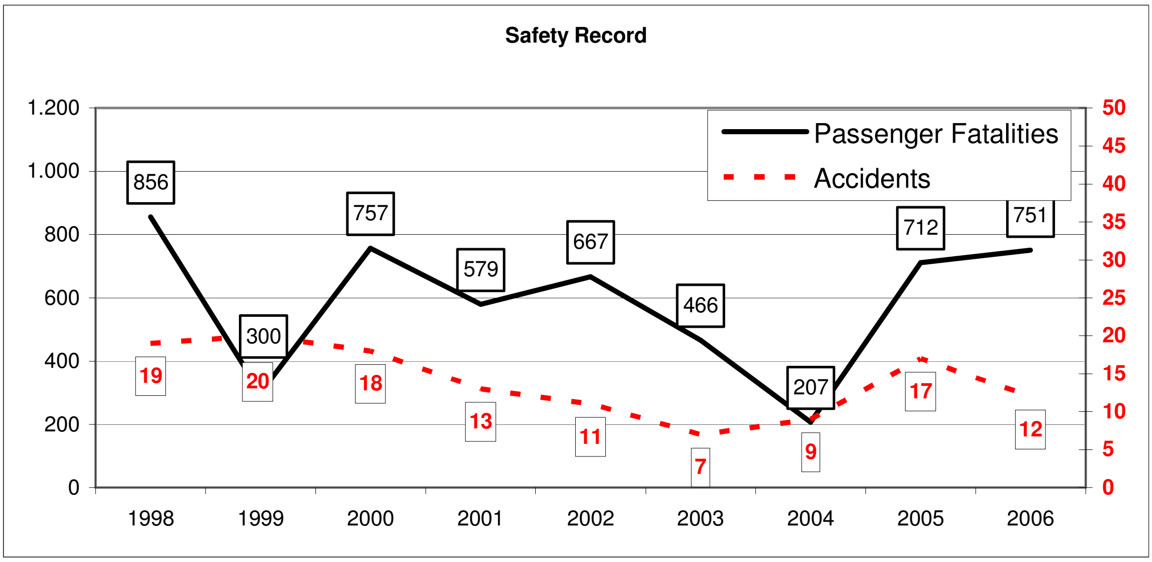


Figure 2. Safety Record. Number of aircraft accidents and passenger fatalities of scheduled aircraft with more than 2250 kg (International Civil Aviation Organization (ICAO), 2007, Appendix 1, p. 5.).

1.2.2 Relevance of fear of flying

Traveling by air is part of the industrial and global world today. Flying has changed from an exclusive to a mass transportation medium, being cheaper and faster than ever in history. The boost of low cost carriers has accelerated this development. Consequently air traffic has grown dramatically during the last decades. In 2007 the world's airlines boarded 2.26 billion passengers compared to 1.64 billion passengers in 2001 according to scheduled services of airlines of ICAO contracting states (International Civil Aviation Organization, ICAO, 2007, Appendix 1, p. 1). Traveling by air has become a commodity whereby the prize is the most important criterion of choice for consumers. The airline industry was forced to improve the seat load factor, the consequence being that more passengers are carried in one aircraft and the comfort for passengers is reduced. The domestic and international air carrier traffic statistics of scheduled passenger flights and seat miles indicate that the seat load factor has increased from 1996 to 2009 from 69% to 80% (U.S. Department of Transportation, 2009). The economic crisis has put even more financial pressure on the airline industry since 2008. Consequently the passengers get less service by travel partners while traveling. Bricker (2005) gives a summary of the stress factors and hazards associated with flying, and the negative consequences for travelers in connection with the large and still growing number of air travelers around the globe.

The extended mobility and growing passenger traffic discriminates those people already excluded from traveling due to their fear of flying even more. The disorder fear of flying is a problem for individuals who suffer from it, by affecting various life areas like professional, social, and family life, regardless whether experienced to a mild, moderate or high degree (van Gerwen, Spinhoven, Diekstra, & van Dyck, 2002). In addition, the disorder has an effect on military and civilian organizations that operate aircraft (Krijn, Emmelkamp, Olafsson, Bouwman, van Gerwen, & Spinhoven, 2007). During the International Conference on Fear of Flying (June 2008) hosted by ICAO in Montreal, renowned experts came together and revealed the implications of fear of flying for air transport worldwide. Participants assumed that anxiety can threaten the safety of a flight as well as the passengers and the crew (Nousi, Haringsma, van Gerwen, & Spinhoven, 2008).

1.2.3 Prevalence of fear of flying

The prevalence of varying degrees of fear of flying of the general population in industrialized countries was asserted by van Gerwen et al. (2004) with 10% to 40% based on previous research (Agras, Sylvester, & Oliveau, 1969; Dean & Whitaker, 1982; Ekeberg, Seeberg, & Ellertsen, 1989; Haug et al., 1987). Data using random sample and screening criteria of the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 1994) show a 2.6% point prevalence of air travel phobia in the general population with the disorder being nearly twice as common in women as in men (Fredrikson, Annas, Fischer, & Wik, 1996). In the Dutch general population the lifetime prevalence is stated with 6.9% (Depla, ten Have, van Balkom, & de Graaf, 2008). According to Curtis, Magee, Eaton, Wittchen, and Kessler (1998) there is a prevalence of 13.2% of the general population suffering from fear of flying and 10% avoid flying definitely (Capafons, Sosa, & Vina, 1999); about 20% of all passengers depend on alcohol or sedatives to reduce anxiety symptoms during flights. Furthermore, every fifth passenger suffers from massive anxiety which is not recognized by the crew (Reinecker, 1993). More current studies on the epidemiology of fear of flying are required (van Gerwen et al., 2004).

The number of people with fear of flying is going to increase with threats of terrorist acts and the spreading of epidemic diseases like SARS (van Gerwen et al., 2004). The stresses of air travel like hassle, long airport security lines, threats of hijackings or bombings, result in air travel anxiety, air travel anger and lack of trust in airlines and airport safety (Bricker, 2008).

1.2.4 Problems of altitude during flights

The cruising altitude of a normal commercial airplane is 39,000 ft (11,887 m) or more (Humphreys, Deyermond, Bali, Stevenson, & Fee, 2005). The high cruising altitude of aircraft and the rapid ascent lead to a reduction of oxygen and may be the reason why passengers suffer from hypoxia (Harding & Mills, 1983; Roth, Gomolla, Meuret, Alpers, Handke, & Wilhelm, 2002). Hypoxia is described as oxygen-deficiency in blood, cells, and tissues (Bogaerde & De Raedt, 2007). Related symptoms are increased ventilation, accompanied by a feeling of breathlessness, increased heart rate, and dizziness (Jaffe, 2005).

US-regulations demand that the air pressure within the cabin has to be kept at air pressure at an altitude of 8,000 ft (2,440 m) or lower at the maximum operating altitude of the airplane. This regulation protects passengers and crew (Federal Aviation Administration, 1996). Gruen et al. (2008) pointed out that even in pressurized aircraft cabins a decrease of oxygen saturation in the arterial blood flow is evident. Studies show that this causes troubles for anemic passengers or passengers with coronary, pulmonary, or cerebrovascular diseases (Aerospace Medical Association, 2003).

A relation between anxiety and low air pressure with reduced oxygen content in the airplane was shown by Roth et al. (2002). Their findings showed that 54% of all passengers had only 94% or less SpO_2 at cruising altitude compared to an oxygen saturation of 97% at sea level. A comparable reduction of SpO_2 was found by Humphreys et al. (2005) during short and long commercial flights. Roth et al. (2002) pointed out that the environment in aircraft during flights may confront some travelers with symptomatic stress related to adaptation to the altitude which may cause an increase in anxiety, especially in persons suffering from anxiety disorders. The authors compared the psychological and physiological responses while adjusting to the altitudes with the psychological and physiological response during panic attacks. Reduced arterial oxygen saturation evokes responses that might be misinterpreted as signs for a pending panic attack by persons suffering from anxiety disorders. That could start a vicious cycle of panic attacks, being in congruence with the *cognitive misinterpretation model* of Clark (1999). Aversive conditioning provoked through hypoxia of high altitude was found to being related to fear of flying, anxiety sensitivity was found to be a vulnerability marker (Bogaerde & De Raedt, 2007). In individuals with high anxiety sensitivity the physical symptoms induced by hypoxia may promote the flight-anxiety (Bogaerde & De Raedt, 2011).

1.2.5 Diagnosis and subtypes of fear of flying

The expressions “fear of flying”, “flight anxiety”, “avia phobia”, and “flight phobia” are used synonymously in literature (Marcinkowski, 1993). In the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV,* American Psychiatric Association, 1994) fear of flying is included within the category *specific phobia* under the subtype of *situational phobia*. The specific phobia is related to the situation of flying with the effect that flying is avoided or only tolerated under considerable stress. It is characteristic that people with fear of flying know that their excessive fears are unreasonable. The fear can involve the anticipatory anxiety, but related situations to flying can also cause intense distress and suffering (Möller, Nortje, & Helders, 1998).

In general, specific phobias are described as most intensive and persistent fear reactions which are evoked by the feared situation or the feared objects, accompanied by the compulsory wish to leave the situation or to avoid it (Hamm, 1997).

The categorization of fear of flying under *specific phobias* in the *DSM-IV* (American Psychiatric Association, 1994) does not take into account that fear of flying might be the expression of several subtypes of phobias and a composition of one or more other phobias like fear of crashing, fear of heights, confinement, claustrophobia, and instability (van Gerwen, Spinhoven, Diekstra, & van Dyck, 1997). The fear is further supposed to be the result of generalization of one or more natural environment phobias, such as fear of heights, fear of falling, fear of storms, fear of water, instability, and others (Cleiren, van Gerwen, Diekstra, van Dyck, Spinhoven, & Brinkhuysen, 1994). The loss of control and the high need to have control over a situation are also very important. About 45% of the people with flight phobia are afraid of a plane crash (Howard, Murphy, & Clarke, 1983), whereas 27% are afraid of being enclosed and 25% are afraid of heights (Hamm, 2006). Also common in fear of flying is agoraphobia, a worry about having a panic attack during the flight (Da Costa, Sardinha, & Nardi, 2008).

Wilhelm and Roth (2001) commented that th*e DSM-IV* (American Psychiatric Association, 1994) relies only on self-reports, which should be enriched by physiological measurements, since many anxiety symptoms have plausible physiological origins.

Ekeberg, Kjeldsen, Greenwood, and Enger (1990) suggested to divide the flight phobics into three different groups: One group that does not fly at all, one that restricts flying to an absolute minimum and one that experiences continuous mild or moderate apprehension of flying but does not avoid it.

More details about the differences of flight phobics regarding sociodemographic and clinical characteristics are delivered in the study of van Gerwen et al. (1997). The 419 participants - self-referred patients seeking treatment for fear of flying - were asked about their flight history and filled in questionnaires about the kind and extent of fear of flying. Persons with a high generalized flight anxiety level were probably not included as they did not look for treatment. Subjects stated fear of crashing followed by claustrophobia, need for control, acrophobia, and loss of control or social anxiety as main reasons for their fear of flying. The following typologies of fear of flying were explored: (1) Patients with a relatively low to intermediate flight anxiety and no panic attack symptoms. They were under 35 years old and their complaints were not closely related to any other phobic complaint. They were described as being sensitive to sounds and movements of the plane provoking anxiety. They feared an aircraft accident and wanted to be in control over the situation. (2) Patients with fear of loss of control over themselves or with social anxiety. This group consisted mostly of women, also younger than 35 years. They gave a great deal of attention to the somatic reactions. (3) Patients with high anxiety regarding airplanes and having fear of water and/or claustrophobia and agoraphobia. They reported panic attacks in the anticipation of flights, during flights, and in relation to stimuli in association with flights. (4) Patients with acrophobia contained more men than the other subgroups. They showed medium to high flight anxiety and they wanted to overcome their fear of height experienced in a plane. Van Gerwen et al. (1997) considered that the detection of those subtypes was supposed to improve diagnosis and matching treatment.

1.2.6 Treatment of fear of flying

Twenty percent of all flight passengers depend on alcohol or sedatives to reduce anxiety symptoms during flights (Howard et al., 1983; Botella, Osma, Garcia-Palacios, Quero, & Baños, 2004). Günther, Haller, and Kinzl (2002) presume that pharmacological self-medication is rather common as well as consumption of alcohol to battle the fear, but reliable studies are rare.

One study conducted by Wilhelm and Roth (1997a) showed that the anxiolytic effect of *alprazolam* tested in individuals with flight phobia could not be maintained on the second flight, when individuals had no medication, indeed the opposite was the case, medication increased physiological activation and had a negative influence on the therapeutic effects of exposure therapy. Subjects took 1 mg *alprazolam* 1.5 hours before the first flight, so that the level of plasma concentration was right at take-off time. As the delayed drug effect was also of interest, one week later the subjects were tested without having taken any medication. The authors discussed that one reason for the inefficiency of medication might have been that only fully triggered emotions can be modified (Foa & Kozak, 1986) and that anxiolytics may only stop propositional fear networks.

Van Gerwen et al. (2004) pointed out that treatment of fear of flying has very good prognoses. Based on their review of treatment programs offered worldwide, several methods and programs were confirmed to be effective. Most flight programs work without medication (van Gerwen et al., 2004). This is also the case in the program of Austrian Airlines, which is the basis for the present study.

Referring to Wilhelm and Roth (1998), a truly successful treatment will be comprehensive in effects when modifying all three emotional response systems namely cognition, behavior, and physiology. For an efficient treatment of anxiety the underlying fear associated with the phobic stimulus needs to be delineated (Kormos, 2003).

Wilhelm and Roth (1997b) pointed out that treatment of flight phobias requires the *exposure* to the external stimuli, for both people with panic disorder and people without panic disorder. According to Peñate, Pitt, Bethencourt, Fuente, and Gracia (2008) the aim in treating phobias is the reprocessing of information derived from the phobic stimuli in an adaptive way, which also demands exposure-based treatment. *In-vivo exposure* is superior to imagination especially in treatment of specific phobias (Reinecker, 1993). *In-vivo exposure* as part of the cognitive behavior therapy as well as the recent concepts of virtual reality therapy (Anderson, Jacobs, & Rothbaum, 2004) are based on the emotional processing theory (Foa & Kozak, 1986; Foa, Steketee, & Rothbaum, 1989). The theory points out that in order to cope with a fear the fear structure needs to be activated and corrective information incompatible with the pathological elements of the fear structure must be available. Foa and Kozak (1998) mentioned three indicators to be relevant for a successful treatment outcome, (1) activation of fear structure, (2) within-session decrease in fear, and (3) across-session fear reduction.

When studying fear or anxiety and its treatment, it is indispensable to consider physiological changes in response to fear (Birbaumer, 1973; Hamm, 1997; Lang, 1971) in order to show the extent and effectiveness of treatment. Particularly the wide approach of analyzing heart rate variability (HRV) derived from electrocardiogram measures provides insight into the neural regulation of the ANS. The neural regulation of the ANS is effected through the interaction between sympathetic and parasympathetic activity (Sztajzel, 2004). HRV gives information about the autonomic flexibility and represents the capacity of emotional responding (Appelhans & Luecken, 2006), a solid approach to study physiological response during fear. Up to now there is lack of such studies illuminating fear of flying.

1.2.7 Treatment programs and efficacy

Already at the first international fear of flying conference (1996) in Tarrytown, NY, participants concluded that the cognitive-behavioral group treatment (CBGT) program could serve as a model for fear of flying treatment (Fodor, 1996), which was confirmed by a controlled study (van Gerwen, Spinhoven, & van Dyck, 2006). Van Gerwen and Diekstra reviewed 15 comprehensive programs for treating fear of flying (2000). However, the components which work best were not clarified. Tortella-Feliu and Rivas (2001) concluded that little is known which particular treatment program is most efficient. Following the second international conference on fear of flying treatment held under the auspices of Austrian Airlines in Vienna in the year 2000 - “Airborne 2000” - van Gerwen et al. (2004) made an update of the first review. They approached 162 airlines and treatment facilities around the world asking them for information on their treatment programs of fear of flying, 36 treatment facilities delivered valid information. Van Gerwen et al. (2004) compiled a table presenting the information they got from the different facilities. This table showed (a) the number of patients treated annually, (b) the use of pre-treatment diagnostic evaluation, (c) whether the treatments were held in a group or individually, (d) the availability of a treatment manual, (e) the use of efficacy measures with follow-up, and (f) the availability of written and audio material. Most facilities used multicomponent treatment programs, including diagnostic assessment, individual preparation sessions, behavioral group treatments, cognitive behavioral group treatment, and a follow-up session after treatment (van Gerwen et al., 2004). Based on statements of experts participating at the

“Airborne 2000” in Vienna *golden rules* as guidelines for patients and for therapists were concluded (van Gerwen et al., 2004). Experts also called for a proper diagnostical screening for all standard treatment facilities (Bor & van Gerwen, 2003).

The following studies demonstrate the efficacy of treating fear of flying with behavior therapy or cognitive behavior therapy:

Beckham, Vrana, May, Gustafson, and Smith (1990) showed that behavior therapy is successful in treating fear of flying. In 2002 van Gerwen et al. compared two treatment programs, cognitive behavioral group treatment (CBGT) and behavioral group treatment (BGT), based on Bandura’s belief in the “self-efficacy” theory with the result that for 715 patients both programs proved to be effective. Treatment components included relaxation, stress management, a coping and distraction component, and/or cognitive techniques, information, and an exposure in the field, usually a test flight, which is sometimes preceded by an exposition in a flight simulator before the actual flight takes place (van Gerwen et al., 2002). Another randomized controlled study with 150 participants demonstrated the long-term efficacy of these two treatment programs (van Gerwen et al., 2006).

Evidence for the long-term benefit of a cognitive behavioral treatment for fear of flying has been provided by Anderson et al. (2006). The treatment included either standard exposure (SE) or virtual reality exposure (VRE). The sustainability after a significant fear-relevant event, based on the data relying to flying behavior and anxiety of 55 subjects collected nine months after the terrorist attacks of 9/11 was proven, too (Anderson et al., 2006). In addition to that, Kim, Palin, Anderson, Edwards, Lindner, and Rothbaum (2008) focused on long-term effects of the cognitive behavior therapy (CBT) regarding the use of skills learned in the cognitive behavioral therapy. The benefit of this therapy was demonstrated on the participants in comparison with a control group.

Nousi et al. (2008) were interested in the relation between the flying histories of persons with fear of flying and treatment of fear of flying. They investigated 174 people who had never flown before, 1712 people who had flown before and reported uneventful flights, and 115 people who had flown before and experienced eventful or even traumatic flights. Regardless of the nature of fear of flying, both treatment conditions, one-day behavioral group treatment and two-day cognitive behavioral group treatment, were effective in decreasing symptoms measured with the following standardized questionnaires: the Flight Anxiety Situations (FAS) questionnaire (van Gerwen, Spinhoven, van Dyck, & Diekstra, 1999), the Flight Anxiety Modality (FAM) questionnaire (van Gerwen et al., 1999) and the Visual Analogue Flight Anxiety Scale-VAFAS (van Gerwen et al., 1999). Those persons who had never flown before profited more than those who had experienced an eventful or traumatic flight.

1.2.8 Virtual reality exposure treatment

The treatment efficacy of fear of flying with virtual reality exposure is not as undisputed as real exposure therapy. The methods' advantages and disadvantages are described in the following.

The review of Da Costa et al. (2008) showed that virtual reality is an important technique to be used in treatment programs of fear of flying, although the methodological differences in studies prevent a definitive conclusion about the effectiveness. The virtual reality exposure therapy may be considered as another form of behavioral therapy; the aim is to induce in-vivo exposure based on the assumption that a virtual environment could elicit fear and provoke the anxiety (Krijn, Emmelkamp, Olafsson, & Biemond, 2004). Patients get confronted in a gradual manner with real anxiety-provoking stimuli. The technique for immersing participants in the computer generated virtual environment is described by Krijn et al. (2004). One possibility is a head mounted display, which is just for individual use. The patient is standing or sitting in a room wearing the special display with screens inside the glasses and speakers near the ears. The sight is focused on computer-generated images on the screens. The other technique in use is the so-called *computer automatic virtual environment*, which is a multi user, projection-based virtual reality system, where patient and therapist are surrounded by computer-generated images on four to six sides and are wearing shutter glasses that lighten and darken with devices generating a correct perspective view. The patient can move through the installation. Both techniques use further visual and auditory stimuli and some body-tracking devices and tactile stimuli (Krinj et al., 2004).

One of the positive aspects of virtual reality exposure treatment is that it improves the confidence of patients (Krijn et al., 2007), since it may be easier for people to take the first step to confront their fear of flying in a virtual world. The graded exposure does not imply an all-or-nothing decision as in-vivo exposures do (Mühlberger, Herrmann, Wiedemann, Ellgring, & Pauli, 2001). Compared to standard exposure therapy it provides greater control for the patient, offering greater convenience, easy repetition of components, and prolongation of exposure (Anderson et al., 2004).

Virtual reality exposure treatment was approved to be as efficient as traditional cognitive-behavior treatments ensuring treatment gains for at least one year (Maltby, Kirsch, Mayers, & Allen, 2002; Mühlberger et al., 2001; Mühlberger, Wiedemann, & Pauli, 2003; Rothbaum et al., 2006). Even in the long-term, the treatment efficiency with virtual reality has been proved (Rothbaum, Hodges, Anderson, Price, & Smith, 2000; Botella et al., 2004). Treatment gains like reduction of anxiety symptoms as well as the persons' ability to actually take a flight could be shown after one year.

Limitations to the positive aspects mentioned above are that studies refer to small sample sizes, e.g. Botella et al. (2004) included only nine individuals and three patients dropped out in the assessment phase before starting the treatment. The small sample size (n=24) applies to the study of Rothbaum et al. (2002), too. Their study also showed that 73% participants of the virtual reality exposure training reported in the 12-months follow-up to being more likely to use medication or alcohol to overcome their anxiety on subsequent flights. In comparison only 30% participants of the in-vivo exposure group reported that. The efficacy of virtual reality is unclear as treatment methods compared are overlapping and little is known about who is likely to benefit from virtual reality (Rothbaum et al., 2006). In addition, Anderson et al. (2004) and Krinj et al.

(2007) pointed out that virtual environment may not match the idiosyncratic fear of the patient and that for some patients the virtual reality simply does not feel real enough to elicit any anxiety. Krinj et al. (2007) discuss that patients doubted that the strategy taken to cope with their fear of flying during virtual reality exposure could be generalized to real flights and that the cost-effectiveness for group treatment as stand-alone treatment might even be superior to virtual reality treatment.

Da Costa et al. (2008) recommend the combination in treatment of virtual reality exposure elements and cognitive behavior therapy, thus conforming Krinj et al. (2004). Only when there is more research available that determines the suitable therapy for the specific types of fear of flying virtual reality exposure therapy could gain more relevance, in particular for persons with fear of flying who could rather expose themselves to virtual a reality environment than to an in-vivo situation.

1.3 Etiology and acquaintance of fear of flying

1.3.1 Etiology on the basis of emotion

In order to describe fear of flying it is necessary to review the theoretical background about fear and anxiety. Anxiety as well as fear is embedded within the large field of emotion theories, represented in the historical emotion concepts. The distinction between anxiety and fear depends on the availability of an external stimulus. If there is no external stimulus available, anxiety is described (LeDoux, 1996). Already in the 19th century, William James tried to find an answer to the nature of human emotions and to the reactions to a stimulus (James, 1884). In his view a stimulus would cause a reaction, which in turn causes – via feedback – an emotion. For example, the threat of a bear is a stimulus which causes tachycardia, a physiological reaction, which is transmitted to the Central Nervous System. The subsequent specific mode of sensoric feedback determines the emotion and its specific quality. In James' theory the emotions are the slaves of physiology (LeDoux, 1996). The James-Lange theory claims that feelings are side-effects of emotions (Lange, 1887).

Cannon (1929) added that the autonomic nervous system reactions are too slow in order to explain emotions. He describes fear as an emergency reaction, the fight-and-flight-reaction, which is an adaptive reaction to a threat starting from the sympathetic nervous system. James and Cannon were concordant that it is due to somatic reactions that emotions get their specific emotional perception (LeDoux, 1996).

The cognitive theory of Schachter and Singer in the 1960s added cognitions to the James-Cannon debate (Schachter & Singer, 1962). Information about the physical and the emotional environment determines the arousal and specifies the emotion, which means that emotions arise from the cognitively interpreted situations. Lazarus and Folkman (1984) showed in their theories that the appraisal of a situation is the key to the resulting emotion.

1.3.2 Etiology on the basis of personality

Genetic factors were found to have an influence on the individual's biological preparedness or vulnerability in acquiring a phobia (Hamm, 1997). The bio-informational theory of Lang (1979) describes associative networks of the brain which are generated as soon as sensory inputs fit to the proposed structures of emotion.

An underlying mechanism of fear of flying could be the individual's anxiety sensitivity which moderates the relationship between somatic sensations and flight anxiety. Typical is the belief that the sensations have threatening somatic, psychological or social consequences (Reiss, 1997). The presence of somatic sensation predicts flight anxiety in individuals with high anxiety sensitivity, whereas this is not the case for individuals with low anxiety sensitivity. Therefore Bogaerde and De Raedt (2007) concluded that anxiety sensitivity can be a cognitive vulnerability marker for the acquisition of fear of flying which is responsible for how a person responds to anxiety related body sensations

Wilhelm and Roth (1997b) list factors that may influence the individual's different responsiveness and vulnerability to fear of flying. Factors of relevance are the extent of *trait-anxiety*, the specific preparedness for conditioning of the stimulus of flight, life events or unusual stressors occurring at the same time when the phobia sets up (Menzies & Clarke, 1995), personality traits such as external locus of control, physiological dysfunction, or misinformation regarding facts about flying and air travel. The individual's danger expectancy or an attentional bias might negatively influence the cognitive processing of information (Ehlers, Margraf, Davies, & Roth, 1988). McLean (2003) considers that the individual's perception of risk and threat contributes to the development of fear of flying.

1.3.3 Acquaintance through learning and conditioning

Conditioning and learning are listed as pathways to specific phobia, e.g. the aversive learning experience, learning by model, learning by information, and lack of learned coping strategies in early childhood (Hamm, 2006). Hamm's classification is in line with Rachman (1977). The author distinguished three pathways how fears can be acquired, (1) conditioning, (2) vicarious exposure, and (3) the transmission of information and instruction.

1.3.3.1 Conditioning

According to Sigmund Freud's works and according to the conditioning theories, LeDoux (1996, p. 253) concludes that anxiety or fear is the result of traumatic experience. Both external dangers as well as internal dangers are relevant when setting up a phobia, although half of all persons with phobias are not able to remember the direct aversive stimulus (Öst, 1987). The classical conditioning model of phobias gives an explanation why persons react with subjective and physiological fear when they are exposed to a phobic conditioned stimulus, the aversive classical conditioning represented by Watson's and Rayner's Little Albert study (Watson & Rayner, 1920) is one example. Mowrer's two-stage theory (Mowrer, 1960) gives an explanation for the conditioned avoidance behavior. The person learns that fear responses to the conditioned stimulus can be reduced by avoiding it, the reduction in fear levels following the avoidance reinforces this behavior, and avoidance finally becomes part of the phobia (Merckelbach, de Jong, Muris, & van Den Hout, 1996). Since traditional conditioning approach often failed and was therefore criticized in the past, the latter theories were orientated on biology and cognitive modification, e.g. the stress emotion coping theory (Lazarus, 1993) or the self efficacy theory (Bandura, 1977).

Wilhelm and Roth (1997b) described that classical conditioning could be involved in flying phobia in three ways. First, certain stimuli occurring during flying can be unconditioned stimuli for classical conditioning, they referred to Watson (1924) when describing the conditioning stimuli like “sudden loss of support (airplane drops during turbulence), loud noises (take-off), and under some circumstances pain (middle ear pain form air pressure changes)”. Second, some situations function as prepared stimuli during a flight and can easily cause fear response, as for example intense accelerating forces in three dimensions and tilting (Öhman, 1986; Seligman, 1971). And third, typical agoraphobic stimuli like cramped quarters and the loss of control can lead to conditioned avoidance of people with fear of flying. When somebody had had a panic attack in the past, the panic attack could be a traumatic experience and function as conditioning effect (McNally & Lukach, 1992). Panic attacks may be regarded as trigger for a conditioning event, as suggested by Klein (1980).

1.3.3.2 Vicarious exposure

Nousi et al. (2008) pointed out that, besides direct conditioning caused by external aversive events during flights, there must be other conditioning stimuli that cause fear of flying. Fears may be transmitted by observation or vicarious conditioning or by verbal or instructional learning, respectively. This is even more likely for persons showing higher levels of general anxiety and agoraphobic avoidance (Nousi et al., 2008).

1.3.3.3 Transmission of information and instruction

Negative media coverage of airline incidents and accidents influence the prevalence of fear of flying by reinforcing the conviction of people concerned (McLean, 2003). For those who have never flown before, the transmission of threatening information seems to be more relevant (Bogaerde & De Raedt, 2007). Kraaij, Garnefski, and van Gerwen (2003) mention the influence of terrorist attacks and plane crashes in general, which might lead to increased numbers of people with flight anxiety. The media coverage of the terrorist attacks of September 11, 2001, lead to a decrease of air travel by 10% to 30% (Rothbaum et al., 2006), however, the prevalence of fear of flying in Germany was not influenced by the incident, although the interviewed people reported more often traumatic experiences (Mühlberger, Alpers, & Pauli, 2005).

1.3.4 Studies on etiology and acquaintance of fear of flying

The study of Wilhelm and Roth (1997b) is a pioneer work providing insight into the etiology and acquaintance of fear of flying. In the study 66 individuals with fear of flying were split into three fear groups: one group with simple phobia of flying, one group with fear of flying showing itself as panic disorder with agoraphobia, and one group with a history of panic disorder, but where the panic disorder had not occurred during the last six months. To check the results, a control group without fear of flying was introduced. The purpose was to see whether characteristics for the individual fear groups can be deducted from the answers of the questionnaires, with particular focus on the characteristics for panic disorder. The interviews and clinical questionnaires revealed that all fear groups were more concerned about external dangers during the flight, e.g. an airplane crash, than the control group. All fear groups stated that a life threatening flight experience was a major reason for their fear of flying. The fear of having a panic attack during a flight was an important factor for the two panic groups. They were concerned about internal and social dangers, e.g. bodily discomfort, or criticism by others. Only the group with simple phobia rated that the fear of heights contributed to their fear of flying. For the acquaintance of fear media information was irrelevant for the fear groups. However, the control group assumed that media information would be a significant factor for acquiring fear of flying.

Nousi et al. (2008) intended to deliver a representative study in contrast to Wilhelm and Roth (1997b). The subjects of that study differed from the subjects of the study of Wilhelm and Roth (1997b) by having experienced external conditioning. The authors concluded that fears might have been socially transmitted by observational or vicarious conditioning. The higher amount of verbal and media information and instructional learning were consistent with higher levels of general anxiety and agoraphobic avoidance behavior.

1.4 Biological processes in anxiety

One can conclude that the biological aspect of anxiety is related to neuroanatomical structures of the brain as well as to neurotransmitter processes as described e.g. by Bandelow (2001), Hamm (1997), and LeDoux, (2000).

Brain areas involved in anxiety are in particular the brain stem, thalamus, the hypothalamus, and cortical regions. A part of the limbic system, the amygdala, plays a key role in connection with learned fears. Stimulation of the amygdala is known to elicit fear and anxiety-like states and sympatho-excitatory effects (Berntson, Sarter, & Cacioppo, 1998). Another part of the limbic system, the hippocampus, is responsible for the declarative memories (Lovallo, 2005). These memories are related to facts and context related to the fear (Phillips & LeDoux, 1992; Berntson, Sarter, & Cacioppo, 2003). The hypothalamus is the most important relay between neurons and the endocrine system. During stress the projections from the central nucleus of the amygdala to the *nucleus paraventricularis* of the hypothalamus cause the endocrinologic reaction and release of stress hormones (LeDoux, 1996).

The nucleus locus coeruleus, part of the formatio reticularis, contains epinephrine fibres which are responsible for the global arousal system in the brain. Epinephrine fibres are highly aroused during fight-or-flight states (Lovallo, 2005).

According to Thayer and Lane (2000) a network of distributed brain areas is responsible for the regulation of emotion. The central autonomic network (CAN) controls visceromotor, neuroendocrine, and behavioral responses. The CAN is seen as command center governing cognitive, behavioral, and physiological elements that characterize emotions. The CAN includes the cortical regions: medial prefrontal and insular cortices, limbic regions (anterior cingulate cortex, hypothalamus, central nucleus of the amygdala, bed nucleus of the stria terminalis), and brainstem regions (periaquaductal gray matter, ventrolateral medulla, parabrachial nucleus, nucleus of the solitary tract). The CAN regulates autonomic influences on the heart rate (Appelhans & Luecken, 2006).

Ascending visceral information of vagal afferents has an impact on cognitive processing and behavior as well. Both noradrenergic and cholinergic routes transmit the visceral information, involving a network of aminergic nuclei. The nucleus tractus solitarius (NTS) serves as the first visceral relay station in the brainstem, from there direct projections lead to the forebrain areas as the amygdala and the basal forebrain cortical cholinergic system (Berntson et al., 2003). The basal forebrain cholinergic system has been considered to play a crucial role between cortical processing substrates which are likely to be involved in the cognitive aspects of anxiety, and subcortical systems involved in anxiety and autonomic regulation (Bernston et al., 1998). Cortical–cognitive processing mechanisms are capable of inducing fear and anxiety in the absence of the relevant environmental fear stimulus (Berntson et al., 1998).

LeDoux (2000) explains the cortical processes related to fear as follows. An emotional stimulus activates the sensory thalamus, and a short connection directly to the amygdala evokes emotional response, whereas the hippocampus is responsible for the fear-related memories. The cognitive processing via the sensory cortex, the long route, determines the severity and appraisal of fear reaction.

1.4.1 Autonomic nervous system and anxiety

The autonomic nervous system (ANS) controls the vital organs by way of three anatomically and functionally distinct branches: the sympathetic nervous system (SNS), the parasympathetic nervous system (PNS), and the enteric nervous system (ENS) (Lovallo, 2005). The SNS is considered to have an excitatory role, whereas the PNS is described by an inhibitory function. SNS and PNS often interact antagonistically to produce varying degrees of physiological arousal (Appelhans & Luecken, 2006). The ENS is controlled by the SNS and the PNS (Lovallo, 2005).

Actions of the ANS are considered to be without conscious awareness or voluntary control in contrast to those of the sensory-somatic system. The ANS regulates individual organ functions like the function of the cardiac muscle, glands, and smooth muscles such as those of the digestive system, respiratory system, and skin. The ANS is responsible for a constant inner milieu in response to environmental changes or varying metabolic conditions (Birbaumer, 1973).

During physical or psychological stress, activity of the SNS becomes dominant with the aim of adapting to the challenge, which is characterized e.g. by increased pulse or heart rate. The PNS is characterized by a lower degree of physiological arousal resulting in a decreased heart rate, it is dominant during periods of relative safety and stability (Appelhans & Luecken, 2006).

Anxiety and the ANS are closely related to each other (Kelly, Brown, & Schaffer, 1970; Thayer, Friedman, & Borkovec, 1996). "Anxiety can be conceptualized as a biological warning system that prepares the body to react mentally and physically to potentially dangerous situations. To be able to respond to the threatening situation, the body prepares itself for fight or flight." (Hoehn-Saric & McLeod, 2000, p, 217). The autonomic stimulations during anxiety are similar to those during severe stress situations as for instance the reactivity during parachute jumping (Ursin, 1978, cited in Hoehn-Saric & McLeod, 2000).

Moderate anxiety was found to be useful as reaction to become vigilant and to produce motivating coping behavior, but severe anxiety may provoke counterproductive reactions (Hoehn-Saric & McLeod, 2000). Anxiety is generally associated with a variety of somatic symptom patterns, primarily reflecting autonomic nervous system activity. Anxiety can be defined, just like stress, as a state of helplessness accompanied by strong physiological or somatic reactions (Lovallo, 2005). Anxiety and fear are emotions that are associated with fight-or-flight response (Lovallo, 2005). The ANS depends on emotions that humans experience while interacting with their environment resulting in varying degrees of physiological arousal (Appelhans & Luecken, 2006) while autonomic rigidity reduces the possibility to respond flexibly to changes in the environment and is considered a deficit.

Birbaumer (1973) described the close relation between the level of fear and the autonomic arousal with an interaction-stress-stereotypy and concluded that any method aimed at reducing anxiety involves the learning of a middle arousal level for both subjective and physiological arousals. Dimensions of valence (aversive versus appetitive) and arousal represent the control parameters that guide the organization of emotional response through physiological, cognitive, and behavioral subsystems (Appelhans & Luecken, 2006).

The following paragraphs address parameters which are used to measure the autonomic response in combination with fear of flying. Heart rate variability (HRV) is supposed to be ideal for the insight into the autonomic functioning of the nervous system (Appelhans & Luecken, 2006; Parati & Mancia, 2006; Stein & Kleiger, 1999).

1.4.2 Heart rate variability

The analysis of heart rate variability (HRV) allows insight into the autonomic nervous system – which is of specific interest in anxiety research – by distinguishing sympathetic versus parasympathetic (vagal) activation. HRV is supposed to be a dynamic marker of load due to its responsiveness and sensitivity to acute stress (Berntson et al., 1997), which is important for flexible adaptation of the organism to changing environmental demands. Hence HRV is a measure of autonomic homeostasis and adaptability. “Research and theory support the utility of HRV as a noninvasive, objective index of the brain’s ability to organize regulated emotional responses through the ANS and as a marker of individual difference in emotion regulatory capacity.” (Appelhans & Luecken, 2006, p. 237).

Thayer and Lane (2000) summarized that HRV serves to quantify the ability of self-regulation, since cardiac variability may be related to both attentional and affective processes. Non-observable alterations in HRV – like inflexibility – give information about cardiovascular risk or disease (Friedman & Thayer, 1998a; Friedman et al., 1993; Horsten et al., 1999; McCraty, Atkinson, Tomasino, & Stuppy, 2001; Piccirillo et al., 1997; van Ravenswaaij-Arts, Kollee, Hopman, Stoelinga, & van Geijn, 1993). High vagal tone promotes greater flexibility and adaptability to a changing environment, while low vagal tone is associated with poor self-regulation. A consistently depressed vagal tone reflects poor homeostasis and causes neurophysiological vulnerability to the deleterious effects of stress (Friedman, 2007).

Appelhans and Luecken (2006) list two main factors which influence HRV in particular: Firstly, they mention the influence of the ANS on cardiac activity. The sympathetic and parasympathetic branches of the ANS innervate the heart and have a regulatory influence on the heart rate (HR) by influencing the activity of the sinoatrial node. The sinoatrial node generates action potentials that characterize a heartbeat. The two autonomic branches regulate the lengths of time between consecutive heartbeats, also called the interbeat intervals. Faster heart rates are related to shorter interbeat intervals and vice versa. Sympathetic influence on cardiac functioning is slower than parasympathetic influence; it is mediated by the neurotransmission of norepinephrine. A change in heart rate due to sympathetic activation has its peak effect after 4 s with a return to baseline after 20 s. Parasympathetic influence is mediated by the neurotransmitter acetylcholine and has a short latency of response. A change in heart rate due to parasympathetic activation has been observed already after 0.5 s with peak effect and a return to baseline within 1 s (Appelhans and Luecken, 2006). The other factor influencing HRV is the CAN, a network of central autonomic brain areas as mentioned in chapter 1.4. The CAN reflects an individual's capacity in generating regulated physiological responses in the context of an emotional expression (Thayer et al., 1996; Thayer & Lane, 2000).

Studies and clinical data indicate that decreased HRV is a predictor for cardiac and/or arrhythmic diseases or at least a risk factor (Sztajzel, 2004). Low HRV is generally described as pathological in many studies and as a predictor for heart disease or even increased risk for sudden death (Anderson et al., 2006; Ori, Monir, Weiss, Sayhouni, & Singer, 1992; Terathongkum & Pickler, 2004). “Decreased HRV could then be conceptualized as a lack of ability to respond by physiological variability and complexity, making the individual physiologically rigid and, therefore, more vulnerable.” (Horsten et al., 1999, p. 50) For MacArthur and MacArthur (2000) decreased HRV is associated with stress, anxiety, and panic disorder.

1.4.3 Assessment and calculation of HRV

HRV can be measured by the use of electrocardiogram (ECG) recording the heart’s electrical activity over time. Figure 3 shows details of a recurrent ECG wave and interval.

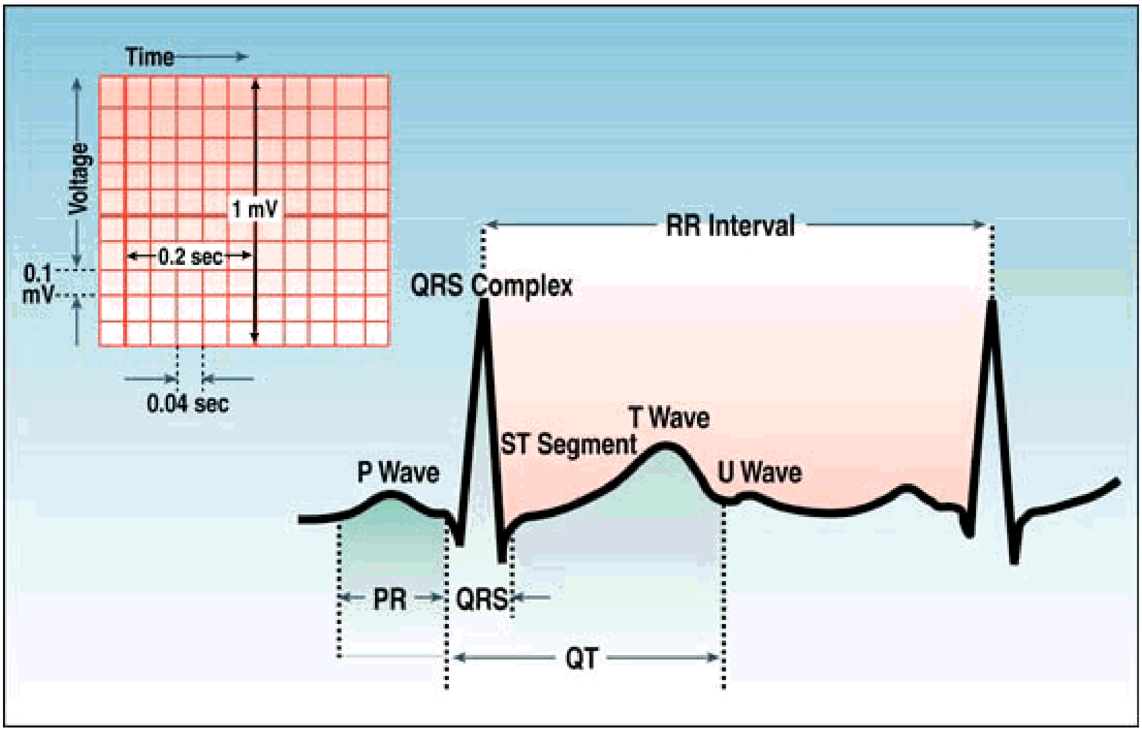


Figure 3. ECG Intervals and Waves. (Based on the University of Utah website, Spencer S. Eckles Health Sciences library, ECG tutorial online, http://library.med.utah.edu/kw/ecg/mml/ecg_533.html, retrieved February 15, 2011: “The P wave represents atrial activation; the PR interval is the time from onset of atrial activation to onset of ventricular activation. The QRS complex represents ventricular activation; the QRS duration is the duration of ventricular activation. The ST-T wave represents ventricular repolarization. The QT interval is the duration of ventricular activation and recovery. The U wave probably represents "afterdepolarizations" in the ventricles”. Copyright by Frank G. Yanowitz, M.D. 1997)

The Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology issued guidelines referring to measurement methods, analysis, interpretation, and clinical use of ECG recordings (Task Force, 1996). This Task Force differentiates between time domain and frequency domain analyses indicating the most frequently employed methods when analyzing HRV. Time domain measures refer to the determination of instantaneous HR and the time between two consecutive R-waves of the QRS complex. This time is called RR interval or NN interval (normal to normal). The following selected time domain indices are described by Task Force (1996). The standard deviation of the normal to normal (SDNN) intervals reflecting all the cyclic components responsible for the variability during the period of recording. SDNN encompasses both short-term and long-term variations in milliseconds (ms). The comparison of adjacent cycle lengths are reflected by the square root of mean squared differences (RMSSD) of successive normal to normal intervals and the proportion derived by dividing NN intervals greater than 50 ms by the total number of NN intervals (pNN50). RMSSD and pNN50 are thought to reflect short-term variations and estimate high frequency variations in heart rate, indicating vagal modulation, and are thought to be highly correlated (Kleiger et al., 1991; Malik, 1998; Task Force, 1996).

Frequency domain methods refer to the power spectral density providing information on how power distributes as a function of frequency (Task Force, 1996). Differences in latencies of action, i.e. the oscillations of the HR produced by sympathetic and parasympathetic activation occurring at different speeds or frequencies, are the basis for the frequency based HRV analyses. The unit for power is ms^2/Hz. Power spectral analysis can be performed by nonparametric methods like the fast Fourier transform or by parametric methods like the autoregressive approach (Malliani, Pagani, & Lombardi, 1994; Mainardi, Bianchi, & Cerutti, 2002). Figure 4 depicts a frequency analyze by Medilog SimpleView program.

In short-term recordings (2 to 5 min recordings) three frequencies of HR oscillations can be detected containing most of the HR power (Task Force, 1996): The power in very low frequency (VLF) range refers to a frequency level of $\leq$ 0.04 Hz. The power in low frequency (LF) range refers to a frequency level of 0.04-0.15 Hz. The power in high frequency (HF) range refers to a frequency level of 0.15-0.4 Hz.

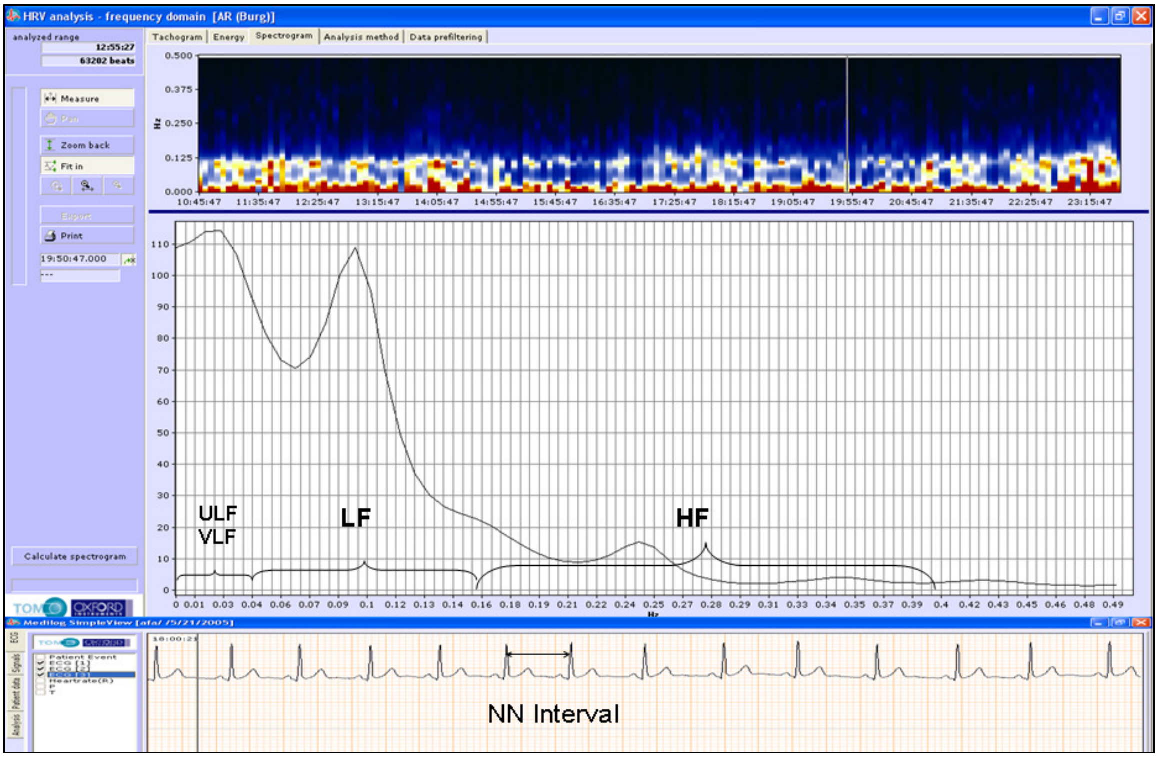


Figure 4. Screenshot of the HRV frequency domain in Medilog SimpleView 2.2 of one participant of the present study for a certain time-point of the recording. In the upper part of the figure is plotted on the x-axis the frequency in Hz and on the y-axis the power in ms². In the middle of the figure the ULF/VLF, LF, and HF oscillations are marked. The normal heart beats are displayed underneath, the NN interval is marked. One can see that in this frequency most power distributes in the ULF/VLF and LF bands.

Long-term recordings refer to 24 hours recordings and include the power in ultra low frequency range < 0.003 Hz (Task Force, 1996, p. 360). The variance of the total power spectrum (TP) refers to the variance of NN intervals over the temporal segment in short-term recordings or to the variance of all NN intervals (analyzes of 24 h recordings).

LF and HF were considered in the current study in normalized units (n.u.). The LF normalized (LFnorm) and HF normalized (HFnorm) represent the relative value of each power component in proportion to the total power minus the VLF component (Pagani et al., 1986; Malliani, Pagani, Lombardi, & Cerutti, 1991). The formula for LFnorm is LF/(Total Power-VLF) × 100 and for HFnorm HF/(Total Power-VLF) × 100 (Task Force, 1996).

HF is considered to be modulated by the parasympathetic (vagal) branch of the ANS (Horsten et al., 1999; Pagani et al., 1986). The so called respiratory sinus arrhythmia (RSA) is considered to be a major contributor to the HF component of HR, it ranges normally from 0.15 Hz to 0.4 Hz and is considered as index of cardiac parasympathetic control (Acharya, Kannathal, Sing, Ping, & Chua, 2004; Appelhans & Luecken, 2006; Berntson, Cacioppo & Quigley., 1993a; Grossman, Wilhelm, & Spoerle, 2004).

The interpretation of LF band is more controversial (Task Force, 1996). LF, especially when expressed in normalized units, is supposed to represent sympathetic modulation (Malliani et al., 1991; Montano et al., 1984)., others consider LF to be influenced by the sympathetic and the parasympathetic system (Akselrod et al., 1985; Pagani et al., 1986).

The LF/HF ratio is discussed to be an index of the sympathovagal balance (Malliani et al., 1991), but this is questioned by Eckberg (1997).

1.4.4 Stress and HRV

The relation between stress and cardiovascular response is similar to the relation between anxiety and autonomic response (Lovallo, 2005). The cardiac response pattern of stress depends on the severity of the stressors. During severe levels of stress, sympathetic influences totally override vagal activation. During moderate stress, however, vagal and sympathetic tone interact antagonistically (Hoehn-Saric & McLeod, 2000). The HR, increased by moderate stressors, can be reduced by vagal stimulation caused by slowed breathing (Grossman, 1983). This fact is of interest when focusing the autonomic response pattern related to flight anxiety.

Stress-related alterations of the cardiac response pattern were shown in the study of Hjortskov et al. (2004). Twelve females were exposed to work-related mental stressors at the computer and consequently their parasympathetic activity decreased, whereas the sympathetic activity increased. The study of Ottaviani, Shapiro, Davydov, and Goldstein (2008) showed that different stressors evoke specific patterns of cardiac autonomic activity. In a laboratory study, 16 males and 29 females were exposed to stressors, such as a handgrip exercise, a mirror-tracing task, a computerized logical-mathematical task, and a rumination task, in order to find out the response patterns. ECG was recorded and blood pressure was taken. An increase of sympathetic activation and a decrease of parasympathetic activation were related to active coping processes, as observed during the logical-mathematical task. Passive coping however evokes an increase in both, sympathetic and parasympathetic activation, as observed during the mirror-tracing and the handgrip exercise. Rumination, a mixed-adrenergic task, evoked a mixed pattern of responses. The SNS and PNS response of individuals were more stable during recovery, suggesting a link between the autonomic profile of an individual and ambulatory HRV.

1.4.5 Cortisol release

Acute psychological stress in humans leads to a cascade of hormonal changes regulated by the hypothalamic-pituitary- adrenocortical (HPA) axis. As frequent consequence to this, an increase in cortisol is measured (Alpers, Abelson, Wilhelm, & Roth, 2003). The investigation of Bandelow et al. (2000) suggested augmented cortisol levels in subjects during acute panic attacks especially in a naturalistic settings which was not evidenced by provoking the panic attack in a laboratory setting. Other studies related to HPA regulation and anxiety disorders have produced mixed results. For example, the effect size for cortisol was low compared to HR in phobic anxiety (Nesse et al., 1985), where phobic anxiety was the stressor. A relationship between change of cortisol levels and stress indices was shown with the study of Vedhara et al. (2003), provocation of stress has also been found being related to increased cortisol levels in normal individuals (Kirschbaum, Scherer, & Strasburger, 1994).

The reason for the increase of cortisol concentration during panic attacks might be the additional experience of stress, or the dysregulation of the HPA axis function (Bandelow et al., 2000). Fear of flying as stressful event for those who suffer from it may be accompanied by increased cortisol level in order to help the body to adapt to the stress. Till now cortisol has not been considered in studies regarding fear of flying.

1.5 Response patterns

1.5.1 Anxiety and physiological response patterns in general

Historically, anxiety research has focused on sympathetic activation and has rather neglected parasympathetic information (Roth et al., 1986). The heart rate (HR) is considered as a good indicator for anxiety (Nesse et al., 1985; Roth et al., 1986; Wilhelm & Roth, 1998). The cardiac vagal tone is seen as dominating the heart rate (Stein & Kleiger, 1999), and it is supposed to function as an arousal and emotional index (Porges, 1995). High vagal tone is linked to high heart rate variability (Malliani et al., 1994; Stein & Asmundson, 1994), which provides flexibility and adaptability to meet environmental demands necessary for health (Berntson, Norman, Hawkley, & Cacioppo, 2008a; McEwen & Wingfield, 2003).

Autonomic response patterns are related to the situational response specificity and the individual response specificity of a person (Blechert, Lajtman, Michael, Margraf, & Wilhelm, 2006). In his review on heart rate variability, cardiac vagal tone, and their relation to anxiety Friedman (2007) summarized that anxiety disorders may be characterized by decreased vagally mediated HRV and/or by decreased chaotic dynamics.

1.5.1.1 Chronic anxiety

There are some characteristic autonomic response patterns of individuals with chronic anxiety disorder or with high scores of *trait-anxiety*, and also an association to biological dysfunctions. Individuals suffering from fear of flying may show comparable patterns, considering the heterogeneity of the disorder, as already shown by van Gerwen et al. (2004) and Wilhelm and Roth (1997b).

Piccirillo et al. (1997) examined whether chronic anxiety is associated with biological dysfunction expressed by sympathetic hyperarousal or parasympathetic decrease. Three groups, a control group of 36 individuals having no anxiety symptoms, 36 individuals with a single anxiety symptom, and 49 individuals with two or more anxiety symptoms were compared in a laboratory investigation with ECG recordings in supine and tilt positions. The study showed that there were already differences in the baseline between individuals with anxiety and the control group. Individuals with two or more anxiety symptoms had lower resting HRV, higher LF/HF ratio, and lower values for all frequency domain measures than those in the control group. Stress (tilt) did not cause further increase of sympathetic activity for anxious people. That is in contrast to parasympathetic activity, which has altered in reaction to tilt. Tilt induced decrease in total power of heart rate frequency, in very low frequency and high frequency in the control group and in very anxious individuals. Tilt caused an increase in LF/HF ratio only in the control group.

Hoehn-Saric and McLeod (2000) pointed out that the majority of individuals with chronic anxiety under non-specific laboratory stress showed rigid and less efficient autonomic responses but no autonomic hyperarousal. Patients showed a strong physiological response in comparison to a control group only when exposed to the specific stimuli that corresponded to the pathological fear.

The relation between reduced vagal control and the level of *trait-anxiety* was shown by Watkins, Grossman, Krishnan, and Sherwood (1998). ECG recordings were taken from 93 healthy individuals lying in a supine position. Results indicated that *trait-anxiety* was negatively correlated with baroreflex control of heart rate. People with high levels of *trait-anxiety* showed reduced vagal control indicated by respiratory sinus arrhythmia. Anxiety and vagal control of HR differentiated between individuals with low or high *trait-anxiety*.

Vagal control of HR was significantly lower in individuals with *trait-anxiety* in the highest quartiles.

It can be concluded that in people with chronic anxiety symptoms or with high scores of *trait-anxiety* a supposed biological dysfunction is associated with a reduction of the HRV. This reduction is expressed by reduced vagal tone. The response pattern will be of relevance when exploring the physiological response pattern of individuals in fear of flying as well.

1.5.1.2 Panic disorder

Empirical evidence shows that panic contributes to a pathophysiological autonomic functioning (Albert, Chae, Rexrode, Manson, & Kawachi, 2005; Kawachi, Sparrow, Vokonas, & Weiss, 1994; van Ravenswaaij-Arts et al., 1993).

The occurrence of panic attacks may have an influence in acquiring fear of flying through conditioning as suggested by Klein (1980). Symptoms of hypoxia are similar to panic attacks which also play a role for acquiring fear of flying (Roth et al., 2002) as outlined in chapter 1.2.4. The following studies address either the basal biological pattern of individuals having panic disorder (Klein, Cnaani, Harel, Braun, & Ben-Haim, 1995; Yeragani et al., 1998; Wilhelm, Trabert, & Roth, 2001) or the physiological response pattern during experimentally evoked panic attacks (Asmundson & Stein, 1994; George et al., 1989; Ito et al., 1999).

In a study of Klein et al. (1995) 10 individuals with panic disorder and 14 individuals of the control group were examined in a laboratory setting in order to find out whether the panic disorder is a result of alterations within the central nervous system or a result of the anticipation of the panic reaction (viscous circle) and the awareness of somatic and physiological alterations. ECG recordings were taken in a resting supine position. Results showed differences between groups. Firstly, HF oscillations were only found in the control group, but not in individuals with panic disorder. Secondly, patients with panic disorder had a higher HR and higher resting LF/HF ratio than the control group. Klein et al. (1995) interpreted the increase in basal HR in patients with panic disorder concurrent with a reduction in parasympathetic control as an expression of tonic inhibition during panic. They concluded that the parasympathetic system plays a more dominant role in determination HR than assumed.

In a study of Yeragani et al. (1998) holter ECG recordings over a 24-hour period were taken from a control group of 23 individuals and 29 individuals with panic disorder. The results showed decreased total power of power spectrum and of absolute ULF in individuals with panic disorder supporting that panic disorder is related to alterations in autonomic functioning of individuals.

Another study on physiologic instability in panic disorder and generalized anxiety was conducted by Wilhelm et al. (2001). They placed 16 individuals with panic disorder, 15 individuals with generalized anxiety disorder and a control group in front of a computer for 30 min (sitting quietly) in a laboratory experiment. The results showed no group differences in cardiovascular response or electrodermal activity (EDA), but all respiratory measures showed differences, indicating a less stable physiological control of individuals with panic disorder.

Asmundson and Stein (1994) investigated the effect of hyperventilation and other manipulations of respiratory pace on parasympathetic nervous system function and subjective reactivity, in order to differentiate individuals with panic disorder from individuals with social phobia and from the control group. The laboratory tasks included hyperventilation, normoventilation, and hypoventilation. The incidence and severity of panic attacks were observed as well as physiological response. Vagal activity decreased only during panic attacks. It was concluded that the parasympathetic nervous system functions normally during epochs without panic attacks, but during the attacks alterations occur.

This is consistent with the findings of George et al. (1989) that panic disorders could be related to the reduced parasympathetic tone. George et al. (1989) evoked panic attacks by administering sodium lactate and provoking hyperventilation in healthy volunteers. With those experiments they showed that not only sympathetic activations but also decrease of parasympathetic activity may contribute to the experience of panic attacks.

Ito et al. (1999) exposed eight individuals with panic disorder and 13 individuals of a control group to a head-up tilt intending to provoke a panic attack. Results showed that individuals with panic disorder differed from the control group during tilt. Individuals with panic disorder had higher LF and unexpectedly higher HF compared to the control group, however, LF/HF ratio and HR did not differ. In the resting position there were no differences in HR, HF, LF, or LF/HF ratio.

The studies above show a discrepancy in the autonomic pattern of panic disorder: Referring to the basal autonomic pattern of individuals with panic disorder the results vary from diminished total power (Yeragani et al., 1998), to disappearance of parasympathetic activity (HF oscillations) combined with an increase of sympathetic activity (HR, LF/HF ratio) (Klein et al., 1995), and respiratory instability (Wilhelm et al., 2001). When panic attacks are evoked the pattern of autonomic response reveals that either both sympathetic and parasympathetic activity (LF, HF) increase (Ito et al., 1999), or parasympathetic activity diminishes (George et al., 1989; Asmundson & Stein, 1994).

Concluding, there are no clearly defined autonomic patterns for panic attacks. Thus, individuals suffering from fear of flying describing their fear as showing as a panic attack or who had suffered from panic attacks in the past are also expected to show heterogeneous autonomic responses.

1.5.1.3 Phobia

Fear of flying is listed under *specific phobias* in the DSM-IV (American Psychiatric Association, 1994). The following studies cover the autonomic response patterns of different phobias, focusing on whether a certain cardiac pattern can be observed during a panic attack.

Friedman et al. (1993) compared the autonomic response pattern of 11 individuals with panic disorder and 10 individuals with blood phobia. Participants of the study were tested in laboratory situation and were exposed to several tasks, including paced breathing, shock avoidance, and a face-immersion task. Results showed that individuals with panic disorder had generally elevated heart rates and a higher LF/HF ratio, whereas individuals with blood phobia showed greater variance in heart rate. The panic attack is evidenced by elevated sympathetic activity and vagal withdrawal. Blood phobia often leads to deactivation like fainting or vascovagal syncope, which is a sympathetic hyperarousal, followed immediately by sympathetic inhibition and concomitant overcompensatory parasympathetic rebound (Friedman et al., 1993).

In 1998 Friedman and Thayer compared the anxiety pattern of 16 individuals with panic disorder, 15 individuals with blood phobia, and 15 individuals of a control group (1998a). The subjects participated in a laboratory study involving the same tasks as used in Friedman et al. (1993). Results showed greater vagal control and spectral reserve (quality indicator for flexible responsivity) in patients with blood phobia compared to subjects with panic disorder. Patients with panic disorder showed shorter inter-beat intervals, less RMSSD, less HF, and higher LF/HF ratio.

Another phobia was the subject of the study of Johnsen et al. (2003). Twenty-seven individuals with dental phobia were examined while seated in a dental chair in a dental clinic during exposure to video scenes of dental treatment Recordings included exposure to the feared stimuli, exposure during mental load tasks and during recovery period. Results showed a decrease in HRV and an increase in HR during exposure to the feared stimuli and during the mental load task.

The relation between higher levels of phobic anxiety and low hear rate variability was evidenced by Kawachi, Sparrow, Vokonas, and Weiss, 1995. Five hundred eighty-one men with phobia were tested in a laboratory study taking ECG measurements in a supine position. SDNN as a marker of HRV and mean HR were analyzed. The phobia was previously determined by a clinical questionnaire and results showed that men with higher levels of phobic anxiety showed lower HRV. The finding is consistent with a reduction of vagal tone.

Summing up there is evidence that diminished HRV and altered vagal control are related to phobic disorders (Kawachi et al., 1995). During exposure to the phobic stimuli increased sympathetic activity (LF/HF ratio or increased HR) was concomitant with attenuated vagus (Johnsen et al., 2003). However, comparing individuals with panic disorder and individuals with phobia it was obvious that diminished HRV is related more clearly to individuals with panic disorder (Friedman & Thayer, 1998b).

1.5.2 Fear of flying and physiological response patterns

There are some studies including physiological parameters in addition to self-reported anxiety regarding fear of flying. The studies including real flights combined with psychophysiology are rare. The questions are whether physiological parameters depict treatment effects, whether virtual flights are comparable to real flights in terms of physiological parameters, and whether comparable patterns have already been documented.

1.5.2.1 Treatment studies including physiology without flights

One of the first controlled group studies on fear of flying and physiology was done by Haug et al. (1987). The authors considered the three-systems model of Lang (1971) - cognitive, physiological, and behavior-motoric - in order to get a valid evaluation of the treatment effect. The cognitive system was measured with self-report measures. The physiological system was determined by the changes in HR. The behavior-motoric system was indicated by the avoidance behavior, i.e. the individual's anxiety measured as distance in meters to the airplane or as time spent in the airplane before leaving the phobic situation. The treatment was differentiated whether it corresponded or did not correspond to the individual's dominating response system. This could be either the cognitive responders measured by the extent of negative cognitions about the prospects of safe take-off and landing during exposure or the physiological responders encountering an increase in heart rate during the flight. Treatment effects could be demonstrated in all 11 participants, HR decreased, self-rating of anxiety improved, independent of the treatment method applied, from pre to post treatment. The consonant treatment method was superior to the non-consonant method regarding subjective experience of physiological arousal and the ratings of fear of flying.

Bornas et al. (2006) carried out a laboratory study with 61 fearful flyers and a control group without fear of flying to explore the variability and complexity measures of electrocardiogram measurements by multiscale entropy. Psychophysiological parameters (HR, RMSSD, HF, LF) during a baseline, paced breathing, and during a five-minute exposure sequence to flight stimuli on the computer were considered. All parameters revealed only significant effects for condition, but not for group. The disadvantage of this study was that the individuals initially assessed their own fear only as moderate. Moreover, HR of the control group and the fearful individuals differed even during baseline. Hence, the varying parameters of the relaxing situation and virtual exposure situation could not provide any further information on the level of anxiety.

1.5.2.2 Treatment studies including physiology and virtual flights

Fear of flying and the physiological response were studied in laboratory and during virtual reality treatment programs as well. Capafons et al. (1999) studied physiological response in a laboratory setting during a flight shown on a video in order to validate two different treatment programs, i.e. systematic desensibilisation and reattribution training. HR and muscle tension were monitored during a flight situation. The treatment effectiveness in terms of physiology could not be determined. It was concluded that real flight situations are necessary for more clarification, regardless of the fact that both intervention programs had beneficial effects on people suffering from fear of flying.

Virtual reality programs were validated by Mühlberger et al. (2001). The authors set up two groups of individuals with phobia; one group underwent virtual reality treatment while the other was treated with relaxation training. Both treatment programs measured physiological parameters. Both groups took one virtual test flight before the treatment and one virtual reality flight after the treatment. The treatment of the virtual reality treatment group included four flights lasting 16 minutes in virtual reality with head-mounted displays. The other group underwent conventional relaxation training. The comparison of the results taken before and after the training of all parameters (self assessments, HR, skin conductance level) showed significant treatment effects in both groups. Skin conductance level (SCL) decreased systematically within the virtual reality flights, as well as across all four flights. However, the HR decreased only across the initial flight and the reference flight in both groups, with a greater effect in the virtual reality treatment group. It was concluded that virtual reality exposure like *in-vivo* exposure was not part of this program and therefore this comparison could not be drawn. Moreover, a control group of individuals without fear of flying was not included in this study, and therefore it is ambiguous whether the results stem from a reduction of fear.

Wiederhold, Jang, Kim, and Wiederhold (2002) included physiological parameters to validate the therapy effects in virtual reality. Individuals with fear of flying (n=36) underwent a 20-minutes graded exposure therapy in virtual reality and were compared to non-phobics (n=22). Physiological response of heart rate, skin resistance, and skin temperature was asserted. Due to the results of the skin resistance the phobics and non-phobics would be definitely allocated to the corresponding group, whereas the HR did not elicit differences. Physiological response of phobics showed a gradual trend of improvement during the treatment, which meant a minimal approach towards the physiological response pattern of non-phobics. It was concluded, that in future the HRV should be included in all studies.

The long-term effects of different treatment methods including physiological response were considered in the following studies. Wiederhold and Wiederhold (2003) made a follow-up study with telephone interviews to show the long-term effects of different treatment methods in laboratory setting. The physiological assessments during the treatments included the electroencephalogram (EEG), respiration rate, skin resistance, heart rate, and peripheral skin temperature.

The graded exposure in virtual reality in combination with visual feedback of the patient's physiology, i.e. breathing retraining, was concluded to have an influence on the long-term effect and was considered a solid treatment. The three-year follow-up demonstrated that individuals of this group were still able to fly without medication or alcohol, which was not the case for those subjects who had undergone virtual reality graded exposure treatment or imaginary exposure therapy with physiological monitoring without visual feedback.

1.5.2.3 Treatment studies including physiology and real flights

The effect of a self-guided treatment program, stress inoculation training, which was applied to 14 individuals compared to 14 individuals of a control group without treatment, was studied by Beckham et al. (1990). The treated individuals and the control group attended a 60 minute flight, during which self-report questionnaires and heart rate were assessed at five different periods, namely arrival at terminal, seating, after take-off, before landing, and on the ground after landing. Treated individuals and the control group did not differ in HR and reported anxiety during the flight. However, results showed that more individuals with treatment were able to take the flight compared to the control group (nine individuals versus five). HR and subjective report of anxiety over time demonstrated high levels of concordance and synchrony. It is relevant that physiological indicators of emotional processing were related to subsequent flight behavior. A high level of fear memory activation defines emotional processing and enables modification and reduction of fear (Foa & Kozak, 1986).

Subjects with flight phobia are particularly suitable for studies on physiological responses to psychological stress (Ekeberg et al., 1990). The relation between the subjective level of anxiety rated by self-assessments and anxiety inventories and physiological variables like blood pressure, heart rate, plasma adrenaline, and plasma noradrenalin was compared by Ekeberg et al. (1990). Twenty-three subjects with flight phobia were exposed to the acute mental stress of two real flights, each a duration of 30 minutes. The study is an example of the relative independence of autonomic indices and low correlations with subjective and behavioral responses. Physiology was the same before and after the flight, during the flights, however, plasma adrenaline, heart rate, and blood pressure increased significantly. Results showed a high sensitivity for a direct relationship between the physiological and psychological stress during the flight. This demonstrates the relevance of several measures being taken during a flight. The psychological self-assessments of anxiety were, like the physiological parameters, highest during the flight. The psychological ratings were lower after the flights than before the flights, indicating that after exposure the subjective anxiety level is reduced. It was unexpected that the physiological parameters did not change from pre to post flight-situations. In hindsight, this outcome might have resulted from the fact that all individuals had taken placebos and were individually accompanied by a doctor or psychologist. These factors interfere considerably with the psychological and physiological parameters, which is why this modus operandi must be questioned.

The importance of including physiological parameters to assess anxiety was underlined Wilhelm and Roth (1998). They demonstrated that ambulatory recording of multiple anxiety measures during a real flight situation was feasible. In addition to self-report data, HRV, electrodermal activity, and respiratory activity were chosen to represent physiological parameters. Motility effects and outside temperature were considered as well. The cardiovascular analyses were supposed to distinguish contributions from the sympathetic and parasympathetic branches of the autonomic nervous system. Fifteen flight phobic women were individually tested and compared with individuals without fear during a pre-flight baseline, during four minutes of flight out of a twelve-minutes lasting commercial flight, and during a post flight baseline. The complete 16 minutes analyses were part of a cognitive-behavioral treatment program investigating the effects of benzodiazepine administration. Participants received a placebo during the study. The authors concluded that controls and phobics had different response patterns during the flight situation, as people with fear of flying reported more anxiety symptoms in combination with additional HR and increased HR during exposure. Skin conductance fluctuations, respiratory rate and ventilation cycles per minute were indicators for excitement, which is a responding pattern that did not differ between phobic individuals and control group. RSA showed a unique pattern in phobic individuals; RSA was lower during the flight. There was no change between pre and post flight in HR, SCL and RSA. Due to the results of the self-report measures of the phobic individuals and the cognitive group the individuals could be definitely allocated to the corresponding group. However, the results of physiological parameters were not so explicit.

The study on fear of flying and physiological parameters of Wilhelm, Pfaltz, Grossmann and Roth (2006) tried to distinguish physiological dysregulation or emotion effects from physical activity in natural environments. They assumed that investigations of emotions in natural environments could be misleading since physical activity might mask the real emotion. The experiment was set up in three different situations, i.e. sitting quietly, exercising physically, and taking a flight. In this study 14 flight phobic individuals and 14 individuals of a control group were compared. ECG, EDA, calibrated respiration pattern, and skin temperature were recorded. Based on the outcome of these measures four patterns of variables were classified according to the sensitivity of the individuals to emotional and physical activation. The clusters identified that HR, RSA, and the skin conductance level and its fluctuations were highly non-specific markers of physical and emotional activity, since they were responding to both emotional and physiological activation. Only the parameter respiratory volume was particularly responsive to exercise. This highlights that context information is important and necessary for identifying physical activation from emotion.

It is difficult to draw conclusions about a dominant physiological response pattern related to fear of flying in the studies mentioned above. That is because the studies differed in their target, e.g. showing the effectiveness of a certain treatment method backed up by physiological parameters (Beckham et al., 1990; Haug et al., 1987), proving the feasibility of ambulatory recoding (Wilhelm & Roth, 1998), comparing subjective and physiological parameters during exposure (Ekeberg et al., 1990), or determining the sensitivity of parameters reflecting emotional or physical activation (Wilhelm et al., 2006). According to the different targets of the studies the composition of the designs differs, e.g. selected time event of recording, duration of recording, or selection of subjects and control group, respectively.

All of those studies included at least HR to represent physiology. The studies showed that HR is a sensitive indicator for physiological response in studies of fear of flying referring to real exposure. Only Wilhelm and Roth (1998), Wilhelm et al. (2006), and Bornas et al. (2006) included HRV, but continuous recording during flights are not available.

The current study will bring new light in this field since the autonomic response pattern during real flight flights along with a control group of individuals without fear of flying has been unexplored so far.

1.5.3 Inconsistencies between psychological/physiological patterns

When implementing the three-system approach to emotion (Lang, 1971) including cognitive, behavioral, and physiological-motoric response, the concordance in these measures is ambiguous. However, according to Cook, Melamed, Cuthbert, MacNeil, and Lang (1988) the response of people with a simple phobia is more concordant than in people with other anxiety disorders. Literature has largely reported discrepancy concerning subjective ratings indicating the extent of anxiety in comparison to changes in physiology or behavior (Barlow, 2000; Hoehn-Saric & McLeod, 2000; Nesse et al., 1985). Studies on fear of flying implementing the three-system approach provided inconsistent results, too (Wilhelm and Roth, 1998; Wilhelm and Roth, 2001).

The relationship between various measures of fear (self-report and physiology) across a number of individuals was expected to be concordant (Hodgson & Rachman, 1974; Rachman & Hodgson, 1974). According to Lang (1971) and Rachman (1977) anxiety manifests itself in three independent systems of response, namely cognitive, behavioral and physiological-motoric response. However, these three systems are not always covarying (Barlow, 2000). Wilhelm and Roth (2001) pointed out the discordance between and even within response modes. As to Nesse et al. (1985) there is often a discordance between response modes, e.g. experience of anxiety without significant changes in physiological activation or overt behavior. The correlation between subjective and physiological measures, for instance, was predictably low in patients with generalized anxiety disorder. Fear response of people with a simple phobia was expected to be more concordant than the fear response of people with other anxiety disorders, according to Cook et al. (1988) because the phobics' memories would show a high level of cue specificity.

The individual's anxiety sensitivity may predict anxious response in biological challenge paradigms and influence information processing via an attentional bias for threat-related cues (McNally, 2002). Domschke, Stevens, Pfleiderer, and Gerlach (2010) conclude that anxiety sensitivity and anxiety disorders are related to a generally subjectively rated hypervigilance for somatic sensations in patients. That subjectively rated sensation is only partly reflected by diminished autonomic flexibility or heightened basal arousal.

The relationship between RSA and subjective ratings of *state-anxiety* in non-clinical individuals showed that higher *state-anxiety* was related to increased RSA-magnitude (Jönsson, 2007). This increase was interpreted as a consequence of the vagal break, which is a function that serves to augment the attention or to increase the stimulus sensitivity, being relevant during anxiety. As a consequence of the vagal break the sympathetic system gets inhibited and may alternate the vagal tone according to the polyvagal theory (Porges, 1995, 2001).

Recently Busscher, van Gerwen, Spinhoven, and Geus (2010) showed that subjective fear responses and autonomic response of fear phobics are only loosely coupled and that the anxiety sensitivity was not mediating the response pattern. Flight related stimuli caused an increase in subjective distress for flight phobics but not for the control group**.** The physiological response of the control group and the flight phobics could not be distinguished, for flight phobics the subjective fear increased during exposure to a flight video and was moderately coupled to HR and cardiac vagal reactivity. The authors had expected a stronger relation and admitted that the phobic stimuli were not reliable enough.

1.6 Regulation of the ANS

There are some theoretical concepts describing the functioning of autonomous nervous processes and their evidence. The response patterns related to anxiety in general and to fear of flying (see chapter 1.5.) refer to those concepts when interpreting psychophysiological data.

1.6.1 Fight-or-flight response

According to Cannon (1929) the fight-or-flight behavior is the prototype of stress response in association with anxiety and fear. The relation between anxiety and increases in sympathetic system activity are for example reflected in increased heart rate and increased blood pressure as a response to threat. A typical fear response to threat is characterized by increased sympathetic activity, while parasympathetic tone diminishes (Abelson, Weg, Nesse, & Curtis, 2001; Appelhans & Luecken, 2006; Friedman & Thayer, 1998b). The increased sympathetic activation in anxiety is related to the idea of autonomic liability or hyper-reactivity, being in accordance with Cannon's view of homeostasis in physiological regulation.

Research by Stein and Asmundson (1994), Yeragani et al. (1993) and Yeragani et al. (1998) suggested sympathetic overreactivity and parasympathetic hypoactivity, or an imbalance between those two systems in anxiety.

1.6.2 The polyvagal theory

The polyvagal theory (Porges, 2001) focuses on the importance of vagal influence on the ANS. Porges (2001) gave an overview of the autonomic nervous system during evolution in relation to fear or threat. The most ancient stage described as freezing or immobilization behavior originated in the unmyelinated dorsal vagal-complex, the next stage was the mobilization by the sympathetic nervous system initiating the fight-or-flight behavior, and the third stage involves the ventral-vagal complexes, which can rapidly withdraw and reinstate its inhibitory influence on sinoatrial node activity. This third stage enables adaptation to the environment by apprehensive and/or aversive behavior without SNS activation. Only when this stage is not efficient in response to fear other systems take effect.

1.6.3 Model of autonomic flexibility and adaptivity

The dynamic system model of emotion regulation (Porges, 1995) emphasizes the key role of inhibiting processes of the parasympathetic system. Inhibition results in a decrease of activity in the parasympathetic system reflected in a decrease of the vagally mediated HRV, i.e. diminished HF band power. Porges' work and the concepts of ANS activity as complex patterns are the basis for the model of autonomic flexibility and adaptivity of Friedman and Thayer (1998a, 1998b). The model reflects the vagally mediated HRV as an index regarding how well a person is able to allocate psychophysiological resources in order to meet environmental demands. Therefore it was concluded that due to anxiety, in its phasic, tonic, and pathologic forms the ANS causes a malfunction of the cardiac control, mainly marked by low vagal and elevated sympathetic activity (Friedman & Thayer, 1998a, 1998b; Thayer & Friedman, 2002; Thayer & Lane, 2000). Low vagally mediated HRV is related to the risk factor for cardiovascular disease (Friedman et al., 1993; Johnsen et al., 2003; Kawachi et al., 1995; Wilhelm & Roth, 1998; Wilhelm et al., 2001; Yeragani, Srinivasan, Balon, Ramesh, & Berchou, 1994).

1.6.4 Autonomic flexibility-neurovisceral integration model

The neurovisceral integration model (Friedman, 2007; Thayer & Lane, 2000) emphasizes the importance of higher brain systems that modulate autonomic outflows (Berntson, Cacioppo, & Grossman, 2007). The autonomic flexibility-neurovisceral integration model of anxiety and cardiac vagal tone focuses on the control of physiological functions, i.e. homeostatic and homeodynamic regulation. It also refers to the architecture of the central nervous system, in particular to the role of the hypothalamus, the reticular formation, and the limbic system. Moreover, the role of the neurotransmitters and neuroreceptors, i.e. the beta-adrenergic and noradrenergic functions, is relevant (Friedman, 2007). The model combines behavioral, cognitive, physiological processes involved in emotion as subsystems of a larger self-organizing system (Thayer & Lane, 2000). The neurocognitive system of the central autonomic network involved is the medial prefrontal cortex which serves to integrate central and autonomic functions.

Friedman (2007) summarizes that anxiety is conceptualized as a systemic inflexibility, a failure of inhibition at multiple response levels. This inflexibility causes an individual's incapacity to inhibit the evolutionarily determined response pattern of fear, indicated by the restricted response range across biological and behavioral realms of functioning, e.g. diminished HRV.

1.6.5 Homeostatic versus allostatic regulation

The *homeostatic regulation* view emphasizes the variability of physiological procedures necessary for an organism to adapt and to be stable (Birbaumer, 1973). The basis for homeostasis may be two-fold: (1) The historical concept of autonomic balance (Wenger, 1966), (2) The regulatory capacity model referring to the overall autonomic flexibility as a marker of the capacity for regulation.

Allostatis is based on the idea that stability is achieved through change (McEwen & Wingfield, 2003). Berntson, Norman, Hawkley, and Cacioppo (2008b) underline the importance of allostatic or allodynamic organization. Alterations in dimensions like blood pressure, heart rate, or myocardial contractility permit an adaptive cardiovascular response to perturbations.

1.7 Model of autonomic space by Berntson

1.7.1 The traditional concept of ANS regulation

Traditionally, reciprocal functioning of the sympathetic and parasympathetic branch of the ANS has been assumed, i.e. increased activity of one branch being associated with decreased activity of the other (Cannon, 1939). Eppinger and Hess (1915, cited in Porges, 2007) assumed that a balance of sympathetic and parasympathetic activity represents health, or that a predominance of one or the other may cause certain psychosomatic disorders. The historical concept of autonomic balance (Wenger, 1966) describes autonomic states along a bipolar continuum from sympathetic to parasympathetic dominance. An index of the LF/HF balance score which represents a metric measure for the balance of sympathetic and parasympathetic activity based on cardiovascular activity (see chapter 1.4.3) was introduced by Pagani et al. (1986) and Malliani et al. (1991).

1.7.2 Criticism on the traditional autonomic balance control

Eckberg (1997) criticized the approach of Malliani et al. (1991) and Pagani et al. (1986) on capturing the sympathovagal balance by a simple number, the ratio of LF/HF. This approach pretends that LF is mainly sympathetically mediated and that HF represents mainly vagal-cardiac nerve activity. Moreover, changes in physiology result in reciprocal changes of sympathetic and vagal neural outflows indicated by the ratio of these periodicities, which was supposed to reflect the balance between the opposing neural mechanisms. LF is known to have its origin in both, sympathetic and vagal influence on the heart (Akselrod et al., 1985; Pomeranz et al., 1985). The concept was further criticized because of its simple mathematical approach of building a ratio between low frequency and high frequency spectral power, thus presuming that the two branches always act antagonistically. In the majority of literature the LF/HF ratio is interpreted as indicating the level of absolute autonomic nerve traffic instead of interpreting the fluctuations that spectral power reflects. The LF/HF ratio pretends that sympathetic and parasympathetic branches are reciprocally controlled, neglecting coactivation or independent activation of both branches (Koizumi & Kollai, 1992). The interpretive caveats of the LF/HF ratio were emphasized by Berntson et al. (1997), too, defeating LF/HF ratio as specific index of sympathetic cardiac control or sympathovagal balance, unless a broad range of conditions is explicitly validated.

Berntson, Cacioppo, and Quigley (1993b) criticized that a one-dimensional design represents the effector's state of an organ insufficiently. “Simple measures of end-organ state may not provide an accurate reflection of the underlying autonomic response”. Moreover, it is necessary to depict the behavioral-physiological context as well. The central control of autonomic function in anxiety is very complex and therefore the historical view regarding the global construct of hyperactivity of the sympathetic branch is not differentiated enough (Berntson et al., 1998). It is insufficient to depict autonomic control as a single, reciprocal autonomic continuum extending from sympathetic dominance at one end to parasympathetic dominance at the other (Berntson et al., 1998). HR, e.g., is influenced by both sympathetic and parasympathetic inputs, and it is not sure what process underlies measured HR. It could be that the concurrent changes of sympathetic and parasympathetic innervations compensate each other with the result that HR remains unchanged. On the other hand, an accelerated HR may be the result either of sympathetic activation, parasympathetic withdrawal, or both (Berntson et al., 1993b). These different underlying relations must not be ignored, in order to come to differentiated psychophysiological inferences of the measures taken.

Reference was made to the studies of Obrist, Wood, and Perez-Reye (1965), as well as to Iwata and LeDoux (1988). The studies of Obrist et al. (1965) and Iwata and LeDoux (1988) built the basis for the elaborations of Berntson, Cacioppo, and Quigley (1991). They were the first to provide examples of coactivation or independent activation, and their studies demonstrated that the underpinning determinants are relevant for interpretation of the autonomic activity. The studies showed that the antagonistic autonomic balance model had to be revised. Already Levy and Zieske (1969) depicted the functional state of a target organ, derived from direct neural stimulation, along a third dimension. The depicted surface was taken on by Berntson et al. (1993b) due to the convenient graphic method to represent the modes of autonomic control.

1.7.3 Description of the model by Berntson

The measures in a number of psychophysiological studies cannot show the underlying autonomic adjustments that cause visceral responses. Berntson et al. (1991) concluded that these measures are ambiguous and claimed that there is more to the autonomic system than just reciprocal activation. The out-dated concept of a reciprocal central control of the sympathetic and parasympathetic branches was replaced by the concept that the two autonomic branches can vary reciprocally, coactively, or independently (Berntson et al., 1991, 1993b, 1994). The traditional doctrine of autonomic reciprocity has been expanded within the model of *autonomic space* providing a complex framework, "whose elements include principles of autonomic organization and control that are consistent with a two-dimensional autonomic space" (Berntson et al., 1991, p. 459).

Berntson et al. (1991) urged that dually innervated organs are better depicted by a bivariate autonomic plane, which includes axes normal to each other (see Figure 5). The model of *autonomic space* clarifies the fact that psychophysiological relations might have different origins, while the traditional approach, with just reciprocal interdependence, may obscure the interpretation (Berntson et al., 1993b). Berntson et al. (1998) gave a framework of relations between anxiety and autonomic functions and emphasized that distinct contexts evoke diverse modes of autonomic response. Environment and context can evoke a variety of autonomic modes of response including sympathetic and parasympathetic coactivation, reciprocity, or independent changes of the autonomic branches. As a result a combination of increased, decreased, or unaltered activity in the sympathetic or parasympathetic division of the ANS is found (Berntson et al., 1994).

The bivariate model shows that a given measure can result from a variety of combinations of sympathetic and parasympathetic activities. Therefore the autonomic origin of an end-organ innervation is ambiguous. Multiple combinations of sympathetic and parasympathetic activities yield equivalent effects, e.g. on the choronotropic state of the heart. This is why coming to an interpretation is an intricate and complex process. The model of autonomic space (Figure 5) is supposed to capture this overall complexity (Berntson et al., 1991).

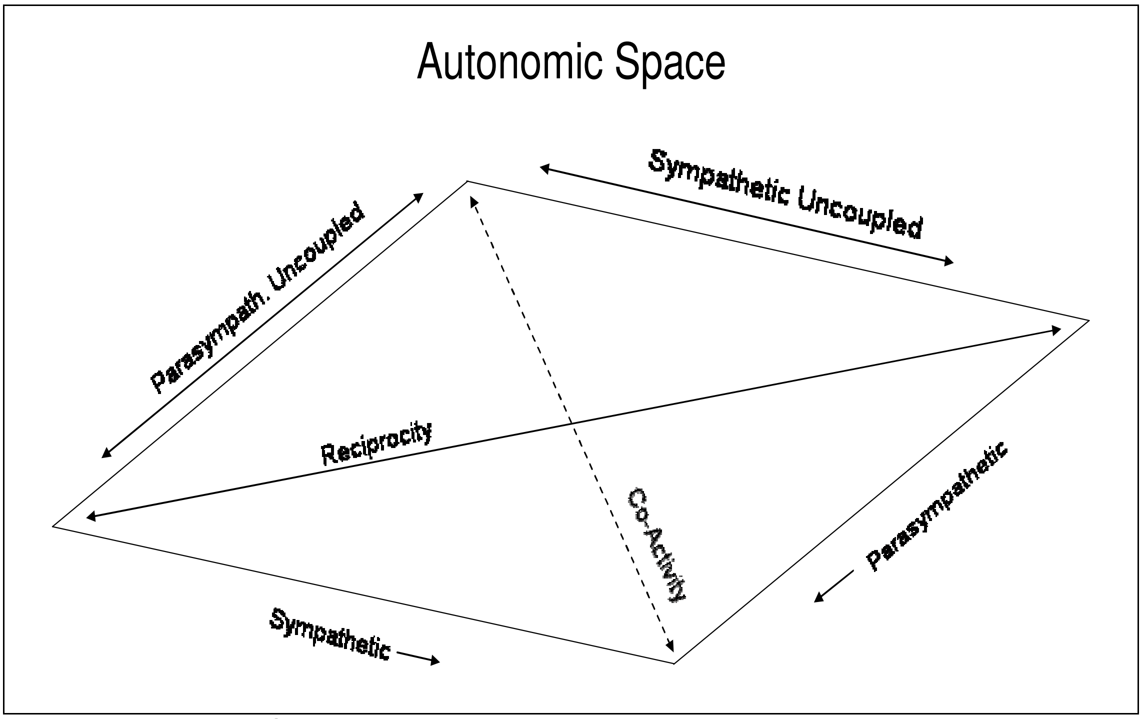


Figure 5. Autonomic Space (after Berntson et al., 1991, p. 469). This figure is described as "Two-dimensional model of autonomic space. (Axes represent the level of activity in sympathetic and parasympathetic innervations). The solid arrow extending from the left to the right axis intersections depicts the diagonal of reciprocity. The dotted arrow extending from the back to the front axis intersections represents the diagonal of coactivity. The arrows alongside the axes depict uncoupled changes in the single autonomic nervous system divisions. These arrows, and vectors parallel to them, illustrate the major modes of autonomic control."

The terms used in Table 1 for the description of the model of autonomic space by Berntson et al. (1991) are as follows. *Coupled modes* means activation of the autonomic branches interdependently from each other. Coupled activation can be *reciprocal* activation, or negatively correlated, resulting in *reciprocal sympathetic activation* or *reciprocal parasympathetic activation*. Increasing activity of one branch in association with decreasing activity of the other branch is called reciprocal. On the other hand, *coupled* activation could be *non-reciprocal activation*, or positively correlated. The effect of which results in *coactivation* or *coinhibition*. *Coactivation* is concurrent activation of sympathetic and parasympathetic control, while *coinhibition* is concurrent inhibition of sympathetic and parasympathetic control. *Uncoupled modes* are selective distinct changes in parasympathetic and sympathetic activity, resulting either in *activation* or in *withdrawal*. Uncoupled activation and uncoupled withdrawal can either be caused by sympathetic or parasympathetic activity.

Table 1. Modes of Autonomic Control adapted after Berntson (1991 et al., p. 461)

		Parasympathetic response		
		Increase	**No change**	**Decrease**
Sympathetic response	**Increase**	Coupled non-reciprocal **coactivation**	Uncoupled **sympathetic activation**	Coupled reciprocal **sympathetic activation**
	No change	Uncoupled **parasympathetic activation**	**Baseline**	Uncoupled **parasympathetic withdrawal**
	Decrease	Coupled reciprocal **parasympathetic activation**	Uncoupled **sympathetic withdrawal**	Coupled non-reciprocal **coinhibition**

Note:
Baseline (grey) | Coupled modes (yellow) | Uncoupled modes (pink)

The model (see Table 1) depicts eight major modes of autonomic control, four modes are *coupled,* the autonomic branches of which vary in a correlated fashion. These four modes correspond to the four quadrants of the bivariate sympathetic-parasympathetic autonomic plane (as shown in Figure 5). Two coupled modes refer to autonomic response modes with negatively correlated branches (*reciprocal sympathetic activation* and *reciprocal parasympathetic activation*, yellow fields). The other two coupled modes refer to autonomic response modes with positively correlated branches (*coactivation* and *coinhibition*, yellow fields). Four modes are uncoupled (pink fields), the autonomic branches of which vary independent from each other. The effect can be activation or withdrawal, either of the parasympathetic branch or of the sympathetic branch (Berntson et al., 1991). The field baseline applies when both sympathetic and parasympathetic modifications remain unchanged (grey field).

Below there are examples for the different categories of autonomic control mentioned by Berntson et al. (1991).

Coupled reciprocal mode: The baroreflex control of heart circulation represents a typical coupled reciprocal functioning (Koizumi, Terui, & Kollai, 1983).

Coupled non-reciprocal mode: Coactivation or coinhibition can occur when two different organs are involved in the sympathetic and parasympathetic activation. During a strong fear reaction in accordance to Cannon (1939) the sympathetic arousal would increase the heart rate and, simultaneously, increase the parasympathetic activation in the bladder, resulting in emptying the bladder. In this case two organs are concurrently activated. The concurrent activation of one organ by the sympathetic and parasympathetic branch is another form of a coupled nonreciprocal mode. Evidence for this was given in animal studies where stress evoked coactivity of both sympathetic and vagal activity over the same target organ, e.g. pancreatic secretions (Gellhorn, Cortell, & Feldman, 1941).

Uncoupled mode: Pupillary light and accommodation reflexes are mentioned to be mediated by variations in parasympathetic control only, which is considered as uncoupled parasympathetic activation (Berntson et al., 1991). The change of heart rate response during a reaction time was found to be an uncoupled sympathetic activation when activated by sympathetic input only (Pollak & Obrist, 1988).

1.7.3.1 Principles of the model of autonomic space

For the model of autonomic space three formal principles are nominated by Berntson et al. (1991):

> (1) The principle of dual innervation is subsumed under innervation, that means that visceral organs may be innervated one by one or by the sympathetic as well as the parasympathetic branch.

(2) The principal of functional antagonism of sympathetic and parasympathetic activity will be replaced by a conjoint action, therefore both antagonism and synergism of the branches can be found.

(3) The principal of reciprocal control is replaced by multiple modes, that means that the control over sympathetic and parasympathetic innervation may be reciprocal, nonreciprocal, or uncoupled.

In addition to these principles, there are some regularities concluded from the model of autonomic space (Berntson et al., 1991):

(1) Directional stability: as soon as the reciprocal mode is given, it is irrelevant whether parasympathetic or sympathetic activation changes; the direction of change remains the same.

(2) For nonreciprocal modes, i.e. coactivation and coinhibiton, the direction of change is extremely variable. It could also be that there is no change of direction at all, when changes of sympathetic and parasympathetic activation equal each other.

(3) For uncoupled modes the direction of change is unidirectional, as is the case with reciprocal modes.

1.7.3.2 Practicability of the model of autonomic space

According to Cacioppo and Berntson (1992) the behavioral context can evoke a wide range of autonomic response modes. Different modes of autonomic control in dependence of the kind of stress were shown by Berntson, Cacioppo, and Fieldstone (1996). The autonomic response was determined with the following non-invasive indices: sympathetic activity by pre-ejection period (PEP) of heart period and parasympathetic activity by RSA. In addition, pharmacological blockades were done, to find out the individual’s intrinsic heart period. Berntson et al. (1996) showed that tasks with minimal cognitive demand (visual illusion) evoked vagal dominance in the absence of sympathetic reactivity, though considerable attentional stimuli were evoked through that task. In comparison to a mental arithmetic task which was supposed to be cognitive demanding the latter task showed a reciprocal pattern, sympathetic activation and vagal withdrawal. Neither PEP nor RSA responses were correlated across the illusion and arithmetic tasks. Thus, the bivariate model of Berntson et al. (1991) allows an accurate mapping between psychological processes and autonomic responding. Only through the wider range of autonomic modes including uncoupled modes, besides bipolar modes, the autonomic patterns dependent on the specific task become apparent.

In the study of Berntson et al. (1994) the reactive autonomic control of the heart was compared in individuals who were exposed to an orthostatic stress and confronted with stress tasks like speech stress, mental arithmetic, and a reaction time task. Sympathetic and parasympathetic innervation was determined by pharmacological blockades. On the group effect the orthostatic and psychological stressors reflected a similar pattern, i.e. sympathetic activation and parasympathetic withdrawal. But during psychological stress, individual's differences within the patterns of autonomic response were remarkably different. The individual's different response patterns were consistent across the stress situations. Only the sensitivity of the model of autonomic space combined with the calculations of the blockade data made the sensitive distinction between stressors and individual's autonomic response patterns possible.

The animal study of Iwata and LeDoux (1988) showed that psychological variables - the different learning history of fear - have an impact on the autonomic reaction. When only considering the HR measures no difference in learning history was apparent. Berntson et al. (1993b) showed through pharmacological selective blockade the underlying mechanism that led to the same HR in conditioned and pseudoconditioned animals. Pseudoconditioning stands for nonassociative learning, when the aversive stimulus is unsystematically paired with the conditioned stimulus, without involving the central networks of the brain. Only specific pharmacological blockades with *propanolol* and *atropine* indicated that the pseudoconditioning was initiated through a selective sympathetic activation. The classical conditioning, however, was initiated by sympathetic and parasympathetic coactivation. The method of conditioning permitted a differentiation of groups. Conditioned aversive stimuli evoked the mode *uncoupled coactivity.* That might be of importance for the explanation of different tachycardiac, brachycardiac or biphasic autonomic responses (Berntson et al., 1993b). Only the model of autonomic space showed the relation between different psychological variables and the depending autonomic pattern.

1.8 Research hypotheses

The following hypotheses are formed:

Hypothesis 1

Behavioral, physiological, and psychological stress reaction will change during the fear of flying seminar (Beckham et al., 1990; Ekeberg et al., 1990, Haug et al., 1987; Kraaij et al., 2003; Krinj et al., 2007; van Gerwen et al., 2006; Wilhelm & Roth, 1998). This hypothesis can be endorsed in detail:

- Participants of the fear of flying seminar change their avoidance behavior and will take part in the real flights despite their fear of flying.

- Context, situation, and physical environment during the seminar affect the physiological and psychological response patterns of individuals differently.

- Increased sympathetic activity accompanied by reduced parasympathetic cardiac activation is expected for people with fear of flying as described by Wilhelm and Roth (1998). HR during the flight serves as a valid indicator for anxiety during specific threatening situations, as described by Haug et al. (1987). Anxiety is accompanied by decreased range of heart rate variability (HRV) and reduced vagal tone (e.g. Friedman & Thayer, 1998b; Porges, 1995, 2007; Yeragani et al., 1998).

- Psychological ratings taken before and after the treatment seminar mirror the efficiency of the seminar.
- The salivary cortisol level is expected to be higher in individuals with fear of flying in a real flight situation compared to individuals who have no fear of flying in accordance to the findings referring to panic attacks in naturalistic settings (Bandelow et al., 2000).
- During the flights reduced oxygen saturation levels are observed in individuals, as also has been observed by Humphreys et al. (2005). There is a relation between reduced oxygen saturation level and the level of anxiety sensitivity according to Bogaerde and De Raedt (2007).

Hypothesis 2

The model of autonomic space as described by Berntson at al. (1991) gives additional information concerning the sympathetic and the parasympathetic autonomic activation related to fear of flying, considering multiple cardiac modes rather than reciprocal modes.

2 Material and methods

2.1 Design

The investigation followed a 2/3 × 55/24/14/6/2 quasi experimental design with the factors Group and Time on Task (as a repeated factor; varying by the number of levels according to the dependent variable to be analyzed). Two groups (low and high anxiety persons) were included in the entire recording period (including seminar days), and 3 groups (by adding a control group) for the real flights. Time on Task for physiological recordings were 55 time points for the whole physiological recording period and 24 time points for the real flight recordings. Time on Task for questionnaire data were 14 time points for the whole recording period and 6 time points for the real flight epoch, and 2 time points (pre vs. post seminar) for anxiety questionnaires.

2.2 Subjects

Twenty-four participants (15 female, 9 male) with ages ranging from 29 to 52 years from three Austrian Airlines' Fear of Flying Seminars agreed to participate voluntarily and unpaid in the study. Participants of the seminar were grouped into Moderate-Anxious and High-Anxious according to their score on the subscale *generalized flight anxiety* of the Flight Anxiety Situations (FAS) questionnaire (van Gerwen et al., 1999). This scale was chosen as group discriminator because according to van Gerwen et al. (1999) it reflects the extent to which flight anxiety is generalized or has become strongly conditioned. The scores of the scale range from *0 = no generalized anxiety* to *28 = extreme generalized anxiety.* The raw scores of the subjects of the present study ranged from 7 to 26 with an average score of 13.5 serving as group discriminator; 15 Moderate-Anxious persons and 9 High-Anxious persons formed the groups. The control group was formed by 9 office employees (4 female, 5 male, with ages ranging from 22 to 43 years) of Austrian Airlines on a flight in their leisure time. As can be seen in Table 2 all groups had different flying histories regarding the number of flights, extent of fear during the last flights, and interventions during the past. All participants were physically healthy and had not taken any psycho-pharmacological medication before the treatment seminar started or during the seminar. Demographic variables of subjects are shown in Table 2.

2.3 Feasibility check of study

In order to prove the feasibility of conducting the comprehensive research and collecting questioning data during fear of flying seminar without disturbing the intervention several pre-tests including flights were conducted. These pre-tests were the basis for the assessment of the procedure and were intended that the organizer and staff of the fear of flying seminar would get involved and familiar with the kind of research, including measuring instruments and including the technical understanding of the measuring.

Table 2. Demographic variables of participants of Fear of Flying Seminar and Control Subjects. Means (M) and standard deviations (SD) or frequencies (N) are given.

Variable	High-Anxious (N = 9)	Anxious (N = 15)	Controls (N = 9)
Age in years / Mean (SD)	36.9 (14.2)	43.2 (11)	32.4 (11.4)
Female (Yes/frequency)	5	10	4
Male (Yes/frequency)	4	5	5
Body Mass Index / Mean (SD)	23.9 (4.4)	24.9 (3.9)	22.9 (1.4)
Education (Yes/frequency)			
completed apprenticeship	5	5	0
secundary school graduation	0	6	8
university degree	4	4	1
Number of Taken Flights			
zero	0	3	0
1-5	1	4	0
5-10	2	2	0
10-100	5	3	1
> 100	1	3	8
Previous Interventions (Yes/frequency)			
psychotherapy	2	2	0
literature about flight anxiety	6	3	0
intake of medicine against anxiety	6	7	0
intake of alcohol	3	2	0
Fear during the last flight (Yes/frequency)			
not applicable	0	3	0
no fear	0	0	9
moderate fear	1	1	0
high fear	5	7	0
fear of death	3	4	0
Fear of Terrorism (Yes/frequency)			
none	1	2	5
moderate	3	6	4
medium	1	4	0
high	2	1	0
very high	0	2	0
fear of death	2	0	0

Table 3 – part 1. Five minute time epochs defined as markers and time schedules congruent with three different fear of flying seminars.

Day	Epoch	Marker	London	Amsterdam1	Amsterdam2
1	1	Begin 1st day 1 (onset rec. head quarter)	17:15	17:15	17:10
1	2	Begin 1st day 2 (after 5 minutes rec.)	17:20	17:20	17:15
1	3	Psychologist 1 (theoretical input part 2)	18:10	18:00	17:25
1	4	Psychologist 2 (theoretical input part 2)	18:40	18:10	18:20
1	5	Captain - aerodynamic explanations	18:55	19:10	20:20
1	6	End 1st day 1 (last 10 minutes)	20:15	20:15	20:35
1	7	End 1st day 2 (last 5 minutes)	20:20	20:20	20:40
2	8	Begin 2nd day 1 (onset recording)	10:00	10:00	10:00
2	9	Begin 2nd day 2 (after 5 minutes recording)	10:05	10:05	10:05
2	10	Simulator boarding	10:30	12:25	10:30
2	11	Seating in simulator	10:40	12:30	10:35
2	12	Take-off in simulator	11:00	12:35	11:20
2	13	Turbulence in simulator	11:20	12:40	11:50
2	14	Cruising - quietly in simulator	11:10	12:45	11:30
2	15	Relaxing - training in simulator	12:15	11:15	10:50
2	16	Descent - flight in simulator	11:45	12:50	12:10
2	17	Landing - session in simulator	11:50	12:55	12:15
2	18	Restaurant 1- lunch airport	13:45	13:20	13:20
2	19	Restaurant 2 - lunch airport	13:50	13:25	13:25
2	20	End 2nd day (last 5 minutes)	13:55	13:30	13:30
3	21	Begin 3rd day 1 (onset recording technical base)	10:00	10:00	10:00
3	22	Begin 3rd day 2 (after 5 minutes recording)	10:05	10:05	10:05
3	23	Hangar (technical base)	11:35	10:40	10:40
3	24	Airplane Visit (technical base)	11:40	11:30	11:40
3	25	Restaurant 1 - lunch airport	13:30	13:30	13:30
3	26	Restaurant 2 - lunch airport	13:35	13:35	13:35
3	27	Crew 1 - theory of crew	15:25	15:30	15:20
3	28	Crew 2	15:30	15:35	15:25
3	29	Briefing with captain	15:35	15:40	15:30
3	30	Lounge 1	16:40	16:45	16:35
3	31	Lounge 2	16:45	16:50	16:40
3	32	Boarding - flight out	17:00	17:00	17:00
3	33	Seating - flight out	17:20	17:20	17:10
3	34	Engines on - flight out	17:50	17:25	17:25
3	35	Take-off - flight out	18:05	17:35	17:40
3	36	Cruising 10 min - flight out	18:15	17:45	17:50
3	37	Cruising 20 min - flight out	18:25	17:55	18:00
3	38	Cruising 30 min - flight out	18:35	18:05	18:10
3	39	Descent - flight out	20:00	18:40	19:00
3	40	10 min to landing - flight out	20:20	18:50	19:05
3	41	5 min to landing - flight out	20:25	18:55	19:10
3	42	Landing - flight out	20:30	19:00	19:15
3	43	Duty Free 1 - before flight in	21:05	19:05	19:40
3	44	Duty Free 2 - before flight in	21:10	19:40	19:45
3	45	Boarding - flight in	21:20	19:45	20:00
3	46	Seating - flight in	21:35	19:55	20:05

Table 3 – part 2. Five minute time epochs defined as markers and time schedules congruent with three different fear of flying seminars.

Day	Epoch	Marker	London	Amsterdam1	Amsterdam2
3	47	Engines on - flight in	21:40	20:05	20:10
3	48	Take-off - flight in	21:55	20:30	20:20
3	49	Cruising 10 min - flight in	22:05	20:40	20:30
3	50	Cruising 20 min - flight in	22:15	20:50	20:40
3	51	Cruising 30 min - flight in	22:25	21:00	20:50
3	52	Descent - flight in	23:05	21:25	21:20
3	53	10 min to landing - flight in	23:20	21:40	21:25
3	54	5 min to landing - flight in	23:25	21:45	21:30
3	55	Landing - flight in	23:30	21:50	21:35

Note: The times refer to the beginning of each 5-minute epoch. London, Amsterdam1, Amsterdam2 stand for three different seminars according to their destination of the graduation flight.

2.4 Procedure and protocol of treatment seminar

Three seminars labeled “London”, Amsterdam1”, “Amsterdam2” – according to the destination of the included real flight at the end of the seminar - with a group size of up to 15 persons were taken into consideration. The main parts of the Austrian Airlines fear of flying seminar (http://www.aua.com/at/deu/About_Flight/medical/fear/, retrieved November, 2009) are described below. The seminars were offered by a team of Austrian Airlines captains, psychologists, flight attendants, and experienced trainers. Registration for the seminar was administrated by an employee of Austrian Airlines. At that time participants gave their written consent to participate in this study. The following questionnaires were filled-in at the time of registration: Flight Anxiety Situations (FAS) questionnaire (van Gerwen et al., 1999), Flight Anxiety Modality (FAM) questionnaire (van Gerwen et al., 1999), State-Trait Anxiety Inventory (STAI) (Spielberger, Gorsuch, & Luchene, 1970), Anxiety Questionnaire (AKV) referring to body sensations, anxiety cognitions, and avoidance (Ehlers, Margraf, & Chambless, 1993) which is the German version of the Body Sensations Questionnaire, Agoraphobic Cognitions Questionnaire and Mobility Inventory (Chambless et al., 1984).

The time course of the seminar is shown in Figure 6 and Table 3, demonstrating the main sessions during the three-day seminar, like units of theory input, simulator, and real flights. A detailed description of the specific epochs is given in chapter 2.6.1.

2.4.1 First day of seminar

Participants met at the Austrian Airlines head office, in Vienna, Austria. The session lasted approximately 3.5 hours and aimed at providing information about relevant psychological factors involved in fear and anxiety, to introduce models of panic and anxiety, to describe personal fear experiences in group atmosphere, and to give information about the aerodynamics of flying. Participants of this study had to arrive an hour in advance to get familiar with the physiological devices and the ECG recorder was attached. The experimenter, a clinical psychologist, collected the questionnaires. She explained (a) the handling of the pulse-oximeter, (b) the filling in of measured values of oxygen saturation and pulse in a form sheet, (c) the ratings of fear and mood during the proceeding seminar, and (d) how to check whether the electrodes were properly adjusted to ensure proper ECG recordings. At the end of the first seminar day electrodes were detached. Data readout and clearance of memory chip of the ECG recorder followed during the night. The experimenter noted the time schedule of the seminar and the specific epochs, time epochs 1 through 7 from Table 3 were selected for comparison.

2.4.2 Second day of seminar

Locations were the Airbus-simulator (a realistic model of an aircraft cabin) at the technical base station, the crew training centre, the restaurant, and air-traffic control, all at Schwechat Airport, Austria. The session lasted approximately seven hours. The aims were confrontation and familiarization with flight situations in a simulated flight, the learning of relaxation techniques, cognitive restructuring, training of coping skills, building confidence in aircraft-crew, and to show the security of air-traffic control management.

After preparing and attaching the measuring equipment the training sequence started in the flight simulator, where a flight attendant explained announcements and the safety system of the flight crew. Two flights were simulated including turbulences and instructions of cabin crew. A video-system monitored an environment during take-off and landing. Participants learned techniques to deal with their fear including relaxation techniques. Lunch was taken at the airport restaurant with panoramic view to the runway, the captain joined the group, and together with the trainer of the course apprehensions toward flying were outlined. In the afternoon a visit to the air-traffic control tower followed. Data readout was undertaken during night. Time epochs 8 through 20 from Table 3 were selected for comparison.

2.4.3 Third day of seminar

Locations were all around the airport, Schwechat, Austria, i.e. technical base, hangar, restaurant, crew-building, terminal, lounge, airplane, and duty free zone. This session lasted approximately 13 hours altogether and aimed at providing technical and aerodynamic information, the desensibilisation of fear, the training in a simulator, affirmation of safety in air-traffic, confidence in professionalism of staff concerned with air-travel business, *in-vivo* implementation of learned cognitive behavioral techniques, and revision of positive management of handling fear. After preparing and attaching measuring equipment, the training sequence started with a lecture held by an aircraft technician and a guided tour through the hangar of the airport followed by explaining an aircraft which was there for maintenance. First the technician responded to any questions and fears of participants, that was followed by sitting in the cockpit and the introduction of instruments, and trying out different seating sections. Psychological interventions were repeated and retrained. The seminar continued with having lunch in the panoramic restaurant together with the captain, the co-pilot, and the senior flight attendant of the imminent flight. Afterwards participants entered the crew building and had lectures about the job description and requirements of flight attendants and their professional training. After repeating relaxation techniques, participants entered the captain's briefing area where they were informed about several flight preparations. The group moved on to the departure area, checked in, passed the security-check with a

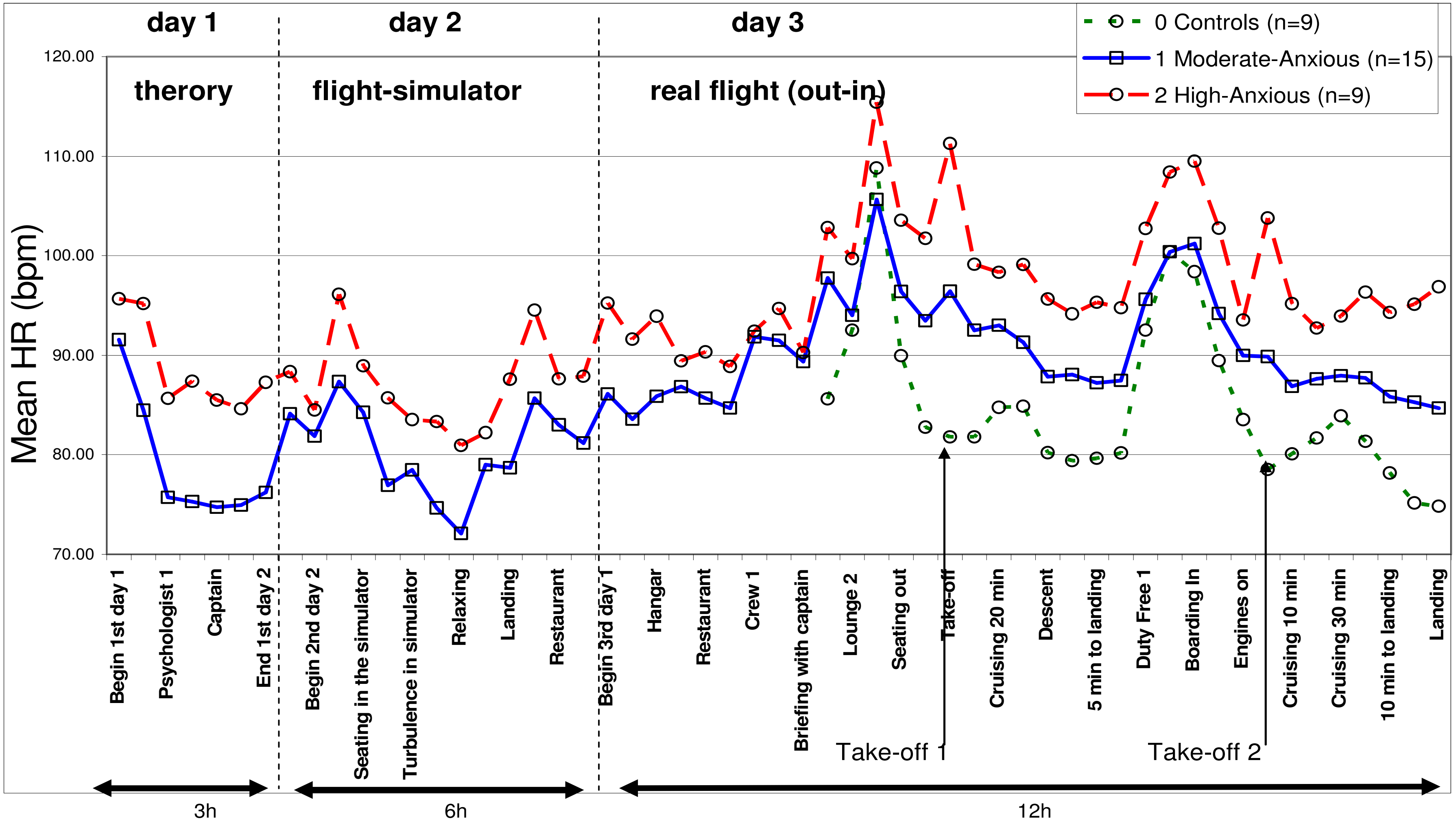


Figure 6. Time and daily schedule of the fear of flying seminar. Mean heart rate for different groups at the 55 measuring epochs of 5 minutes.

special security allowance for ECG-devices, and gathered in the lounge shortly before the flight. The selected time epochs were 21 to 31 from Table 3. At that time the control subjects joined the fear of flying seminar group and met with the experimenter (time epochs 30, 31), who fixed the ECG recording equipment. Seminar participants and controls followed the same further procedure of seminar, boarding an airbus A 320 for the commercial flight to Amsterdam or London depending on the respective Seminar (see Table 3). After arrival at the flight destination participants walked around in the duty free shopping area and re-boarded for the return trip to Vienna. After landing, certificates for the graduation flight were distributed and all recording devices and rating forms were collected. The participants were asked to rate their anxiety and fear of flying again on the next day and to return their ratings to the experimenter by mail. Finally the group was seen off. Time epochs related to the flight were 32 through 55 as described in Table 3.

2.5 Recordings and equipment

2.5.1 Electrocardiogram

Continuous ambulatory recordings of electrocardiogram (ECG; a holter ECG MK3 Scientific TOM Medical, Austria) with a total recording time of 26 hours (3 hours on the first seminar day, 6 hours on the second seminar day and 12 hours on the third seminar day) were conducted. Data of ECG recordings were recorded on a compact flash memory card (ScanDisk Inc.) in the portable ECG recorder and stored on a personal computer.

The skin was cleaned with alcohol, 3M one way Ag/AgCl electrodes were used for all recordings. Settings of TOM for data prefiltering before calculation of N to N intervals were from 300 ms to 2000 ms, interval decrease maximum 30%, increase maximum 30%, HR beats per minute minimum 30, maximum 200, respiration frequency recordings were set valid for 6 to 20 cycles per minute, window size was 5 min, digitalization and pre-processing of N to N intervals was done with a digitalization rate of 4 kHz.

2.5.2 Fingertip pulse oximeter

Peripheral oxygen saturation of arterial haemoglobin and pulse rate were measured by pulse-oximeter, Nonin Onyx Model 9500. The spot measurements of oxygen saturation (SpO_2) were taken through participants' fingers at 10 different time points, namely 1, 6, 8, 14, 21, 30, 36, 39, 49, 52 (see Table 3 and the chapter on data reduction for more details).

2.5.3 Salivary cortisol

Saliva samples of cortisol were collected with cotton swabs in tubes from two real flights out of Vienna during descent flight (epoch 39), and were collected at the same time of day in all flights considering circadian variations. Samples were refrigerated and concentration in ng/ml was analyzed at the laboratory of the Institute for Environmental Hygiene of the Medical University of Vienna.

2.5.4 Blood pressure

Arterial pressure was intended to be analyzed as well, but the pre-tests had shown that taking the measurements was too laborious in a natural environment and would disturb the ongoing seminar since participants would focus their attention to their measured values and would be distracted.

2.6 Data reduction

2.6.1 Definition of specific epochs

The 26 hours of continuous ECG recordings were reduced by defining relevant time epochs for the analysis. The seminar procedure was explored by preliminary investigations including the attendance of three seminars. The procedure was known, although the sequence of particular procedures could vary. Fifty-five time epochs of 5 minutes each were chosen in advance following a standard protocol, resulting in 7 epochs on the first day, 13 epochs on the second day during confrontation in the simulator, and 35 epochs on the third day. Mean values were computed for each of the 5-minute epochs corresponding to specific situations as presented in Table 3. Epochs 1, 2, 8, 9, 21, and 22 represent the individual onset-time of recording of each seminar day.

The description of the 55 epochs in detail: (1) first five minutes of recording on the first day, (2) second five minutes of recording on the first day, (3) theoretical input of psychologist, (4) second part of theoretical input of psychologist, (5) explanation by the captain, (6) 10 minutes before end of seminar to 5 minutes before end of seminar on the first day, (7) last five minutes of seminar on the first day, (8) first five minutes of recording on the second day, (9) second five minutes of recording on the second day, (10) approaching and boarding the flight simulator, (11) seating and buckling up in the simulator, (12) take-off in the simulator, (13) turbulence in simulator, (14) cruising quietly in simulator, (15) relaxation training in simulator, (16) descent flight in simulator, (17) landing in simulator, (18) first five-minutes sequence during lunch together with psychologist and the crew at the airport restaurant with view to the runway, (19) second five-minutes sequence during lunch together with psychologist and the crew at the airport restaurant with view to the runway, (20) last five minutes of seminar on the second day, (21) first five minutes of recording on the third day, (22) second five minutes of recording on the third day, (23) explanations by a technician at the aircraft hangar, (24) visit of an aircraft on ground, (25) first five-minute sequence during lunch with psychologist, captain, and crew at the airport restaurant (26) second five-minute sequence during lunch with psychologist, captain, and crew at the airport restaurant, (27) aerodynamic information of crew at the crew building, (28) information about training and job requirements of crew members at the crew building, (29) briefing by the captain by explaining preparations before the flight at the briefing hall, (30) first five minutes in the lounge before boarding, (31) second five minutes staying in the lounge before boarding, (32) boarding the aircraft for the flight out of Vienna, (33) seating and buckling up in the aircraft, (34) engines on, (35) take-off, (36) cruising 10 minutes after take off, (37) cruising 20 minutes after take off, (38) cruising 30 minutes after take off, (39) descent flight, (40) 10 minutes to landing, (41) 5 minutes to landing, (42) landing in Amsterdam or London, (43) first five-minute sequence when walking in the duty free shopping area, (44) second five-minute sequence of waiting in the duty-free shopping area before boarding, (45) boarding the aircraft for the flight to Vienna, (46) seating and buckling up in the aircraft, (47) engines on, (48) take-off, (49) cruising 10 minutes after take off, (50) cruising 20 minutes after take-off, (51) cruising 30 minutes after take-off, (52) descent flight, (53) 10 minutes to landing, (54) 5 minutes to landing, (55) landing in Vienna.

2.6.2 Analyzed parameters

ECG was analyzed from *lead 1* for assessment of time domain and frequency domain measures. Offline analyses were done with *Medilog SimpleView* software program. Spectral power was analyzed by the use of an autoregressive method (AR), detrended linear in accordance to suggestions by Task Force (1996). The statistical analysis of heart rate (HR) and heart rate variability (HRV) were done only for normal-to-normal (NN) beat intervals for five minutes epochs. Only blocks with 5 successive valid PQRST-appearances were included. Calculated parameters of time domain were SDNN (ms), RMSSD (ms), and pNN50 (%) as described in chapter 1.4.3. The frequency-based analysis of HRV included TP and spectral power of HF and LF in absolute units (ms^2) and in normalized units (HFnorm and LFnorm). The log transformed ratio of LF to HF power (log LF/HF) was considered as well. These HRV parameter values were exported into Microsoft Excel ® files and the 55 recording periods of question as presented in Table 3 filtered (see chapter 2.6.1). The Excel files of all patients were assembled in one file for statistical analysis.

2.7 Self-report questionnaires

To asses the changes in anxiety of seminar participants in connection with the fear of flying seminar the following ratings of fear and mood were assessed before and after the seminar.

2.7.1 Flight Anxiety Situations (FAS) questionnaire

The Flight Anxiety Situations (FAS) questionnaire (van Gerwen et al., 1999) is a 32-item self-report inventory assessing the degree of anxiety experienced in different flying-related situations on a five-point Likert scale, ranging from 1 = *no anxiety* to 5 = *overwhelming anxiety*, with the three subscales *anticipatory flight anxiety* referring to anticipatory anxiety up to just before the flight actually starts (Cronbach's Alpha = 0.96), *in-flight anxiety* referring to experienced anxiety during a flight (Cronbach's Alpha = 0.93) and *generalized flight anxiety* reflecting the extent to which anxiety is generalized (Cronbach's Alpha = 0.84).

2.7.2 Flight Anxiety Modality (FAM) questionnaire

The Flight Anxiety Modality (FAM) questionnaire (van Gerwen et al., 1999) is an 18-item self-report inventory assessing the symptoms by which flying-related anxiety is expressed on a five-point Likert scale ranging from 1 = *not at all* to 5 = *very intensively*, with the two subscales *somatic modality* consisting of 11 items that assess the extent to which anxiety is expressed in physical symptoms (Cronbach's Alpha = 0.91) and *cognitive modality* consisting of seven items dealing with cognitive aspects of flight anxiety (Cronbach's Alpha = 0.86).

2.7.3 State-Trait Anxiety Inventory (STAI)

The two scales *state-anxiety* and *trait-anxiety* were assessed by the 20-item State-Trait Anxiety Inventory (Spielberger et al., 1970) rating the tendency to experience apprehension, tension, nervousness, and worry on a scale from 1 *(almost never)* to 4 *(almost always).*

2.7.4 Anxiety questionnaire: body sensation, cognitions, and avoidance

The Anxiety Questionnaire (AKV) referring to body sensations, anxiety cognitions, and avoidance (Ehlers, Margraf, & Chambless, 1993) is the German version of the Body Sensations Questionnaire, Agoraphobic Cognitions Questionnaire and Mobility Inventory (Chambless et al., 1984).

The Body Sensations Questionnaire (BSQ) refers to the physical and physiological body responses and contains 17 items ranging from 1 *(not worried)* to 5 *(extremely)*.

The Agoraphobic Cognitions Questionnaire (ACQ) refers to the catastrophic thoughts about both the physical and social consequences of panic attacks and contains 14 items, ranging from 1 *(I never think this)* to 5 *(always).*

The Mobility Inventory (MI) refers to agoraphobic environments or situations and contains 27 items indicating avoidance behavior when being alone (MIA) and being accompanied (MIB) ranging from 1 *(never)* to 5 *(always).*

2.7.5 Anxiety and mood (Appendix 9.19)

Ratings concerning the subjective perception of the situation during the seminar were taken at 14 specific time epochs, namely 1, 6, 9, 11, 17, 22, 25, 28, 33, 36, 39, 46, 49, and 52, as can be seen in Table 3. The 12 items concerning anxiety and mood (1) "I feel colder than usual", (2) "My heart rate is faster", (3) "I have the need for more air", (4) "I have the need for more control", (5) "I am sweating more than normal", (6) "I feel happy", (7) "I feel sad", (8) "I am wrought up", (9) "I feel nervous", (10) "I feel relaxed", (11) "I feel self-confident", (12) "I feel general fear of flying" were rated on a seven point scale according to the extent of negative feeling (scale: 1 – 7) with the extremes "is not true", and "is 100% true" (see Annex 9.15). Principal component analysis by alternating least squares revealed 4 scales: *"Physiological sensation"* containing items 1, 2, 3, 5 with a Cronbach's Alpha of 0.82, "*Diffuse fear*" containing items 8, 9, 10 with a Cronbach's Alpha of 0.74, "*Cognitive fear*" containing items 4 and 12 with a Cronbach's Alpha of 0.77, and "*Unconfident/Joyless*" containing items 6 and 11 with a Cronbach's Alpha of 0.90.

2.8 Method of data analysis

Physiological measures related to the seminar were compared by a 2 × 55 ANOVA (Group) × (Epoch) with repeated measures on the second factor. Physiological parameters of real flights were compared by a 3 × 24 ANOVA (Group × Epoch), with epoch as a repeated factor. Appropriate degrees of freedom were epsilon corrected according to Greenhouse-Geißer (GG). Probability levels are cited for results close to or reaching significance (P=0.05), Statistica 6.0. software by StatSoft Incorporation was used for all analyses. Means and 95% confidence intervals are presented to describe the data.

3 Results

3.1 Physiological parameters of people with fear of flying

For the following physiological measures a two-way repeated measures Group (Moderate-Anxious vs. High-Anxious) × Epoch (see Table 3 for epochs 1-55) ANOVA was computed. A summary of the ANOVA results of cardiovascular parameters is shown in Table 4. The analyses of HFnorm and LFnorm refer to the underlying data of TP, VLF, HF(ms^2), LF (ms^2) which are shown in Annex 9.12 to 9.15 (Tables 24 to 27).

Table 4. Main effects and interactions of ANOVAs for HR and HRV measures for Epochs during the three days of fear of flight seminar x Group (High-Anxious vs. Moderate-Anxious)

Variable	Group		Epoch	Group x Epoch
	$F(1, 22)$	ε	$F(54, 1188)$	$F(54, 1188)$
Mean HR	2.41	0.148	22.58***	0.96
SDNN	2.47	0.187	11.32***	0.86
pNN50	0.29	0.110	4.48***	0.58
rMSSD	0.00	0.129	4.61***	0.70
LF norm	4.38*	0.247	3.69***	1.41
HF norm	0.13	0.192	2.01**	0.99
LF/HF	1.08	0.193	1.55	1.24

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

3.1.1 Mean heart rate

ANOVA of Mean HR indicated a significant main effect for Epoch $F(54, 1188)=22.58$, $p<0.001$, $\varepsilon=0.148$, neither the interaction Group × Epoch $F(54, 1188)=0.964$, $p=0.46$, $\varepsilon=0.148$ nor the main effect Group $F(1, 22)=2.41$, $p=0.134$ was significant. Means and confidence intervals are reported in Table 10 (Annex 9.1) and Figure 7. Results showed that mean HR was higher during the real flights on the third day than during the theoretical input on the first day or during the epochs in the flight simulator on the second day. Mean HR differed from 72 bpm in the simulator up to 106 bpm during boarding the real flight out of Vienna within the Moderate-Anxious group and from 81 up to 115 bpm within the High-Anxious group. HR was higher when subjects were moving around. Confidence Intervals revealed that High-Anxious showed a higher HR than Moderate-Anxious during the complete first day except for the beginning. High-Anxious had a higher HR than Moderate-Anxious for cruising and relaxing in the simulator and on the real flights, on the flight-out during boarding, engines on and take-off, on flight-in during take off, and during landing.

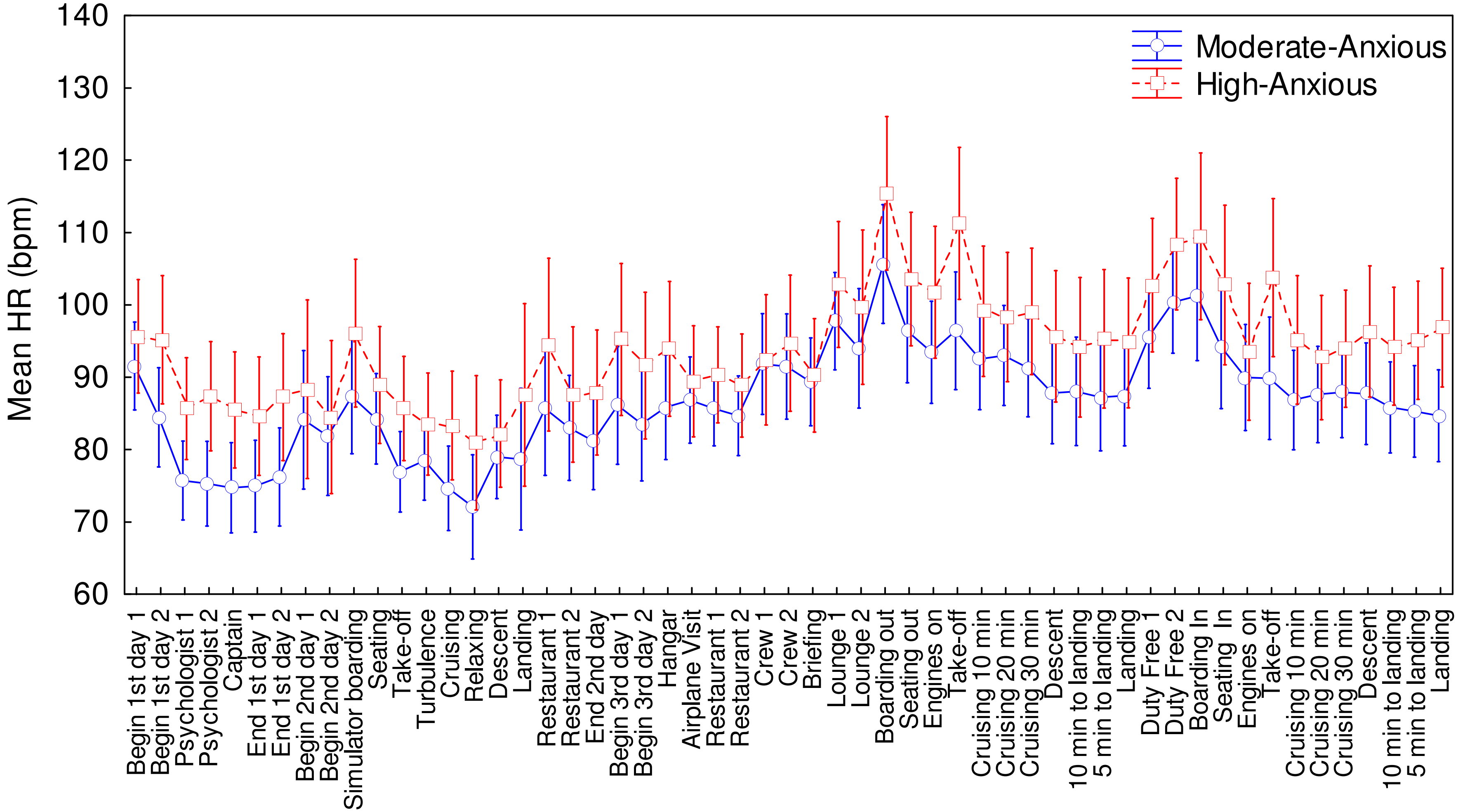


Figure 7. Mean heart rate (HR) of 55 time epochs of the three-day lasting fear of flying seminar for two groups of subjects with flight anxiety. Means +/- 95% confidence intervals

3.1.2 Heart rate variability

ANOVA of SDNN showed a significant main effect for Epoch $F(54, 1188)=11.321$, $p<.001$, $\varepsilon=0.187$. The main effect for Group was not significant $F(1, 22)=2.47$, $p=0.130$, neither was the interaction Group × Epoch $F(54, 1188)=0.861$, $p=0.753$, $\varepsilon=0.187$. For means and confidence intervals see Table 11 (Annex 9.2) and Figure 8. SDNN was higher for boarding and sitting in the simulator and for visiting the parked airplane in the hangar compared to the real flights: 82 ms (Moderate-Anxious), 94 ms (High-Anxious) compared to 40 ms (Moderate-Anxious) and 41 ms (High-Anxious) for boarding the flight-out. Confidence intervals revealed that High-Anxious showed a higher SDNN than Moderate-Anxious for epochs in the simulator during boarding, seating, take-off, and turbulence, and on the real flight-out during seating, cruising 20 min, landing, on the flight-in for the epoch engines on.

ANOVA of pNN50 showed a significant main effect for Epoch $F(54, 1188)=4.475$, $p<0.001$, $\varepsilon=0.110$, no significant effect for Group $F(1, 22)=0.287$, $p=0.598$, nor for interaction Group × Epoch $F(54, 1188)=0.581$, $p=0.742$, $\varepsilon=0.110$. PNN50 showed higher values in the simulator compared to the real flights. Moderate-Anxious and High-Anxious showed reduced pNN50 patterns during the whole time course of seminar and pNN50 was lowest before take-off for the real flights (0.04 for High-Anxious and 0.03 for Moderate-Anxious). For means and confidence intervals see Table 12 (Annex 9.3) and Figure 9.

ANOVA of RMMSD showed a significant main effect for Epoch $F(54, 1188)=4.608$, $p<0.001$, $\varepsilon=0.129$. No difference was found between Moderate-Anxious and High-Anxious $F(1, 22)<0.001$, $p=0.985$, $\varepsilon=0.129$ and no interaction was found between Group and Epoch $F(54, 1188)=0.702$, $p=0.670$. On the first day, mean RMMSD of Moderate-Anxious (maximum 32.46) and of High-Anxious (maximum 29.31) was lower than on the second day in the simulator (maximum 35.76 and 40.02 respectively). Shortly before the real flights and during the flight situations after take-off RMSSD was lower compared to the simulator. For means and confidence intervals see Table 13 (Annex 9.4) and Figure 10.

ANOVA of LFnorm showed a significant Group effect for Moderate-Anxious and High-Anxious $F(1, 22)=4.386$, $p=0.048$. The main effect Epoch was significant $F(54, 1188)=3.689$, $p<0.001$, $\varepsilon=0.251$, no interaction Group × Epoch was found $F(54, 1188)=1.414$, $p=0.15$, $\varepsilon=0.247$. The confidence intervals (see Table 14, Annex 9.5, and Figure 11) indicated higher LF power in High-Anxious than in Moderate-Anxious at the beginning, during the input of the captain, and at the end of the first seminar day. The seminar training in the simulator showed similar LFnorm for Moderate-Anxious and High-Anxious. Differences between High-Anxious and Moderate-Anxious were evident during the third day at the beginning, during visiting the hangar, and during the real flights. High-Anxious showed higher LF proportion than Moderate-Anxious on the flight-out during cruising and landing and almost continuously on the flight-in, except engines-on, descent, and shortly before landing.

ANOVA of HFnorm showed a significant effect for Epoch $F(54, 1188)=2.012$, $p=0.03$, $\varepsilon=0.192$, no main effect for Group $F(1, 22)=0{,}132$, $p=0.723$, and no interaction Group × Epoch $F(54, 1188)=0.995$, $p=0.44$, $\varepsilon=0.192$. The confidence intervals (see Table 15, Annex 9.6, and Figure 12) differed from 21 to 8 in High-Anxious and from 19 to 7 in Moderate-Anxious during the seminar. During take-off on the flight-in to Vienna Moderate-Anxious reached higher HFnorm than High-Anxious, as well as shortly before landing.

ANOVA of log LF/HF indicated a statistical trend (one-tailed $p=0.061$) effect for Epoch $F(54, 1188)=1.546$, $p=0.121$, $\varepsilon=0.193$. There was neither a significant group effect $F(1, 22)=1{,}077$, $p=0.311$ nor an interaction Group × Epoch $F(54, 1188)=1{,}239$, $p=0.265$, $\varepsilon=0.193$. The confidence intervals as shown in Table 16 (Annex 9.7) and Figure 13 indicated differences between Moderate-Anxious and High-Anxious as at the beginning of the seminar at the first day, at the second day in the simulator for landing and for the real flights in and out during cruising, and for the flight-in shortly before landing showing higher log LF/HF for High-Anxious compared to Moderate-Anxious.

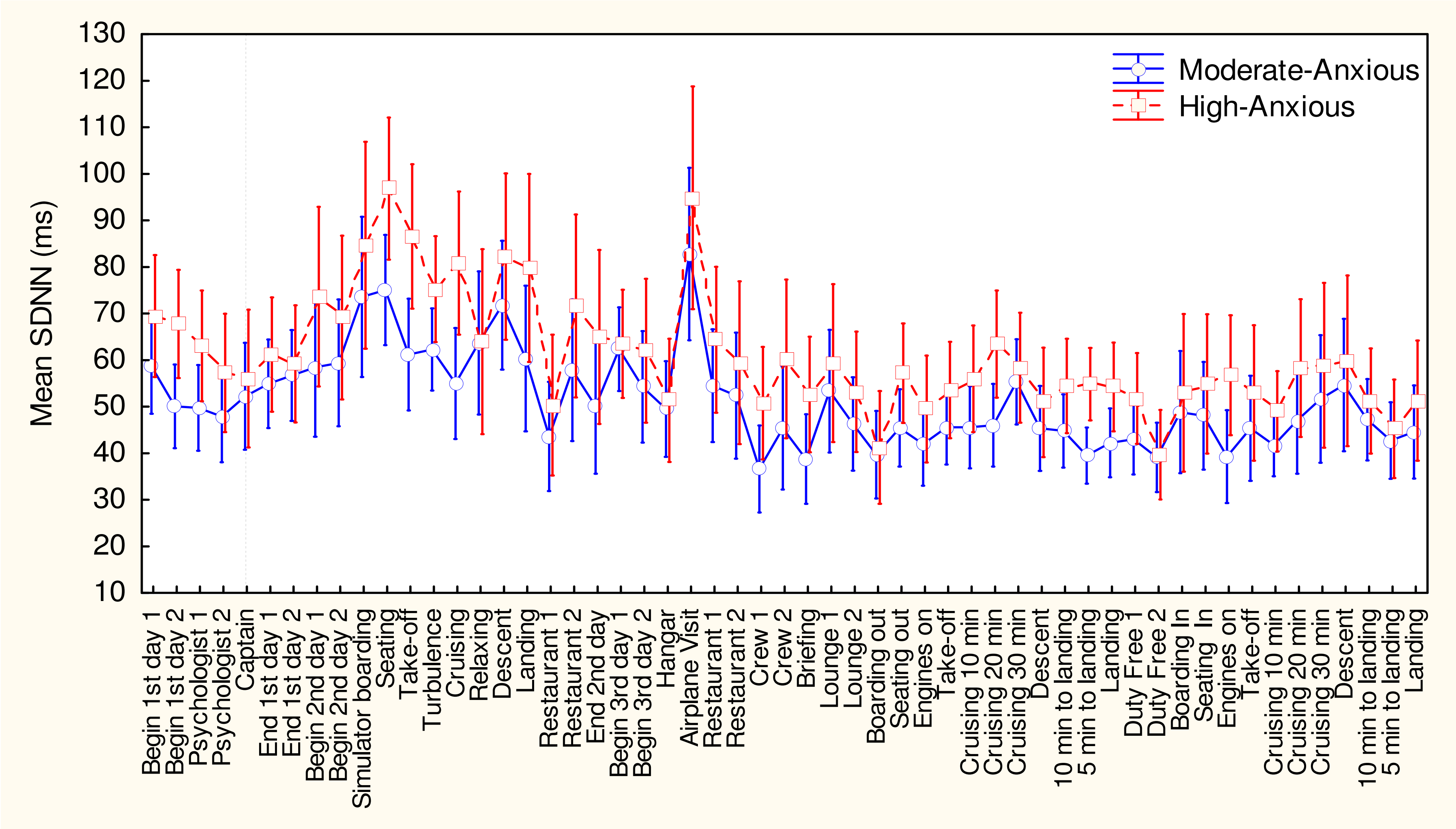


Figure 8. SDNN of 55 time epochs during a three-day seminar for Anxious Groups. Means +/-95% confidence intervals.

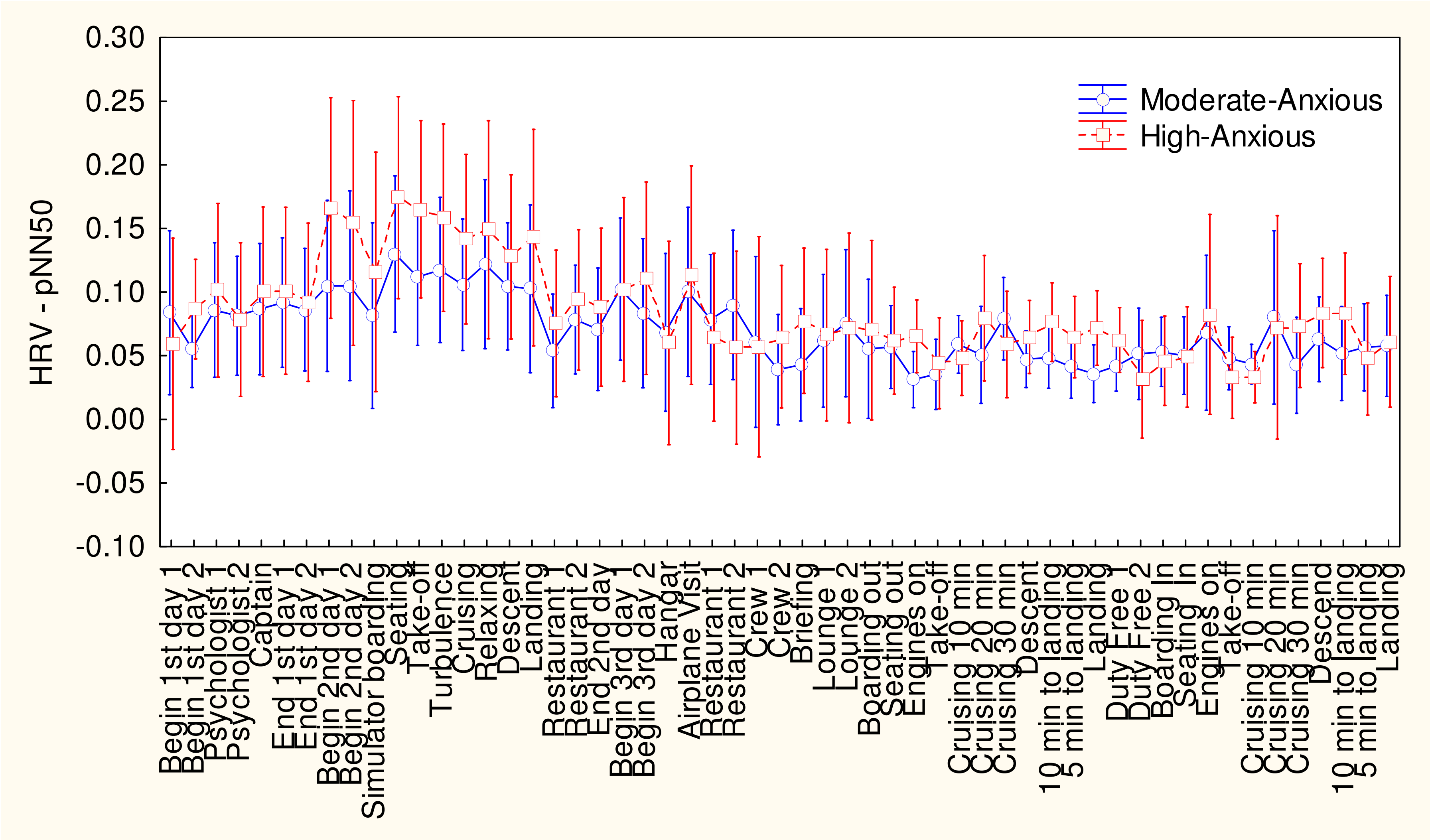


Figure 9. Mean pNN50 of 55 time epochs during three-day seminar for Anxious Groups. Means +/-95% confidence intervals.

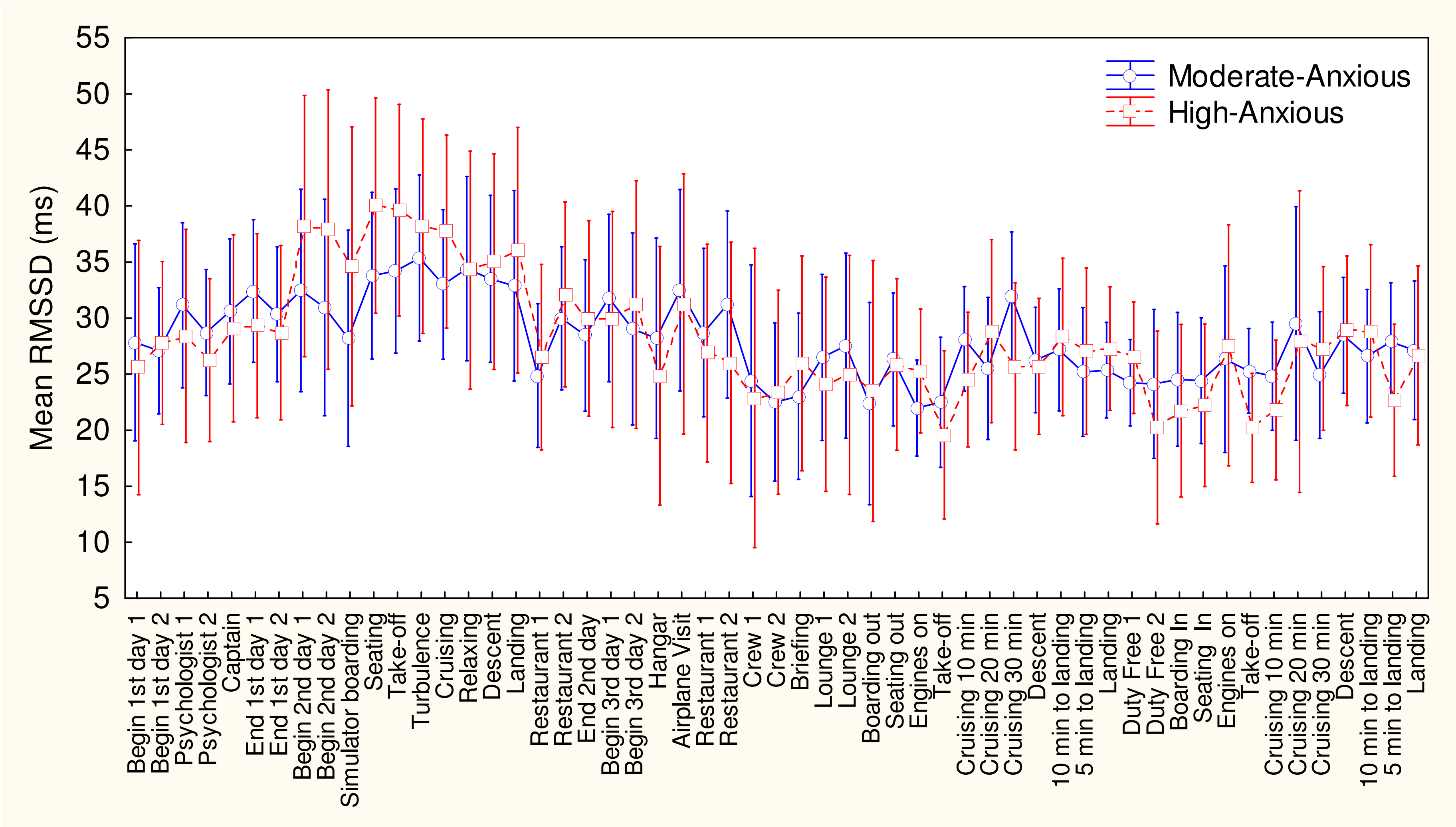


Figure 10. RMMSD of 55 time epochs during three-day seminar for Anxious Groups. Means +/- 95% confidence intervals.

Figure 11. HRV – LFnorm of power of 55 time epochs during three-day seminar for Anxious Groups. Means +/- 95% confidence intervals.

Figure 12. HFnorm of 55 time epochs during three-day seminar for Anxious Groups Means. +/- 95% confidence intervals.

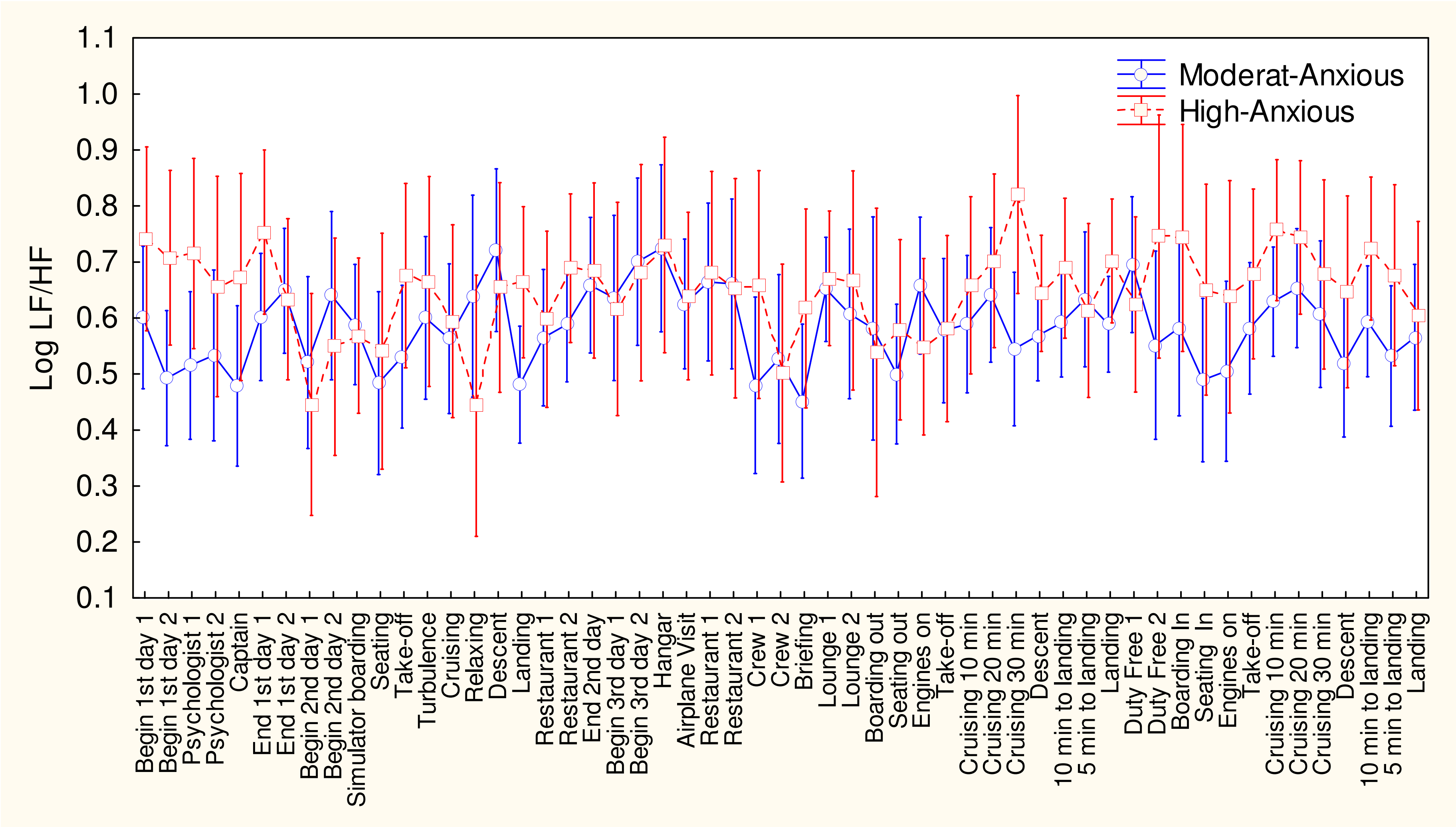


Figure 13. Log LF/HF of 55 time epochs during three-day seminar for Anxious Groups. Means +/- 95% confidence intervals.

3.1.3 Arterial oxygen saturation (SpO_2)

For SpO_2 a two-way Group (Moderate-Anxious vs. High-Anxious) × Epoch (1, 6, 8, 14, 21, 30, 36, 39, 49, 52 from Table 3) ANOVA with Epoch as a repeated factor was computed.

ANOVA showed a significant main effect for Epoch $F(9, 198)=12.70$, $p<0.001$, $\varepsilon=0.60$, no significant main effect for Group $F(1, 22)=0$, $p=0.98$ and no significant interaction for Group × Epoch $F(9, 198)=0.44$, $p<0.84$, $\varepsilon=0.60$. The means during the first and the second day were higher than those during the real flight situations on the third day, the values differed from 98.00 to 94.27, the confidence intervals are shown in Table 17 (Annex 9.8) and Figure 14.

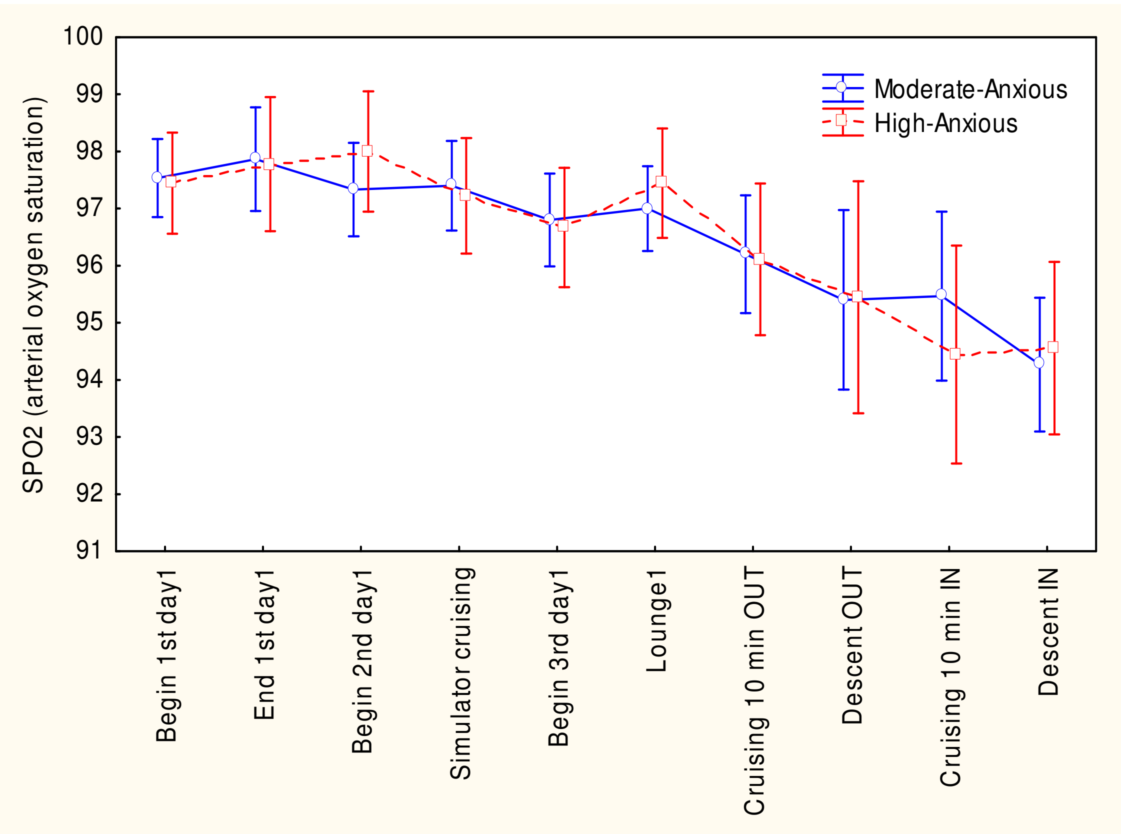


Figure 14. SpO_2 - arterial oxygen saturation of spot measurements during three-day seminar of Anxious Groups. Means +/- 95% confidence intervals.

3.2 Psychological ratings during 3-day seminar

For the scales of fear and mood a two-way ANOVA Group (Moderate-Anxious vs. High-Anxious) × Epoch (1, 6, 8, 14, 21, 30, 36, 39, 49, and 52 from Table 3) with Epoch as a repeated factor was computed.

ANOVA for *physiological sensation* ratings indicated no significant effect for Group $F(1, 22)=2.37$, $p=0.14$, Moderate-Anxious and High-Anxious rated similarly. The main effect Epoch showed significant results $F(13, 286)=9.05$, $p<0.001$, $\varepsilon=0.409$, showing the highest ratings in the simulator and during seating in the flight out of Vienna. The ratings decreased with the ongoing seminar. Group × Epoch was not significant $F(1, 22)=1.43$, $p=0.21$, $\varepsilon=0.409$, confidence intervals are shown in Table 18 (Annex 9.9) and Figure 15.

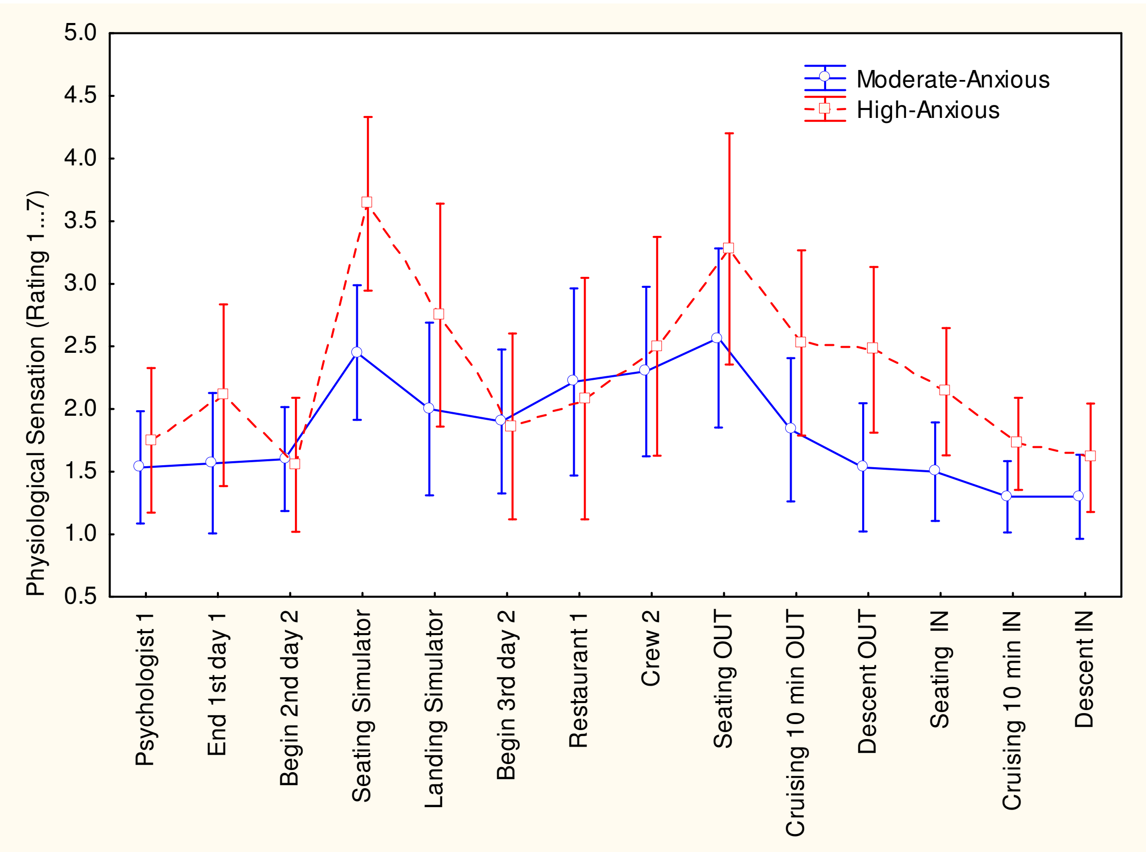


Figure 15. Ratings on Physiological Sensation by Epochs during three-day seminar of Anxious Groups, Means +/- 95% confidence intervals.

ANOVA for *diffuse fear* ratings indicated a statistical trend for Group $F(1, 22)=2.95$, $p=0.09$, High-Anxious rated higher than Moderate-Anxious during the input of the psychologist, during landing in the simulator, during taking the seat and cruising in the real flight-out. Diffuse fear was rated lower towards the end of the flight situations. The main effect epoch was significant $F(13, 286)=7.71$, $p<0.001$, $\varepsilon=0.462$ as diffuse fear is most present during confrontation in the simulator and during the flight out of Vienna. No interaction Group × Epoch $F(13, 286)=0.679$, $p=0.66$, $\varepsilon=0.462$, was found. Confidence intervals are shown in Table 19 (Annex 9.10) and Figure 16.

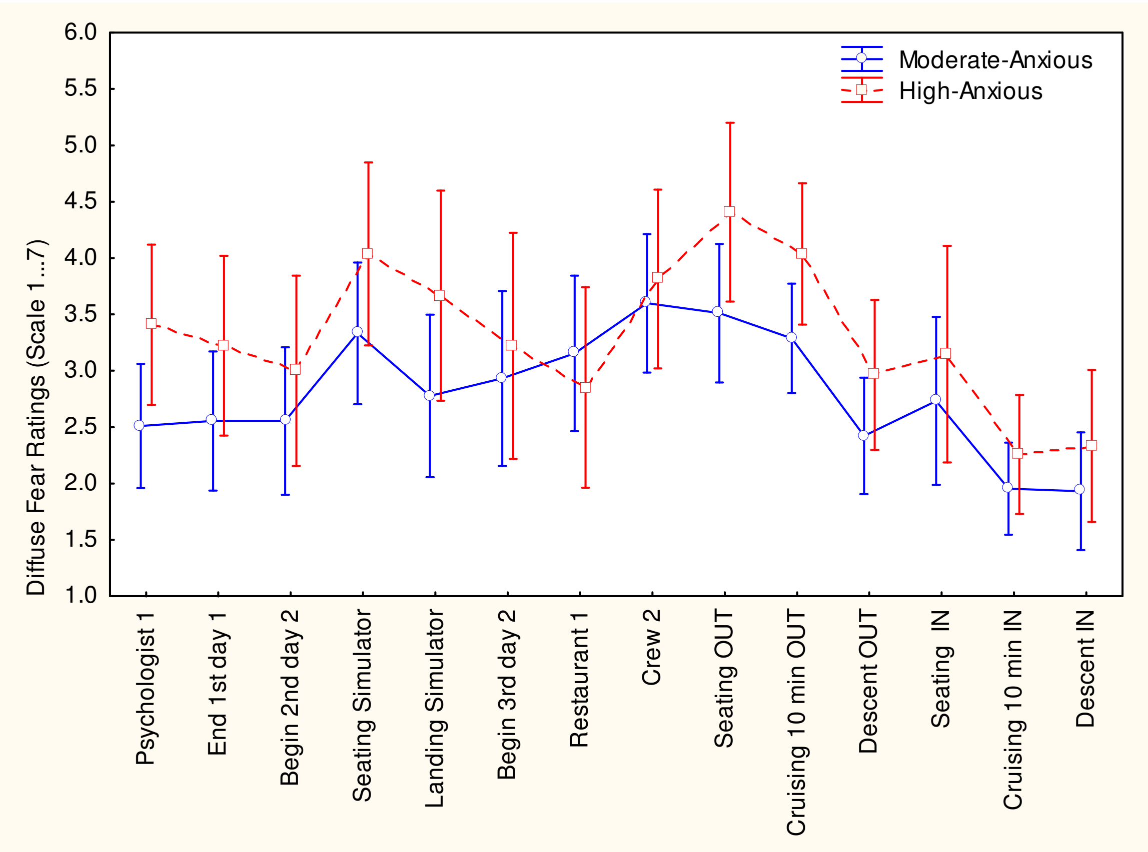


Figure 16. Ratings on Diffuse Fear by Epochs for three-day seminar for Anxious Groups. Means +/- 95% confidence intervals.

ANOVA for *cognitive fear* ratings indicated a trend effect for Group $F(1, 22)=3.82$, $p=0.06$, High-Anxious showed more cognitive fear than Moderate-Anxious, especially during the first day of seminar, partly in the simulator and in the flight-out of Vienna. The epochs showed significant effects $F(13, 286)=7.41$, $p<0.001$, $\varepsilon=0.395$, indicating that exposure to the simulator and the real flights created higher cognitive fear, but at the end of the flight situation both groups got habituated. No interaction Group × Epoch was found $F(13, 286)=1.11$,

p=0.35, ε=0.395. The means and confidence intervals are shown in Table 20 (Annex 9.11) and Figure 17.

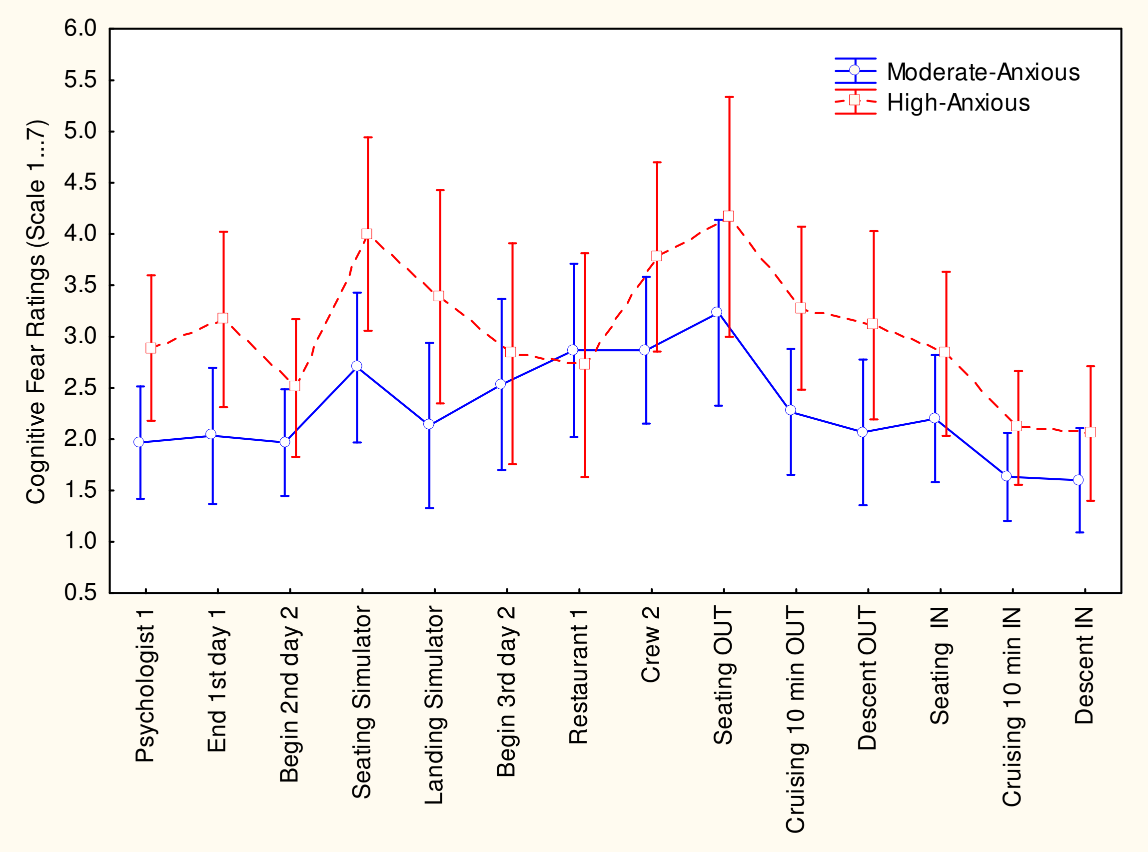


Figure 17. Ratings on Cognitive Fear by Epochs for three-day seminar for Anxious Groups. Means +/- 95% confidence intervals.

Unconfident/Joyless: ANOVA for ratings on feelings like unconfident and joyless indicated a significant main effect for Epoch $F(13, 286)=5.81$, $p<0.001$, ε=0.465. The main effect Group was not significant $F(1, 22)=0.11$, $p=0.74$. The ratings at the beginning of the seminar, during real flights-out were above those for real flights-in. Moderate-Anxious and High-Anxious had significantly lower ratings towards the end of the seminar, mean ratings varied from 4 to 2.5. No interaction between Moderate-Anxious and High-Anxious $F(13, 286)=0.788$, $p=0.582$, ε=0.465 was found. Means and confidence intervals are shown in Table 21 (Annex 9.12) and Figure 18.

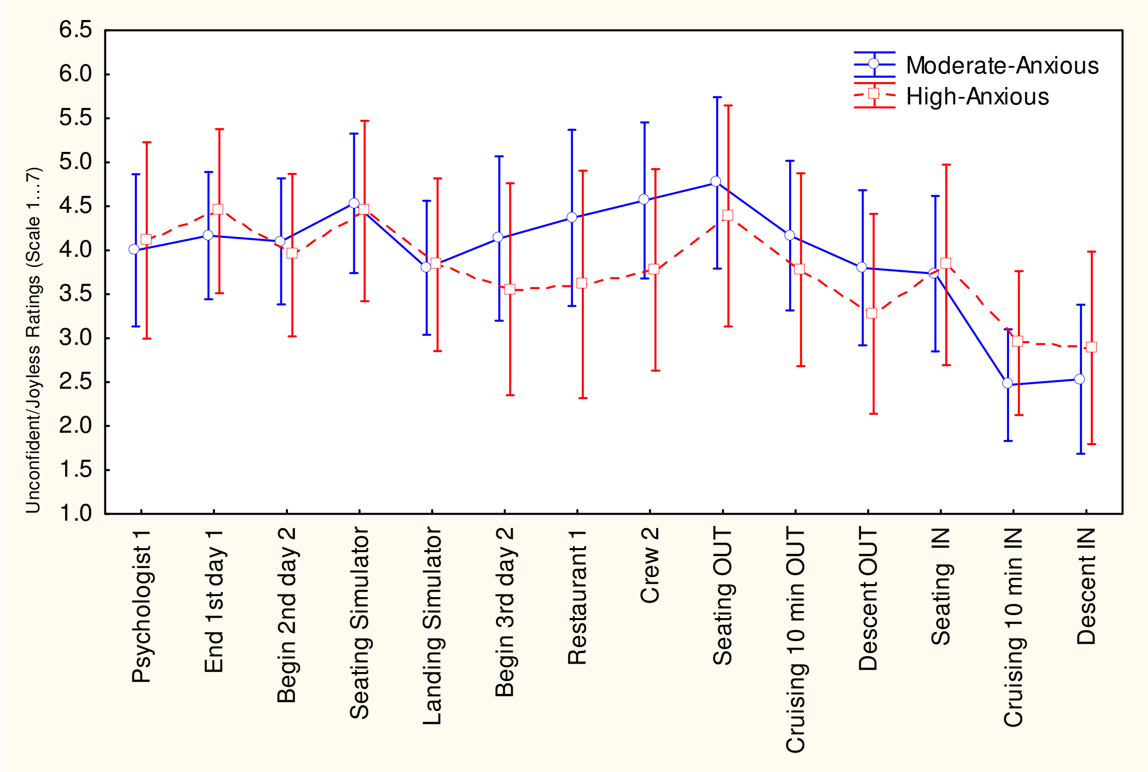


Figure 18. Ratings on Unconfident/Joyless by Epochs for three-day seminar for Anxious Groups. Means +/- 95% confidence intervals.

3.3 Anxiety before and after seminar

Analysis of anxiety of seminar participants was computed by a two-way ANOVA Group (Moderate-Anxious vs. High-Anxious) × Time (pre vs. post seminar; with Time as a repeated measure) on the subscales of anxiety questionnaires.

Table 5. Means (M) and standard deviations (SD) on self-report questionnaires of subjects with fear of flying, Moderate-Anxious and High-Anxious, pre and post seminar.

Variable	High-Anxious (N=9)				Moderate-Anxious (N=15)			
	pre		post		pre		post	
	M	SD	M	SD	M	SD	M	SD
FAS								
Anticipatory	63.49	12.18	14.88	16.70	44.06	23.33	12.50	14.25
In-flight	72.22	11.74	19.19	21.05	70.15	13.55	16.52	11.51
Generalized	43.25	13.30	10.32	12.56	11.68	8.02	4.52	6.54
Total	62.07	10.16	15.19	16.68	45.63	12.73	11.88	10.96
FAM								
Somatic	30.81	16.86	9.34	10.19	27.58	15.91	11.82	10.17
Cogntive	73.41	14.30	24.60	20.78	57.62	22.70	21.19	20.13
Number Panic	28.21	12.16	5.13	8.60	28.72	18.03	5.13	8.05
Panic Score	38.89	13.42	14.96	11.49	34.10	17.53	17.18	13.41
STAI	37.11	10.29	30.11	12.40	38.27	12.23	32.60	11.81
TAI	39.78	8.26	35.67	6.76	38.73	10.15	35.80	9.60
TAI PR	63.67	25.53	52.00	24.40	58.07	30.70	49.20	30.37
ACQ	1.50	0.36	1.19	0.20	1.66	0.48	1.36	0.35
BSQ	2.16	0.71	1.45	0.35	2.05	0.62	1.42	0.38
MIB	1.64	0.66	1.19	0.15	1.38	0.30	1.20	0.24
MIA	1.77	0.61	1.34	0.36	1.56	0.32	1.39	0.31

Note: Flight Anxiety Situations (FAS) questionnaire, Flight Anxiety Modality (FAM) questionnaire (van Gerwen et al., 1999); State Anxiety (STAI), Trait Anxiety (TAI) (Spielberger, Gorsuch, & Luchene, 1970); Agoraphobic Cognitions Questionnaire (ACQ), Body Sensations Questionnaire (BSQ), Mobility Inventory Accompanied (MIB); Mobility Inventory Alone (MIA) (Ehlers, Margraf, & Chambless, 1993)

3.3.1 Flight Anxiety Situations (FAS) questionnaire

ANOVA of FAS *in-flight anxiety* indicated a significant pre to post seminar effect $F(1, 22)=191.75$, $p<0.001$, but no group difference $F(1, 22)=0.258$, $p=0.61$ or interaction $F(1, 22)=0.006$, $p=0.938$. Means and SD are shown in Table 5 and Figure 19.

ANOVA of FAS *anticipatory flight anxiety* indicated a significant interaction effect Group × Time $F(1, 22)=4.81$, $p=0.039$, High-Anxious and Moderate-Anxious reduced their fear to an equal level. The main effect Time pre to post seminar was significant $F(1, 22)=106.47$, $p<0.001$. The result for Group was $F(1, 22)=2.901$, $p=0.103$. Means and SD are shown in Table 5 and Figure 19.

ANOVA of FAS g*eneralized flight anxiety* indicated a significant interaction effect Group × Time $F(1, 22)=33.02$, $p<0.001$, High-Anxious showed higher levels of general flight anxiety than Moderate-Anxious before the seminar, which was reduced to the level of Moderate-Anxious $F(1, 22)=29{,}50$, $p<0.001$ and pre to post seminar $F(1, 22)=79.824$, $p<0.001$. Means and SD are shown in Table 5 and Figure 19.

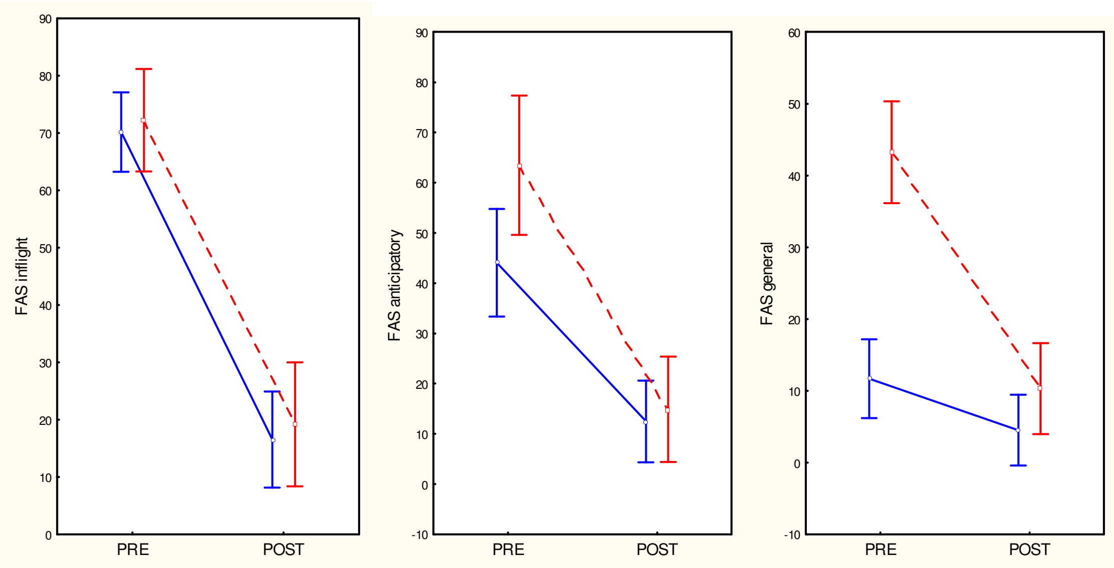


Figure 19. Changes pre to post seminar in association with fear of flying seminar rated by people with fear of flying, Moderate-Anxious (solid line) and High-Anxious (broken line), on three scales of the Flight Anxiety Situations (FAS) questionnaire, FAS in-flight (left figure), FAS anticipatory (middle figure) and FAS general (right figure).

3.3.2 Flight Anxiety Modality (FAM) questionnaire

ANOVA from FAM *somatic modality* of flight anxiety showed a significant main effect pre to post seminar $F(1, 22)=32.76$, $p<0.001$, Moderate-Anxious and High-Anxious showed comparable reductions from pre to post seminar. The results indicated neither a significant group difference $F(1, 22)=0.006$, $p=0.937$, nor an interaction effect *F*(1, 22)=0.77, *p*=0.39. Means and SD are shown in Table 5 and Figure 20.

ANOVA from FAM *Cognitive modality* of flight anxiety indicated significant pre to post effects for the ratings of fear *F*(1, 22)=82.31, *p*<0.001, no Group effect *F*(1, 22)=1.823, *p*=0,191, no interaction was found *F*(1, 22)=1.736, *p*=0.201. Moderate-Anxious and High-Anxious showed comparable reductions from pre to post seminar in the scales, means and SD are shown in Table 5 and Figure 20.

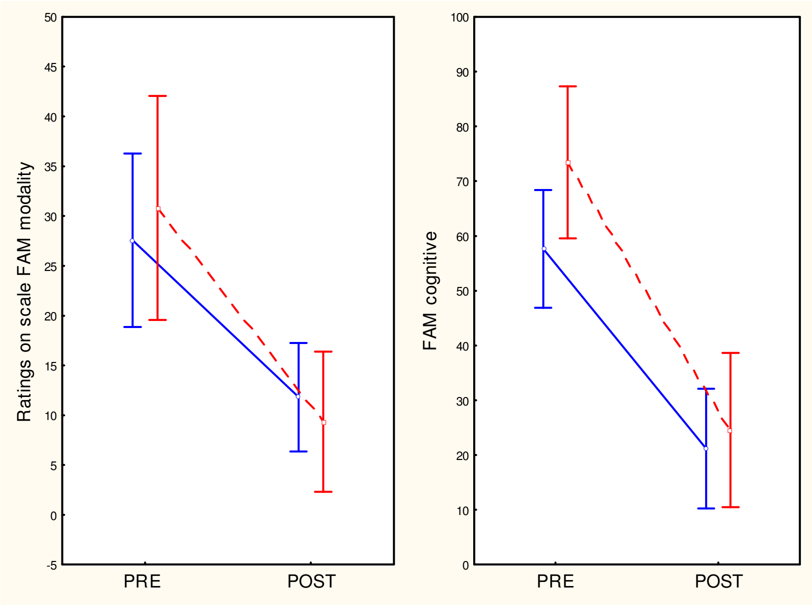


Figure 20. Changes pre to post seminar in association with fear of flying seminar rated by people with fear of flying, Moderate-Anxious (solid line) and High-Anxious (broken line), on the two scales of the Flight Anxiety Modality (FAM) questionnaire, FAM somatic modality (left figure) and FAM cognitive (right figure).

3.3.3 State–Trait Anxiety Inventory (STAI)

ANOVA from the ratings of STAI scale *state-anxiety* indicated a significant pre to post effect *F*(1, 22)=7.70, *p*=0.011. The Moderate-Anxious and High-Anxious showed comparable reductions from pre to post seminar in the scales, no group effects *F*(1, 22)=0.17, *p*=0.68 or interaction effects *F*(1, 22)=0.086, *p*=0.77 were found. Means and SD are shown in Table 5 and Figure 21.

ANOVA from the ratings of STAI scale *trait-anxiety* indicated a significant pre to post seminar effect $F(1, 22)=15.51$, $p<0.002$, no interaction effects were found for these measures $F(1, 22)=0.237$, $p=0.63$. The Moderate-Anxious and High-Anxious showed comparable reductions from pre to post seminar in the scales, no group effect was found $F(1, 22)=0.128$, $p=0.724$, see Table 5 and Figure 21 for Means and SD.

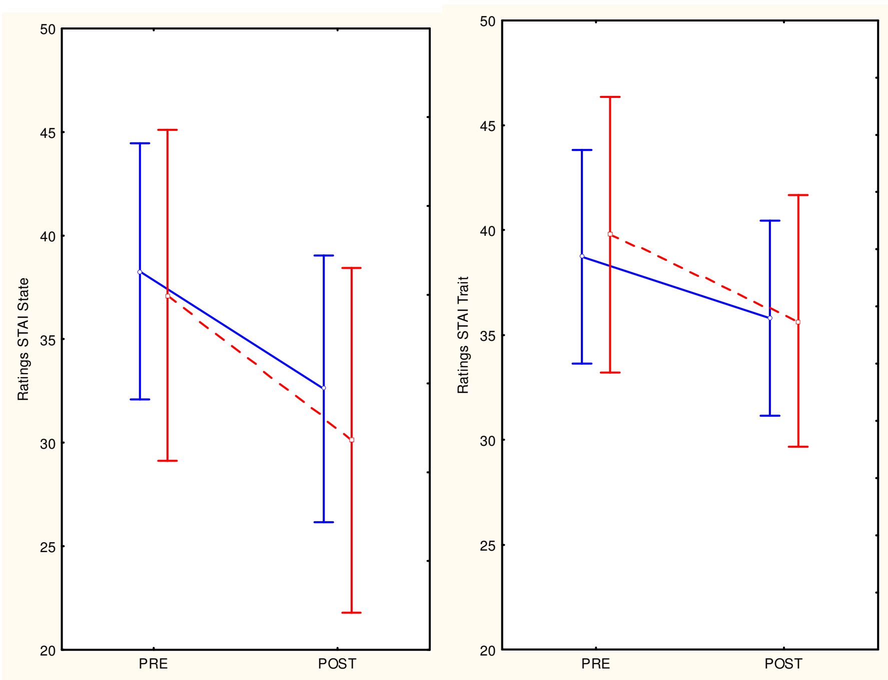


Figure 21. Changes pre to post seminar in association with anti-fear of flying seminar rated by people with fear of flying, Moderate-Anxious (solid line) and High-Anxious (broken line), on the two scales State (left figure) and Trait anxiety (right figure) questionnaire.

3.3.4 Anxiety questionnaires: body sensation, cognition, avoidance

The results of the Anxiety Questionnaire (Ehlers et al., 1993) were as follows: ANOVA from the ratings on the Agoraphobic Cognitions Questionnaire (ACQ) indicated significant pre to post seminar effects $F(1, 22)=7.895$, $p<0.01$. However no Group by pre to post interaction effects $F(1, 22)=0.062$, $p=0.805$ were found for these measures. The Moderate-Anxious and High-Anxious showed comparable reductions from pre to post seminar in the scales, no group effect was found $F(1, 22)= 1.474$, $p=0.237$, see Table 5 and Figure 22 for Means and SD.

Significant pre to post effects were found for the ratings of Body Sensations Questionnaire (BSQ) $F(1, 22)=16.12$, $p<0.001$. However, no group effects $F(1, 22)=0.255$, $p=0.619$ were found for these measures. The Moderate-Anxious and High-Anxious showed comparable reductions from pre to post seminar in the scales, no group effect was found $F(1, 22)=0.059$, $p=0.809$, see Table 5 and Figure 22 for Means and SD.

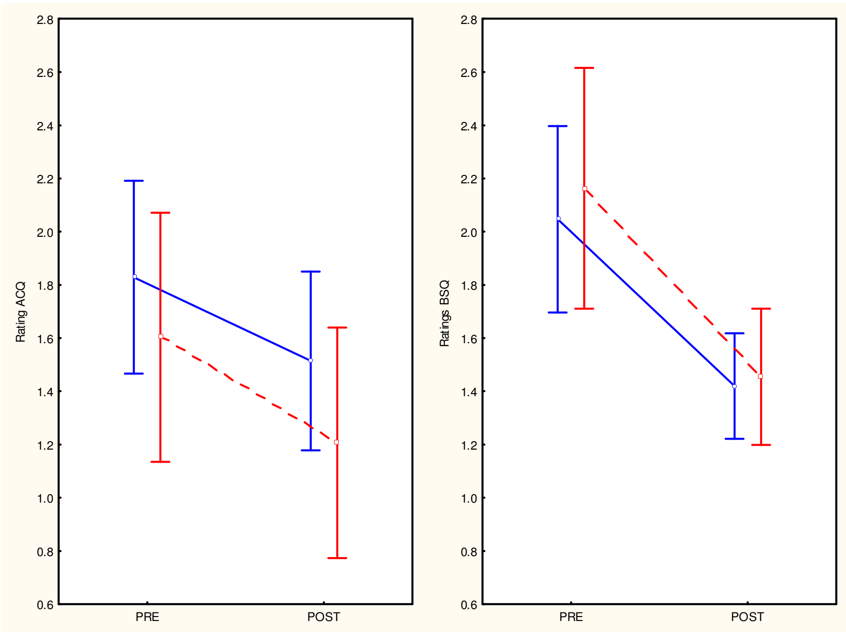


Figure 22. Changes pre to post seminar in association with fear of flying seminar rated by people with fear of flying, Moderate-Anxious (solid line) and High-Anxious (broken line), on the two scales Agoraphobic Cognitions Questionnaire (ACQ; left figure) and Body Sensations Questionnaire (BSQ; right figure).

Mobility Inventory Alone (MIA): Significant pre to post effects were found for the ratings of Mobility Inventory Alone $F(1, 22)=10.867$, $p=0.003$. However, no group effects $F(1, 22)=2.078$, $p=0.163$ were found for these measures. The Moderate-Anxious and High-Anxious showed comparable reductions from pre to post seminar in the scales, no group effect was found $F(1, 22)=0.276$, p=0.605, see Table 5 and Figure 23 for Means and SD.

Mobility Inventory Accompanied (MIB): Significant pre to post seminar effects were found for the ratings of Mobility Inventory Accompanied $F(1, 22)=13.30$, $p=0.001$. However no group effects $F(1, 22)=2.605$, $p=0.121$ were found for these measures. The Moderate-Anxious and High-Anxious showed comparable reductions from pre to post seminar, no group effect was found $F(1, 22)=0.965$, $p=0.336$, see Table 5 and Figure 23 for Means and SD.

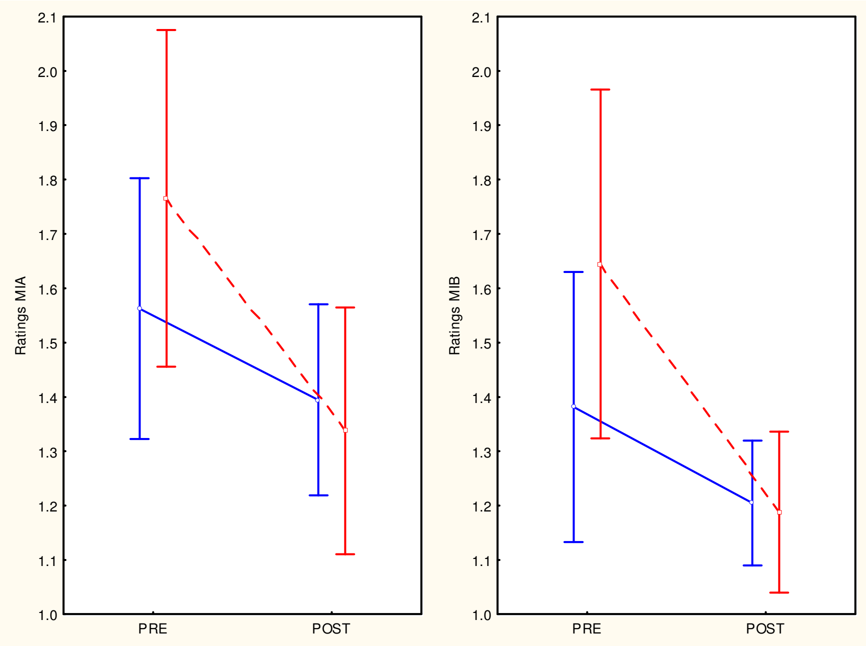


Figure 23. Changes pre to post seminar in association with anti-fear of flying seminar rated by people with fear of flying, Moderate-Anxious (solid line) and High-Anxious (broken line), on the two scales Mobility Inventory Accompanied (MIB; left figure) and Mobility Inventory Alone (MIA; right figure).

3.4 Physiological response during real flights

For the following physiological measures a two-way repeated measures Group (Moderate-Anxious / High-Anxious / Controls) × Epochs (32 through 55 as can be seen in Table 3) ANOVA was computed. A summary of the main effects of the cardiac autonomic variables is shown in Table 6.

Table 6. Main effects of ANOVAs for HR and HRV measures for Epoch during real flights × Group (Controls, High-Anxious, Moderate-Anxious)

Variable	Group		Epoch	Group x Epoch
	F (2, 30)	*ε*	*F* (23, 690)	*F* (46, 690)
Mean HR	4.26*	0.328	36.63***	2.24**
SDNN	1.06	0.436	2.49**	1.14
pNN50	0.72	0.288	2.19**	1.64†
RMSSD	0.06	0.333	3.30**	1.25
LF norm	5.95**	0.522	2.53**	1.80**
HF norm	1.12	0.456	2.31*	1.27
LF/HF	1.2	0.422	1.61*	1.75*

Note: † < p =.10, * p < .05, ** p < .01, *** p < .001.

3.4.1 Mean heart rate during real flights

ANOVA of Mean HR indicated a significant interaction of Group × Epoch $F(46, 690)=2.24$, $p=0.006$, $\varepsilon=0.328$ beside a significant main effect for group $F(2, 30)=4.256$, $p=0.023$ and a highly significant effect for epoch $F(23, 690)=36.63$, $p<0.001$, $\varepsilon=0.328$. For boarding there was no difference between controls and anxious groups evident. Subsequently HR increased in all groups during the real flights and the groups differed clearly, higher values were found for seating, engines on and take-off within Moderate-Anxious and High-Anxious compared to Controls. The most accelerated HR appeared for take-off within the High-Anxious (M=111 bpm) compared to Controls (M=81 bpm) and remained accelerated for both flights. High-Anxious differed from Controls during flight situations except boarding. During the return flight for take-off and landing Moderate-Anxious and High-Anxious displayed accelerated HR compared to Controls. Within Controls there were differences between the epochs, the highest Mean HR appeared for boarding (M=108 bpm) and the lowest Mean HR for landing (M=75.bpm). The Moderate-Anxious group had its peaks for boarding and shortly before the flight. For the flights the HR reduced during the first flight from M=105 bpm to M=90 bpm and from M=105 bpm to M=84 bpm for the return flight. The High-Anxious group had additional peaks for take-off. Means and confidence intervals are reported in Table 10 (Annex 9.1) and Figure 24.

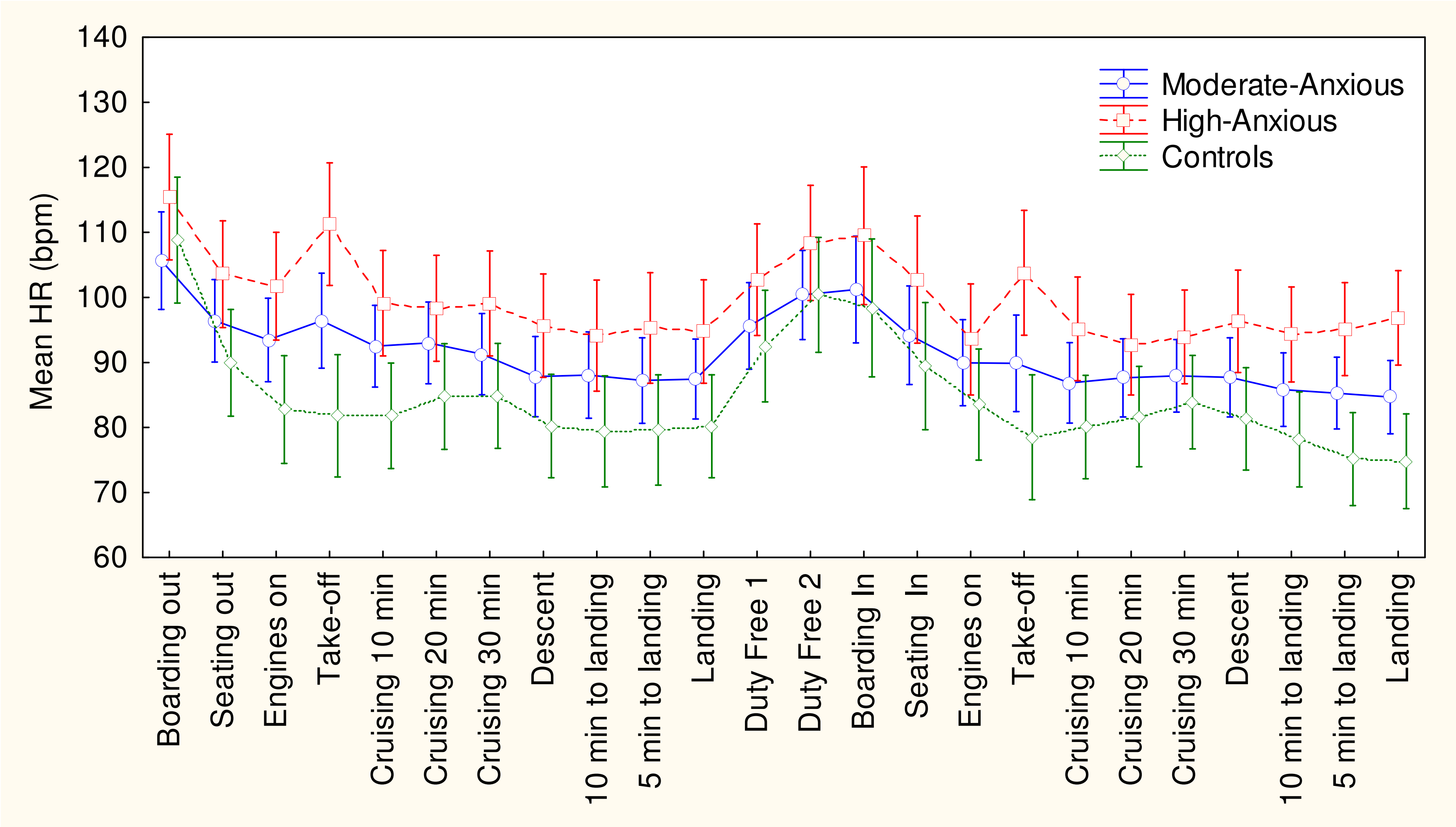


Figure 24. Mean heart rate (HR) of 24 time epochs during real flights by Groups. Means +/- 95% confidence intervals.

3.4.2 Heart rate variability during real flights

ANOVA of SDNN indicated a significant main effect for Epoch $F(23, 690)=2.488$, $p=0.006$, $\varepsilon=0.436$. The main effect Group was not significant $F(2, 30)=1.058$, $p=0.359$, the interaction Group × Epoch was not significant either $F(46, 690)=1.136$, $p=0.31$, $\varepsilon=0.436$. Controls showed similar SDNN as Anxious Groups, except High-Anxious, who showed a higher SDNN for cruising according the confidence intervals. Moderate-Anxious displayed the lowest values especially before landing during the first flight. While staying in the duty free zone the values decreased for Moderate-Anxious and High-Anxious to 40, whereas during the flights High-Anxious had their peaks at 60. Controls showed means of 60 on the return-flight during landing. Means and confidence intervals are reported in Table 11 (Annex 9.2) and Figure 25.

ANOVA of pNN50 indicated a statistical trend effect regarding interaction of Group × Epoch $F(46, 690)=1.641$, $p=0.075$, $\varepsilon=0.288$, besides an obvious main effect for Epoch $F(23, 690)=2.191$, $p=0.03$, $\varepsilon=0.288$, the main effect Group was not significant $F(2, 30)=0.72$, $p=0.495$. The confidence intervals indicated significant differences for Epochs, especially during boarding both flights. Controls displayed only a pNN50-value of 0.001; the values went up within the flights to peaks of 0.15 for landing on the return-flight. Means and confidence intervals are reported in Table 12 (Annex 9.3) and Figure 26.

ANOVA of RMSSD indicated a significant main effect of Epoch $F(23, 690)=3.295$, $p=0.002$, $\varepsilon=0.333$. The main effect Group was not significant $F(2, 30)=0.06$, $p=0.941$, the interaction Group × Epoch was not significant $F(46, 690)=1.251$, $p=0.23$, $\varepsilon=0.333$. Confidence intervals indicated differences between High-Anxious and Controls for take-off on the flight-out and on the flight-in. For landing during the flight-in the Controls had higher means (M=33.60) than High-Anxious (M=22.7) and Moderate-Anxious (M=27.9). Means and confidence intervals are reported in Table 13 (Annex 9.4) and Figure 25.

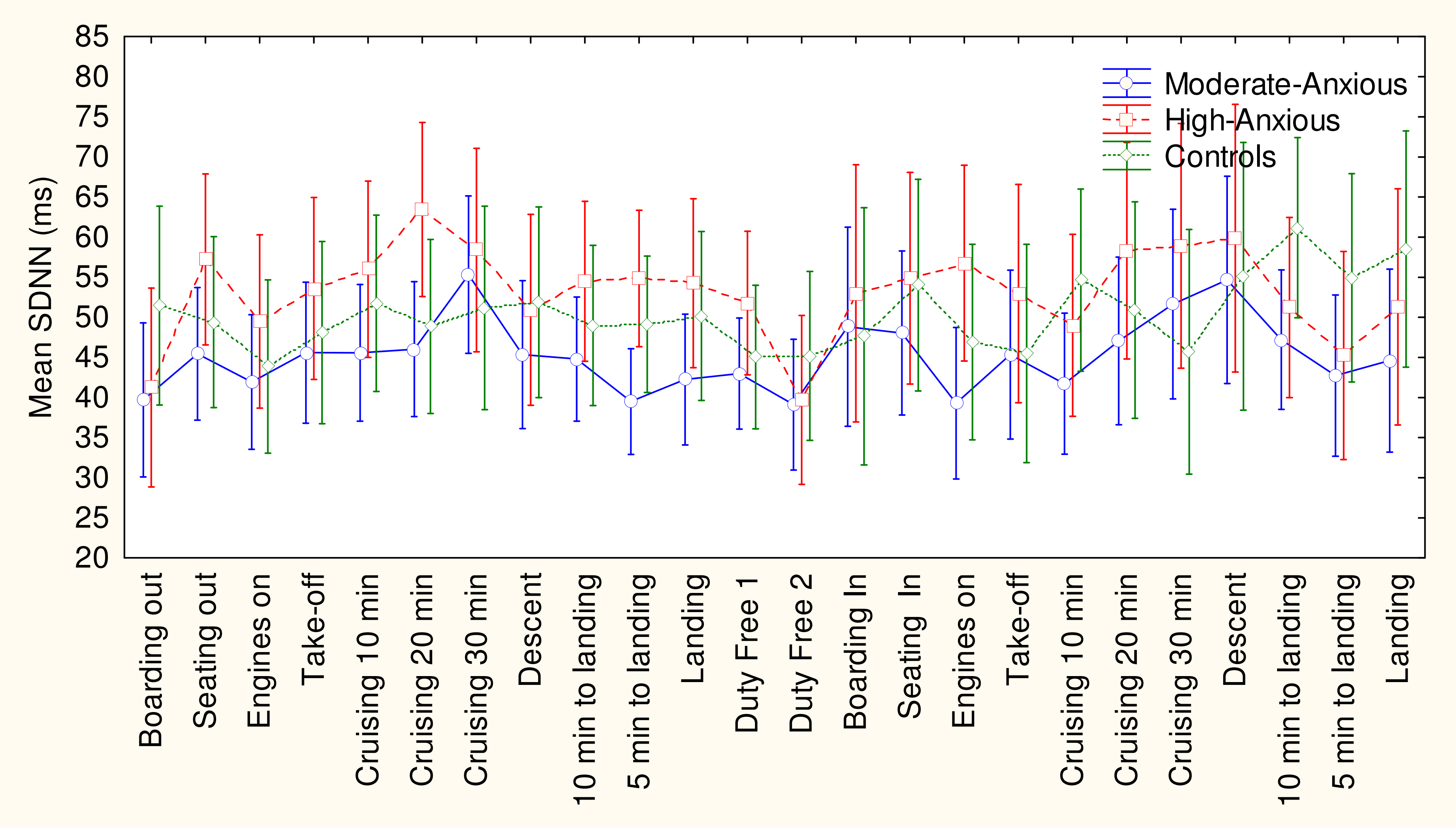


Figure 25. SDNN of 24 time epochs during real flights by Groups. Means +/- 95% confidence intervals.

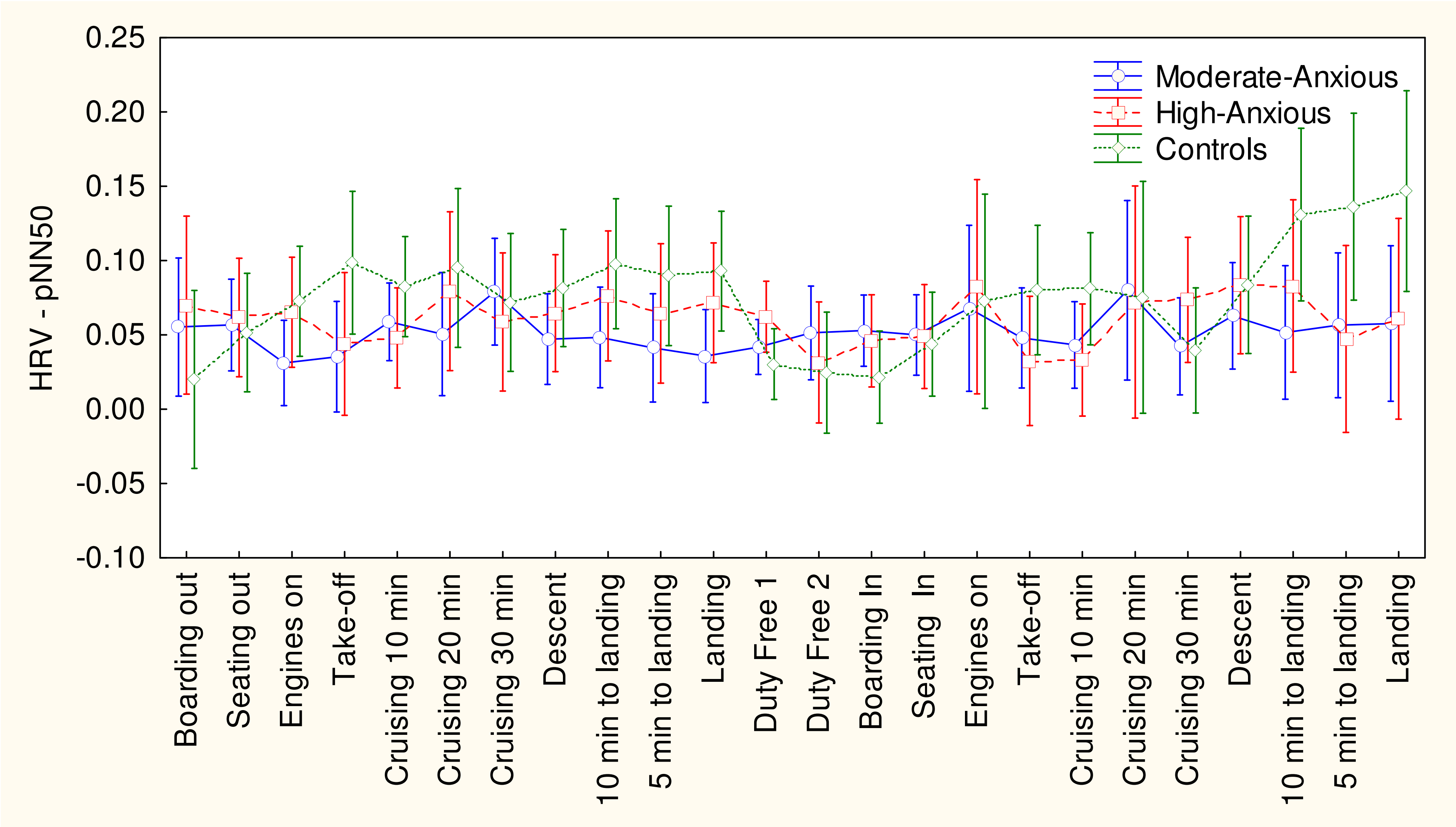


Figure 26. HRV - pNN50 of 24 time epochs during real flights by Groups. Means +/- 95% confidence intervals.

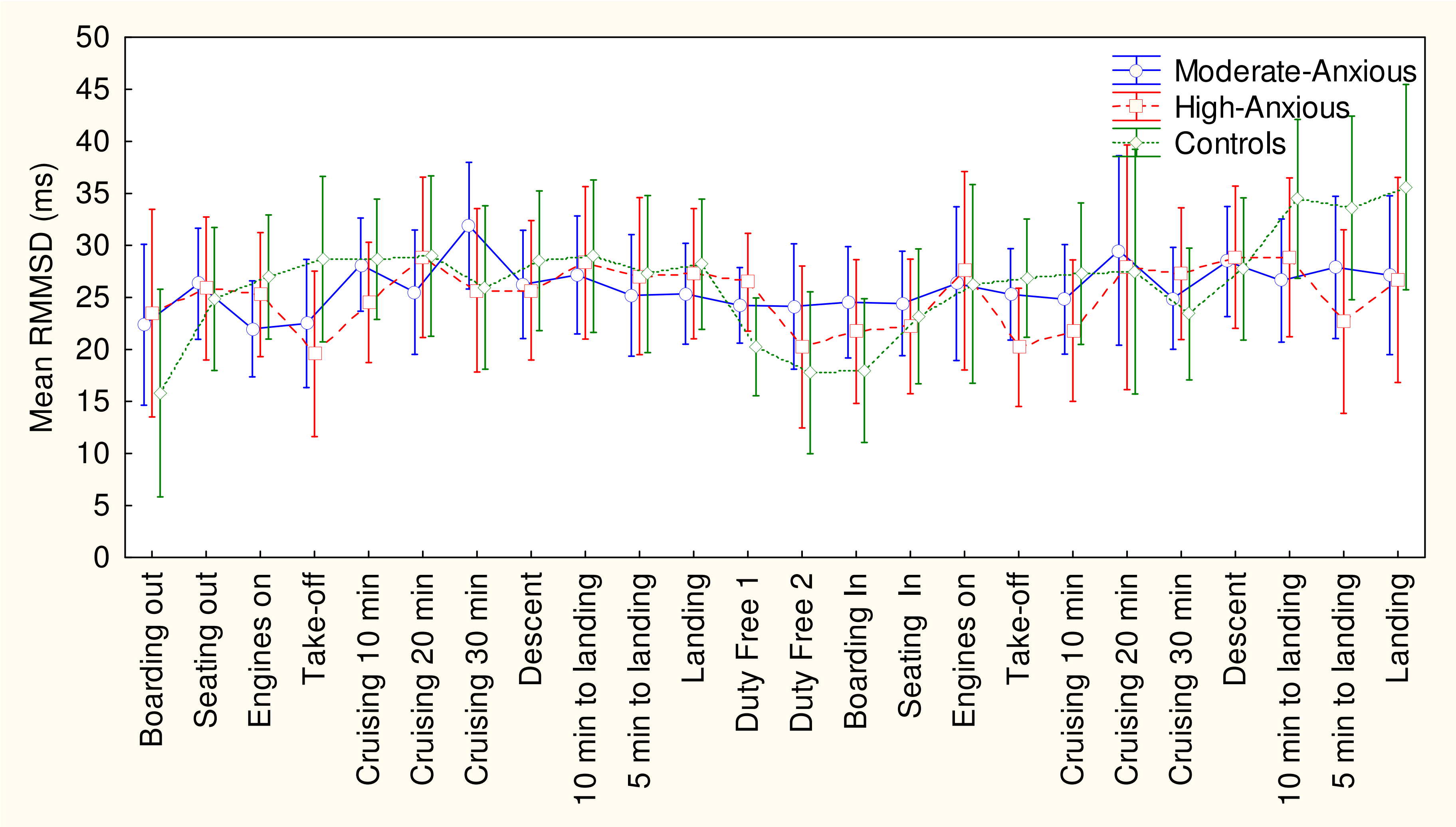


Figure 27. RMMSD of 24 time epochs during real flights by Groups. Means +/- 95% confidence intervals.

ANOVA of LFnorm indicated a significant interaction of Group × Epoch $F(46, 690)=1.804$, $p=0.001$, $\varepsilon=0.522$, besides a significant main effect for Group $F(2, 30)=5.95$, $p=0.003$ and significant for Epoch $F(23, 690)=2.532$, $p=0.003$, $\varepsilon=0.522$. According to the confidence intervals Controls had higher LFnorm than Moderate-Anxious and High-Anxious for engines on and for take-off on the flight-out. The Moderate-Anxious showed less LFnorm than Controls and High-Anxious for all situations. During the return-flight High-Anxious showed the lowest LFnorm at take-off and the highest LFnorm at cruising. The lowest values were found in all groups during moving around in the duty free zone. Means and confidence intervals are reported in Table 14 (Annex 9.5) and Figure 28.

ANOVA of HFnorm indicated a significant effect for Epoch $F(23, 690)=2.314$, $p=0.01$, $\varepsilon=0.456$. The main effect Group was not significant $F(2, 30)=1.12$, $p=0.341$, the interaction Group × Epoch was not significant either $F(46, 690)=1.27$, $p=0.19$, $\varepsilon=0.456$. Controls showed higher HFnorm than that of Moderate-Anxious and High-Anxious during the flight-out for take-off and during the flight-in for landing. The means of all groups were equivalent for boarding on the return flight, and for duty free zone, where the HFnorm of Controls was as low as that of Moderate-Anxious and High-Anxious. Means and confidence intervals are reported in Table 15 (Annex 9.6) and Figure 29.

ANOVA of the log LF/HF-balance score indicated a significant interaction of Group × Epoch $F(46, 690)=1.717$, $p=0.03$, $\varepsilon=0.422$, besides a trend effect for Epoch $F(23, 690)=1.613$, $p=0.105$, $\varepsilon=0.422$. The main effect Group was not significant $F(2, 30)=1.195$, $p=0.317$. The confidence intervals indicated that for boarding the flight-out the Controls showed higher log LF/HF ratio than during the flight situations. The Moderate-Anxious showed lower means during duty free with a minimum value shortly before the return-flight. High-Anxious showed peaks for flight situations, and higher values for cruising on the flight-out and 10 minutes before landing on the flight-in. Means and confidence intervals are reported in Table 16 (Annex 9.7) and Figure 30.

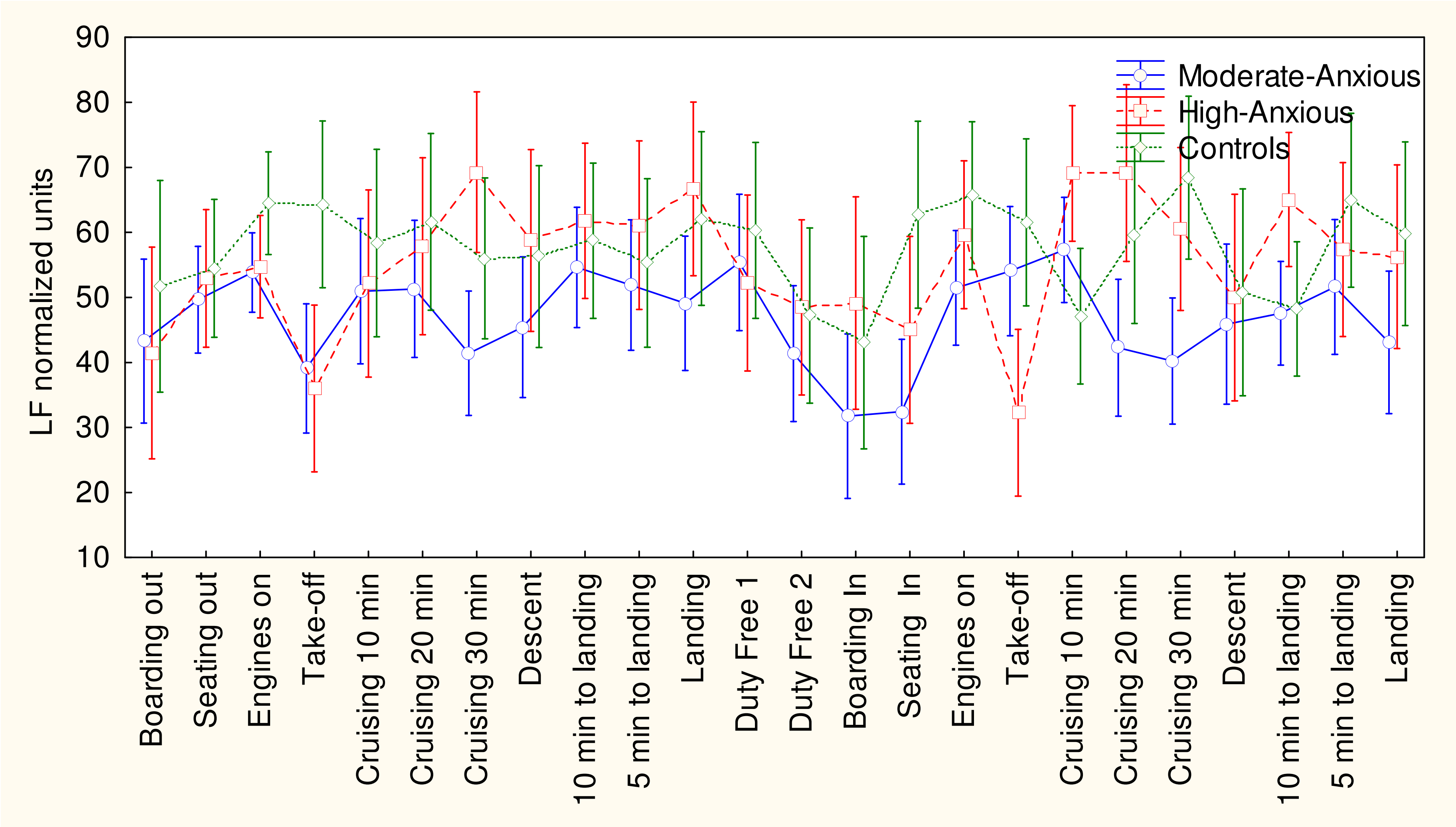


Figure 28. HRV – LFnorm of 24 time epochs during real flights by Groups. Means +/-95% confidence intervals.

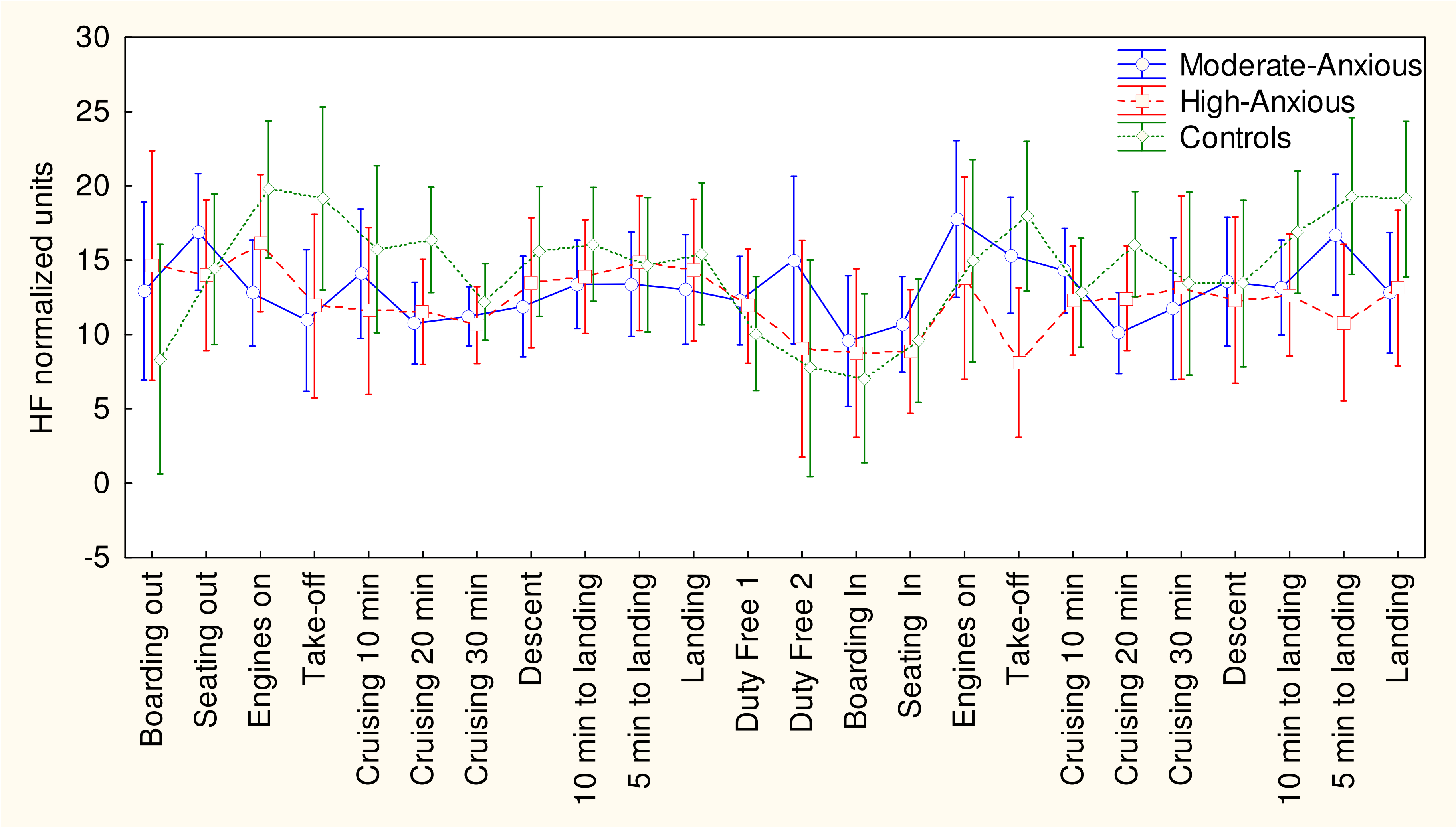


Figure 29. HFnorm of power of 24 time epochs during real flights by Groups. Means +/- 95% confidence intervals.

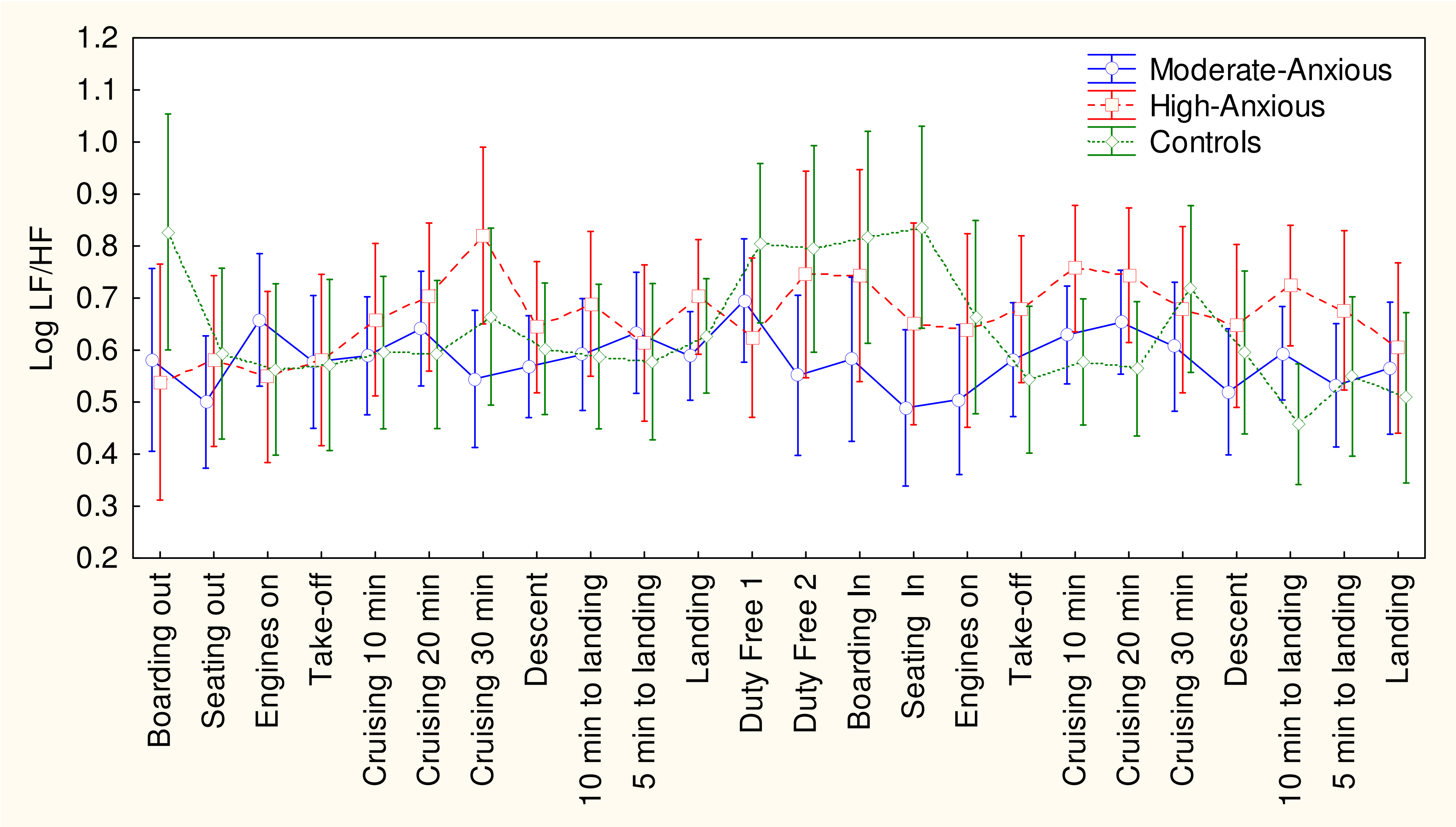


Figure 30. Log LF/HF ratio of 24 time epochs during real flights by Groups. Means +/- 95% confidence intervals.

3.4.3 Arterial oxygen saturation during real flights

A repeated 3 × 5 ANOVA with Group (Controls, Moderate-Anxious, High-Anxious) and Epoch (30, 36, 39, 49, 52 from Table 3) was computed. The ANOVA indicated a significant main effect for Epoch $F(4, 120)=8.7$, $p=0.000$, $\varepsilon=0.84$. The main effect Group was not significant $F(2, 30)=0.6$, $p=0.55$, the interaction Group × Epoch was not significant $F(8, 120)=1.2$, $p=0.33$, $\varepsilon=0.84$ either. The epochs differed highly significant $F(4, 120)=0,6$, $p<0.001$, the SpO_2 level reduced from the first flight to the second flight within people with fear of flying and Controls. Shortly after take-off on the return-flight to Vienna (epoch 49) the control group recovered faster (M=96.80 ± 0.80) compared to the High-Anxious (M=94.44 ± 0.80). Means and confidence intervals are shown in Table 17 (Annex 9.8) and Figure 31.

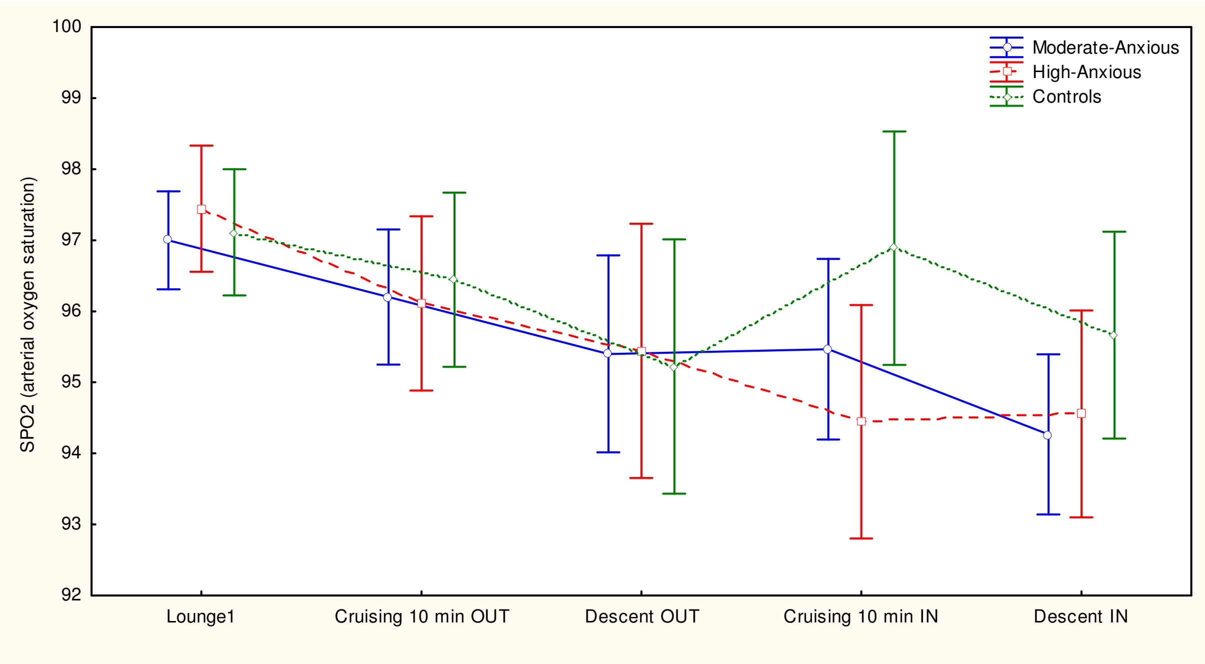


Figure 31. SpO_2 of spot measurements during real flights by Groups. Means +/- 95% confidence intervals.

3.4.4 Cortisol concentration during flights

ANOVA of cortisol concentration was computed with the factor Group (Controls, Moderate-Anxious, High-Anxious). The hypotheses that fear of flying increases the cortisol concentration level was expected to be reflected in significant group differences between Controls to Moderate-Anxious and High-Anxious.

The ANOVA revealed a significant main effect for Group $F(2, 18)=4.103$, $p=0.034$, the post hoc-Test Fisher LSD revealed significant differences between Controls to Moderate-Anxious $p=0.012$ and to High-Anxious $p=0.041$, these findings indicated a significant higher Cortisol level in people with fear of flying for the real flight than in Controls (Means±SDs; Controls: 1.86 ±1.27, Moderate-Anxious:11.57±8.04, High-Anxious: 10.86±5.09).

3.5 Psychological ratings during real flights

For the scales *fear* and *mood* a repeated ANOVA Group (Moderate-Anxious, High-Anxious, Controls) × Epoch was computed.

ANOVA of the scale *physiological sensation* revealed a significant Group × Epoch interaction $F(10, 150)=3.53$, $p=0.004$, $\varepsilon=0.53$, besides a main effect for Group $F(2, 30)=9.86$, $p < 0.001$ and Epoch $F(5, 150)=14.08$, $p < 0.001$, $\varepsilon=0.53$. Means and confidence intervals from Table 18 (Annex 9.9) and Figure 32) show the reductions in physiological sensations in Moderate-Anxious and in High-Anxious. Controls did not state any physiological sensation during the flights.

ANOVA of the scale *diffuse fear* revealed significant interaction Group × Epoch $F(10, 150)=4.07$, $p<0.001$, $\varepsilon=0.61$, besides a main effect for Group $F(2, 30)=11.46$, $p<0.001$ and for Epoch $F(5, 150)=4.07$, $p<0.001$, $\varepsilon=0.61$. Means and confidence intervals from Table 19 (Annex 9.10) and Figure 33 show the reductions in diffuse fear in Moderate-Anxious and High-Anxious during flights. Controls rated their diffuse fear at all epochs below that of Moderate-Anxious and High-Anxious.

ANOVA of the scale *cognitive fear* revealed a significant interaction Group × Epoch $F(10, 150)=4.24$, $p<0.001$, $\varepsilon=0.53$, besides a main effect for Group $F(2, 30)=21.31$, $p<0.001$ and for Epoch $F(5, 150)=20.39$, $p<0.001$, $\varepsilon=0.53$. The confidence intervals from Table 20 (Annex 9.11) and Figure 34 show the reductions in Moderate-Anxious and in High-Anxious during the flights. Controls did not rate any cognitive fear.

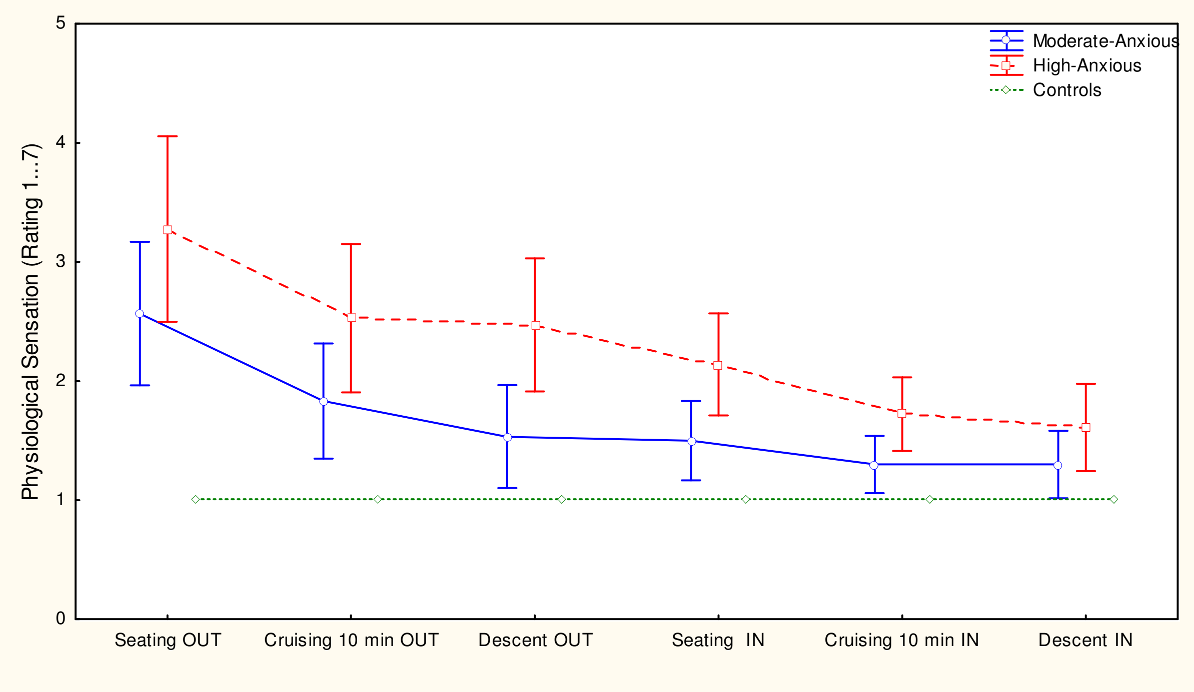


Figure 32. Ratings on Physiological Sensation of Epochs during real flights by Groups. Means +/- 95% confidence intervals.

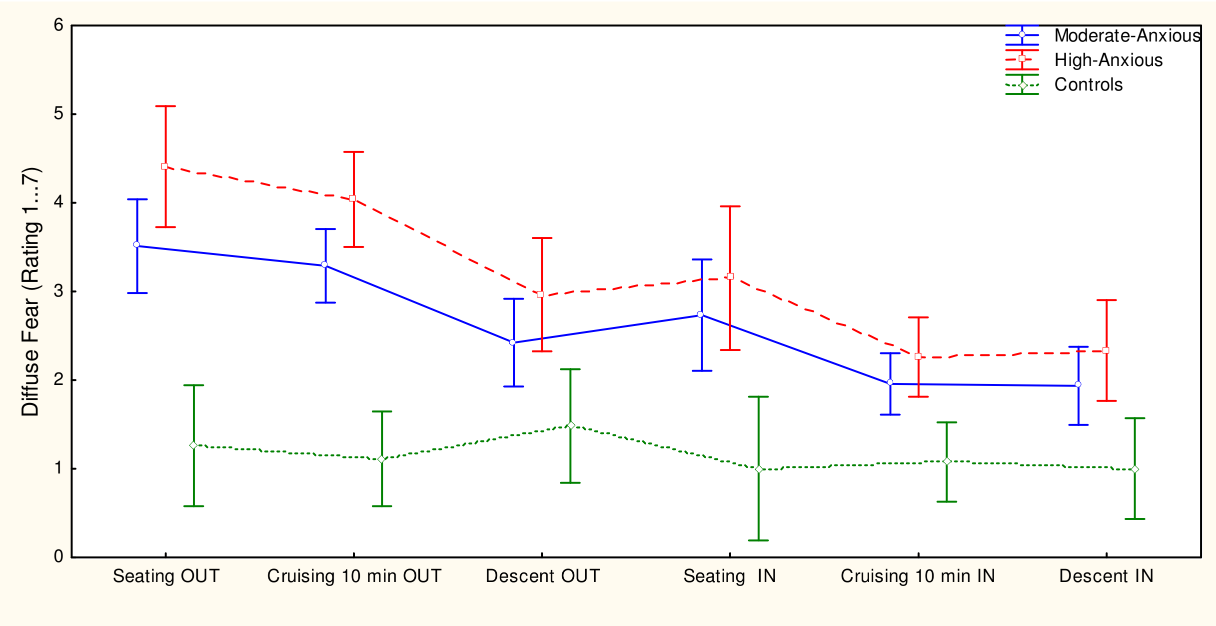


Figure 33. Ratings on Diffuse Fear of Epochs during real flights by Groups. Means +/- 95% confidence intervals.

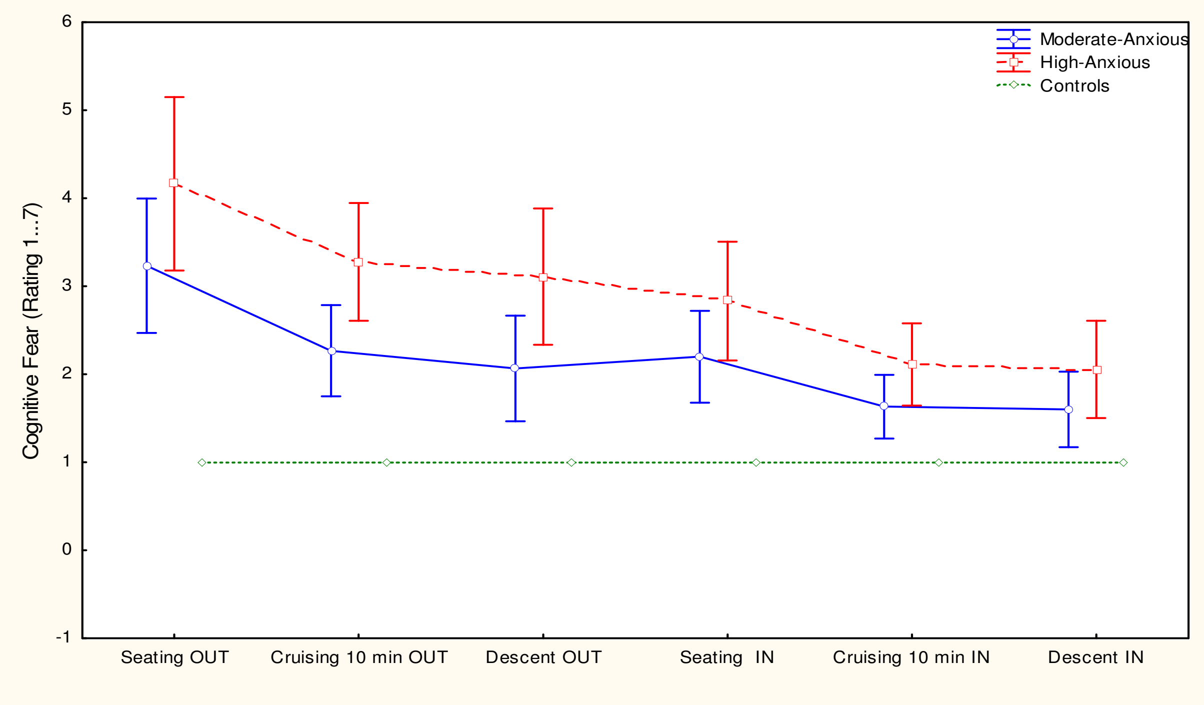


Figure 34. Ratings on Cognitive Fear of Epochs during real flights by Groups. Means +/- 95% confidence intervals.

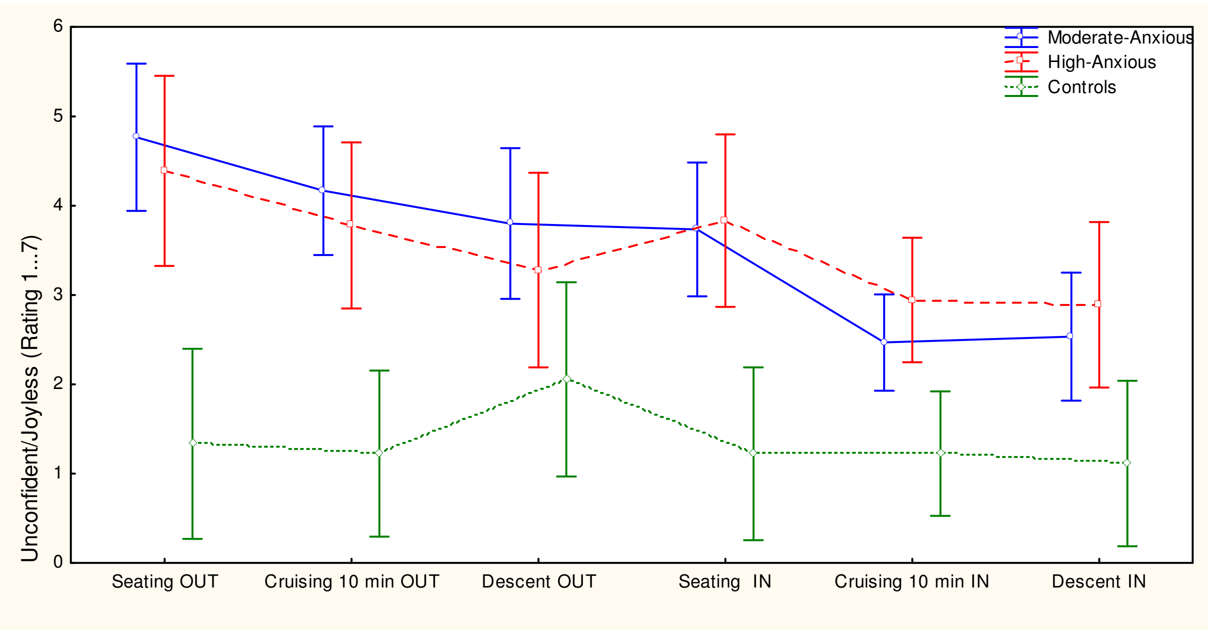


Figure 35. Ratings on Unconfident/Joyless of Epochs during real flights by Groups. Means +/- 95% confidence intervals.

ANOVA of *unconfident/joyless* scale revealed a significant interaction Group × Epoch $F(10, 150)=3.46$, $p=0.001$, $\varepsilon=0.76$, besides a main effect for Group $F(2, 30)=11.69$, $p<0.001$, and for Epoch $F(5, 150)=11.47$, $p<0.001$, $\varepsilon=0.76$. Means and confidence intervals are reported in Table 21 (Annex 9.12) and Figure 35, the confidence intervals show the reductions of unconfidence and being joyless in Moderate-Anxious and in High-Anxious during the flights, Controls were more confident and joyful than High-Anxious and Moderate-Anxious.

3.6 Exploration based on the model of autonomic space

The following descriptive analysis explores the cardiac control of the autonomic system based on the theory of Berntson et al. (1991) regarding the model of autonomic space. The model refers to sympathetic and parasympathetic cardiac activation, differentiated as *coactivation, coinhibition, reciprocal parasympathetic activation, reciprocal sympathetic activation, uncoupled parasympathetic activation, uncoupled parasympathetic withdrawal, uncoupled sympathetic activation, uncoupled sympathetic withdrawal,* and *baseline* as described in chapter 1.7.3. and Table 1. The modes were explored in relation to the groups (High-Anxious, Moderate-Anxious, Controls) and in relation to the different epochs during the fear of flying seminar. Although Berntson et al. (1991) suggested using clear independent indices of sympathetic and parasympathetic autonomic control for their model, this study depends on ECG measures only. An additional implementation of an impedance cardiograph was not feasible in this field study, since an impedance cardiograph is very sensitive to movement. Therefore, the exploration had to rely on the sympathetic division represented by LFnorm and the parasympathetic division represented by HFnorm, based on the common understanding that LF power expressed in normalized units is usually interpreted to represent sympathetic modulation and that HF cardiac rhythms are predominately mediated by vagal modulation on the SA node (Task Force, 1996).

3.6.1 Classification of sympathetic and parasympathetic changes

LFnorm - supposed to represent sympathetic control of the heart - of High-Anxious and Moderate-Anxious at the epochs 1 to 55 was compared to epoch 3 in order to classify the changes in sympathetic reactivity. LFnorm of Controls at the epochs 32 to 55 was compared to epoch 38. A change was counted if the actual value exceeded the average SD per group. The average SD of LFnorm was computed in Table 14. *Not changed* (N) applied when the difference was less than the average SD, *decreased* (D) LFnorm applied when the change was higher than the average SD and the direction of change was negative. *Increased* (I) LFnorm applied when the change was higher than the average SD and when the direction of change was positive. Classification is shown in Table 22 under column *class.*

HFnorm - supposed to represent parasympathetic control of the heart - of High-Anxious and Moderate-Anxious at the epochs 1 to 55 was compared to epoch 3 in order to classify the changes of parasympathetic reactivity. HFnorm of Controls at the epochs 32 to 55 was compared to epoch 38. A change was counted if the actual value exceeded the average SD per group. The average SD of HFnorm is computed in Table 15. *Not changed* (N) applied when the difference value was less than the average SD, *decreased* (D) HFnorm applied when the value of change was higher than average SD and negative. *Increased* (I) LFnorm applied when the change was higher than the average SD and when the direction of change was positive. Classification is shown in Table 23 under column *class.*

3.6.2 Definition of autonomic modes after Berntson

Following the classification of change of cardiac reactivity at different time points in LFnorm and HFnorm (Tables 22, 23, Appendix 9.13 and 9.14) the combination of changes resulted in the specification of the related modes in accordance to the theory of Berntson et al. (1991). The procedure is depicted in Table 7.

Table 7. The combination of sympathetic and parasympathetic change classification resulting in one of the nine modes according to the definition of Berntson et al. (1991).

Change in LF norm	Change in HF norm	Resulting mode
N	N	Baseline
I	I	Coactivation
D	D	Coinhibition
I	D	Reciprocal sympathetic activation
D	I	Reciprocal parasympathetic activation
I	N	Uncoupled sympathetic activation
N	I	Uncoupled parasympathetic activation
D	N	Uncoupled sympathetic withdrawal
N	D	Uncoupled parasympathetic withdrawal

Note: N=Not changed, I=Increased, D=Decreased

The specification of mode at epochs 1 to 31 is shown in Figure 36 describing High-Anxious and Moderate-Anxious. The specification of mode at epochs 32 to 55 is shown in Figure 37 describing High-Anxious, Moderate Anxious, and Controls. Figure 38 gives an overview of High-Anxious, Moderate-Anxious, and Controls regarding the applied autonomic mode during each epoch. Unchanged modes are depicted in grey (baseline), coupled modes are depicted in yellow, uncoupled modes are depicted in pink.

Table 8. Frequencies of modes: number of hits of High-Anxious (HA), Moderate-Anxious (MA) during the epochs 1 to 55.

	HA	MA
Baseline	**20**	9
Coactivation	5	0
Coinhibition	4	**21**
Reciprocal sympathetic activation	0	0
Reciprocal parasympathetic activation	2	0
Uncoupled sympathetic activation	**14**	1
Uncoupled parasympathetic activation	3	1
Uncoupled parasympathetic withdrawal	2	**20**
Uncoupled sympathetic withdrawal	5	3

Note: Grey (Baseline) indicates that sympathetic and parasympathetic cardiac control remained unchanged, Yellow indicates coupled modes, Pink indicates uncoupled modes.

Table 8 and Figure 38 show which modes occur most frequently during the three-day seminar (epochs 1-55). Relative high frequencies of mode *baseline* (20) and of mode *uncoupled sympathetic activation* (14) were found in High-Anxious. Relative high frequencies of mode *coinhibition* (21) and of mode *uncoupled parasympathetic withdrawal* (20) were found in Moderate-Anxious.

Table 9. Frequencies of modes: number of hits of High-Anxious (HA), Moderate-Anxious (MA), Controls (C) during real flights (epochs 32 to 55).

	HA	MA	C
Baseline	**8**	4	4
Coactivation	1	0	4
Coinhibition	2	**12**	2
Reciprocal sympathetic activation	0	0	1
Reciprocal parasympathetic activation	0	0	1
Uncoupled sympathetic activation	**8**	0	1
Uncoupled parasympathetic activation	1	0	**9**
Uncoupled parasympathetic withdrawal	2	8	1
Uncoupled sympathetic withdrawal	2	0	1

Note: Grey (Baseline) indicates that sympathetic and parasympathetic cardiac control remained unchanged, Yellow indicates coupled modes, Pink indicates uncoupled modes.

Table 9 and Figure 37 show which modes are most frequent during the real flights (epochs 32-55). Relative high frequencies of mode *baseline* (8) and of mode *uncoupled sympathetic activation* (8) were found in High-Anxious. Relative high frequencies of mode *coinhibiton* (12) and of mode *uncoupled parasympathetic withdrawal* (8) were found in Moderate-Anxious. High frequency of mode *uncoupled parasympathetic activation* (9) was found in Controls.

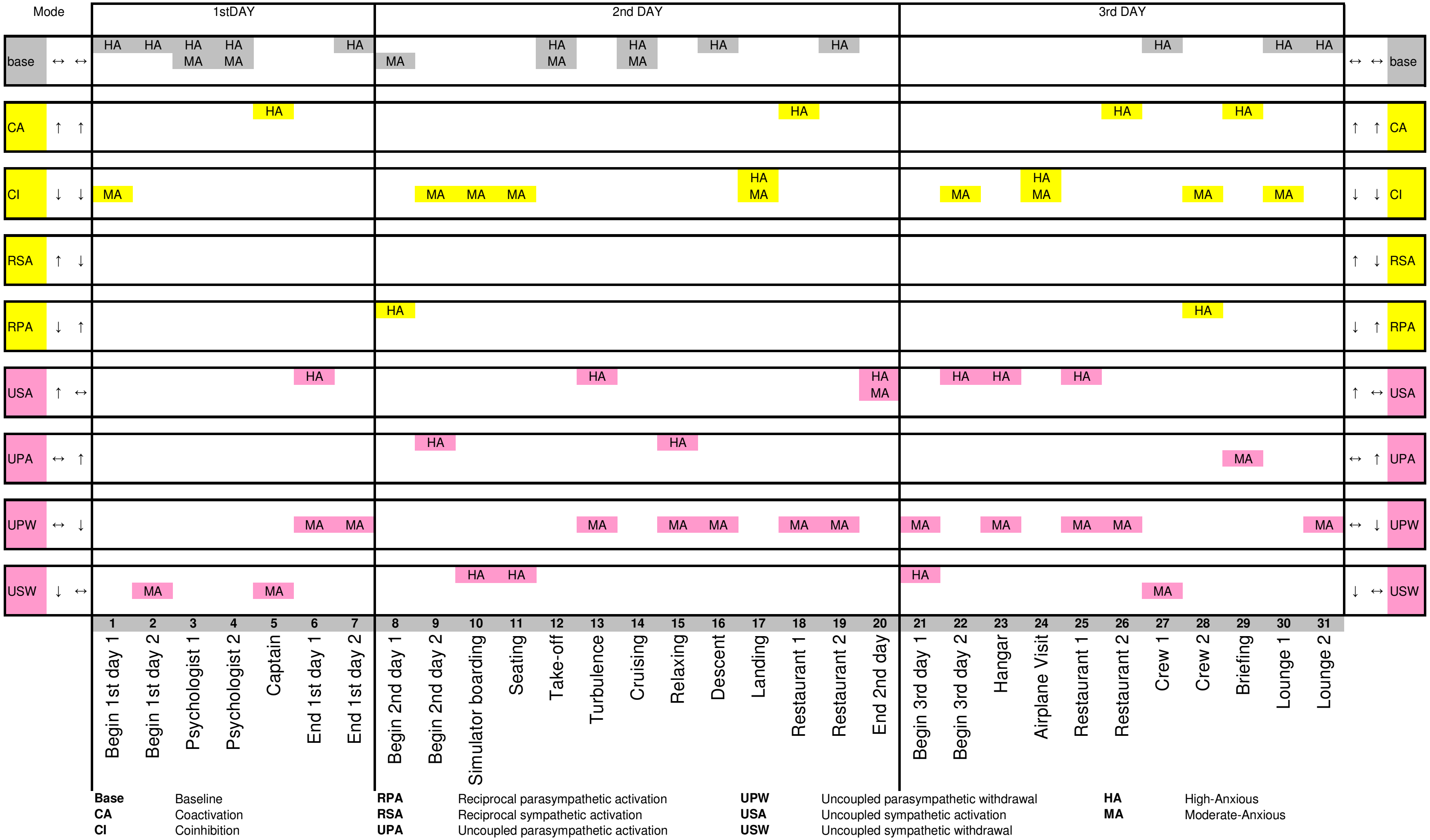
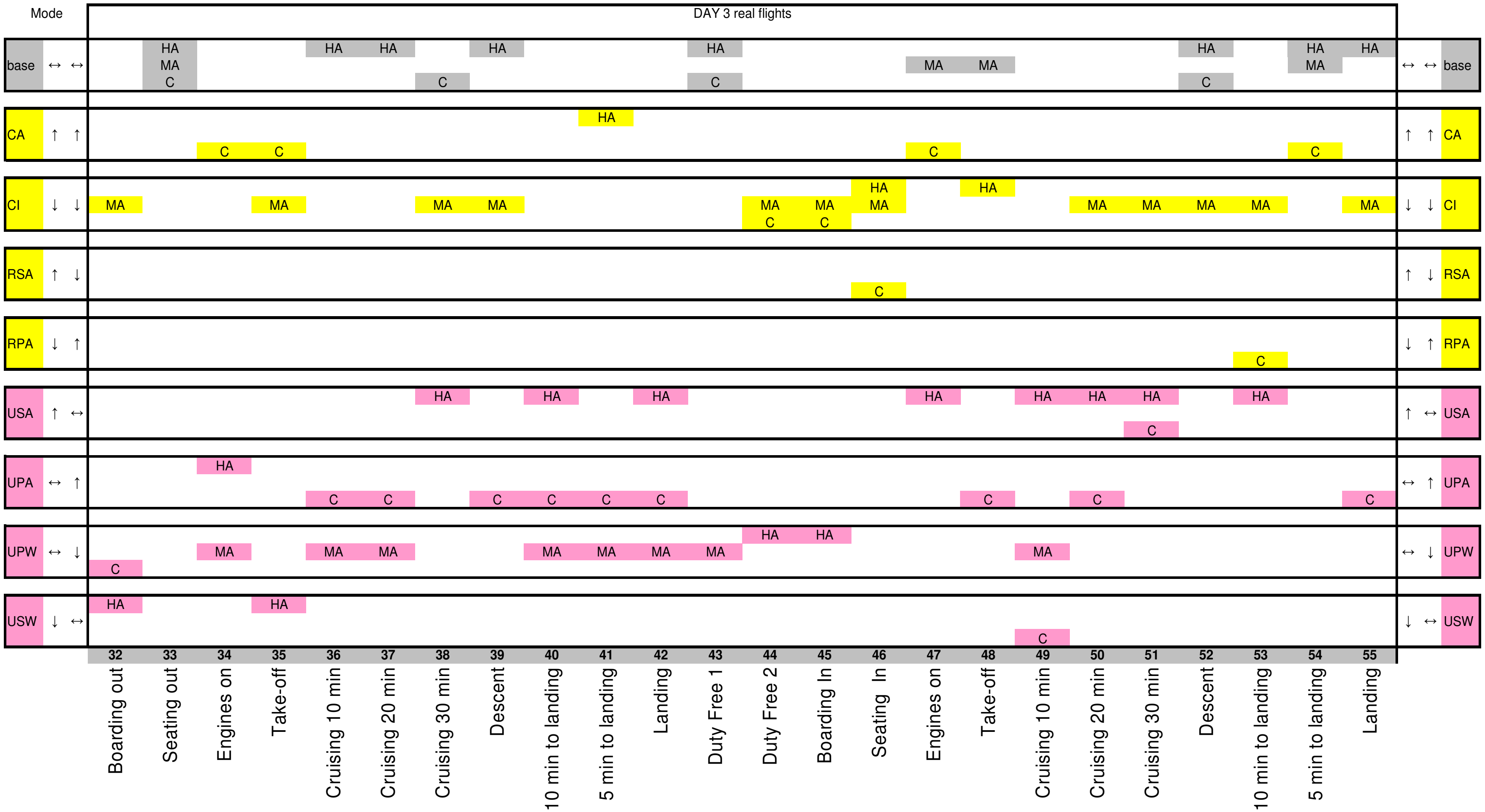


Figure 36. Modes of autonomic response for High-Anxious (HA) and Moderate-Anxious (MA during seminar epochs 1 to 31.



Base	Baseline	**RPA**	Reciprocal parasympathetic activation	**UPW**	Uncoupled parasympathetic withdrawal	**HA**	High-Anxious
CA	Coactivation	**RSA**	Reciprocal sympathetic activation	**USA**	Uncoupled sympathetic activation	**MA**	Moderate-Anxious
CI	Coinhibition	**UPA**	Uncoupled parasympathetic activation	**USW**	Uncoupled sympathetic withdrawal	**C**	Control group

Figure 37. Modes of autonomic response for High-Anxious (HA), Moderate-Anxious (MA), Controls (C) during real flights, epochs 32-55.

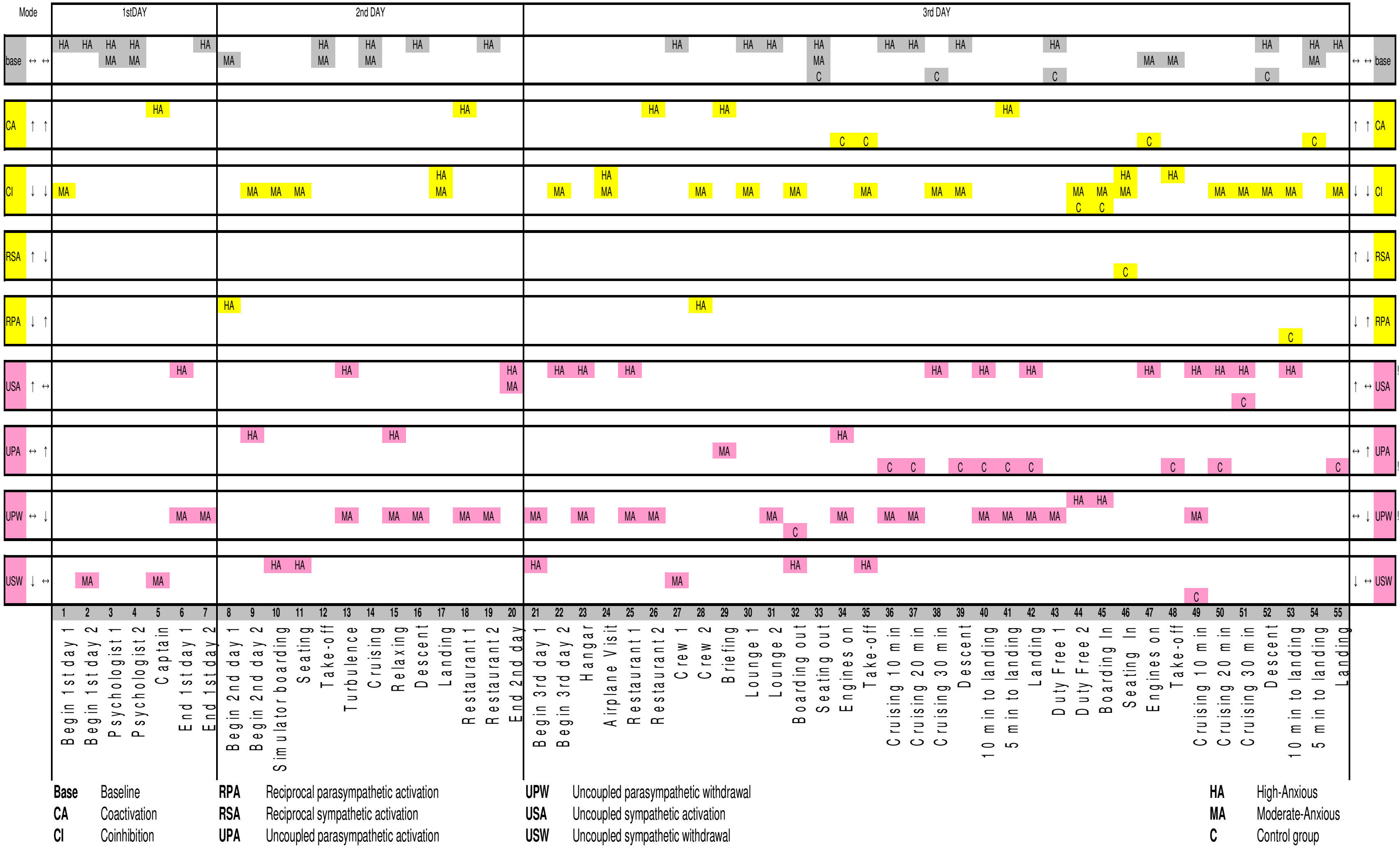


Figure 38. Modes of autonomic response for High-Anxious (HA), Moderate-Anxious (MA), Controls (C) during all epochs of the seminar (1-55).

4 Discussion

An overview of the relevant analyses arranged according to the different levels of responses related to fear of flying, taking into consideration the behavioral, physiological, and psychological systems as proposed by Lang (1971), is shown in Figure 39.

4.1 Discussion of Hypothesis 1 – Response modes

4.1.1 Behavioral Response

The fear of flying seminar enabled all participants to overcome their avoidance behavior and to successfully complete their "graduate flight". The treatment components included relaxation, stress management, coping, cognitive techniques, information, and several different exposures, and were effective in treating the fear of flying, as was shown by van Gerwen et al. (2004). That can be attributed by the changed attitudes of the participants and by their changed cognitions towards fear of flying. The newly learned coping mechanisms helped to overcome the fear: cognitive modifications regarding the ability to control and to evaluate the feared situations lead to toleration and acceptance of the autonomic response. Exposure is the core component for the effective treatment as has been suggested by Öst (1987), van Gerwen et al. (2002), and Barlow (2000). The behavioral change was confirmed by the psychological ratings comparing measurements taken before and after the seminar.

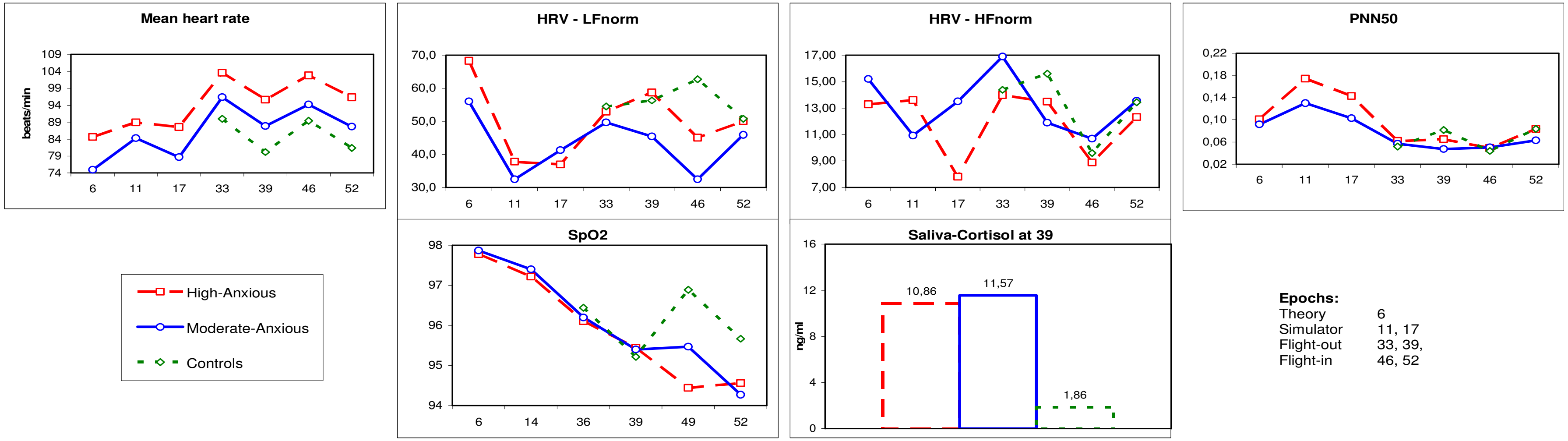
4.1.2 Physiological response

Figure 39 shows that the physiological parameters did not change during the seminar in a common direction: no absolute decrease or absolute increase of neither sympathetic (HR, LFnorm) nor parasympathetic activity (HFnorm, pNN50) can be observed from the beginning to the end of recordings during the fear of flying seminar. Changes in physiology depend much more on the context, the situation, and whether the persons are High-Anxious or Moderate-Anxious.

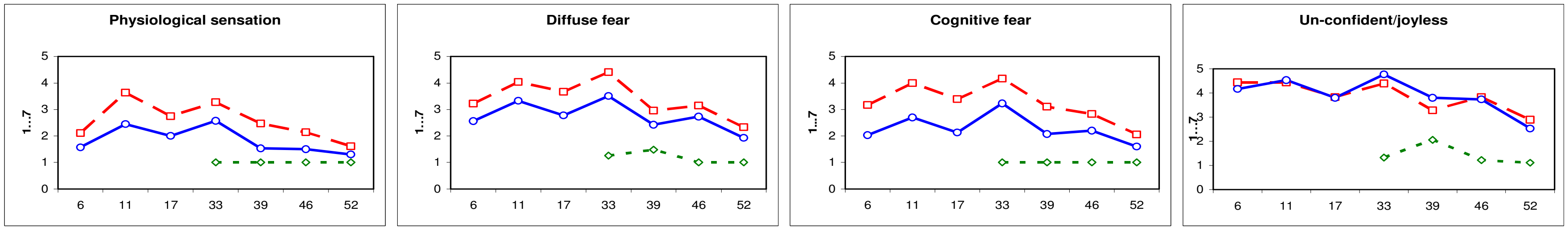
BEHAVIORAL RESPONSE

All participants of the anti-fear of flying seminars succeeded in taking the graduate flights.

PHYSIOLOGICAL RESPONSE



PSYCHOLOGICAL RESPONSE



Significant reduction in self-rated fear from before to after treatment seminar

	Moderate-A	High-Anxious		Moderate-A	High-Anxious
Anticipatory Flight Anxiety	**	**	State Anxiety	*	*
In-Flight Anxiety	**	**	Trait Anxiety	**	**
General Flight Anxiety	**	**	Agoraphobic Cognitions	*	*
Somatic Modality of Flight Anxiety	**	**	Body Sensations Questionnaire	**	**
Cognitive Modality of Flight Anxiety	**	**	Mobility Inventory accompanied	**	**

Figure 39. Composition of the results to give an overview at certain stages of the survey.

4.1.3 Parameters indicating sympathetic activity

HR shows no absolute decrease during the seminar, the differences between High-Anxious and Moderate-Anxious remained throughout the seminar. Alterations of HR are evident (Figure 7) in different contexts and situations like comparing real flights with other seminar situations during the three-day-seminar.

For both High-Anxious and Moderate-Anxious the exposure in real flights caused a much higher HR than a flight in the simulator. This is indicated by the mean HR (confidence intervals), as can be seen in Table 10 (Annex 9.1) despite the success of the ongoing treatment seminar. Given that HR increase expresses fear, this finding suggests that the simulated flight does not evoke the same level of fear as real flights in physiology. The reactivity of simulated flights seem to show a comparable reactivity as virtual flights, also virtual flights did not evoke as much fear as real flights according to Krinj et al. (2007). The fact that real flights evoke higher emotional awareness has been discussed by Bornas et al. (2006), Busscher et al. (2010), and Krinj et al. (2007). The high response expressed in HR during real flights may underline the high emotional awareness of anxiety, which is an important requirement for any efficient treatment (Foa & Kozak, 1986).

The increased HR, especially during the real flights, may be related not only to anxiety but also to the physical and environmental impacts of the situation like low air pressure in the airplane, which are not the case in simulated flights.

Taking a control group into consideration during real flights brings additional information, people with fear of flying, both Moderate-Anxious and High-Anxious, show a higher HR than Controls, confirming the view that anxiety provokes sympathetic activation expressed in higher HR (Nesse et al., 1985). Sympathetic overactivity as proposed by Hoehn-Saric and McLeod (2000) and Lovallo (2005) seems to be characteristic for fear of flying during highly feared situations as e.g. take-off. In the out-going flights during seating, take-off, and landing, and in the in-coming flights during take-off and landing differences in the HR between all three groups were found, but no differences were observed in pNN50, which is supposed to be an indicator of parasympathetic activity. Differences in HR between subjects with fear of flying and control subjects did not decrease over the time although desensitization and habituation occurred after exposure in the flight-simulator and in the aircraft parked in the hangar. That means that although exposure in real flights caused significant alterations in HR, the intervention caused no adaptation to the level of Controls in High-Anxious or Moderate-Anxious.

The HR during real flights corresponds to the findings of Ekeberg et al. (1990) reporting an increased HR during two real flights of persons with flight phobia compared to a baseline taken during pre-flight. However, in that study only one measurement was taken in-flight and subjects took part in a pharmaceutical study, probably interfering the findings, The mean HR of those subjects is $M=83\pm2.6$ during flight, compared to the measurements of this study with a mean HR during take-off in the out-going flight of $M=111\pm15$ in High-Anxious and $M=96\pm15$ in Moderate-Anxious and on the in-coming flight of $M=104\pm16$ in High-Anxious and $M=90\pm15$ in Moderate-Anxious. In the present study take-off evoked the highest HR reaction, while during the ongoing flight situations HR decreases in both flights (Figures 7 and 24). The highest values showed High-Anxious during boarding (M=115 bpm) and during take-off (M=111 bpm).

The findings of Beckham et al. (1990) showed that HR of subjects with flight phobia during exposure in a real flight does not differ between treated and untreated persons, as is also shown in the studies of Howard et al. (1983). Those two studies demonstrated the effectiveness of treatment intervention only in anxiety ratings but not in HR. That corresponds to the findings in the present study, indicating that treatment does not have an immediate and significant influence on the HR but on anxiety ratings. In contrast to that, treatment with virtual reality (Wiederhold et al., 2002) indicates HR reduction within a virtual treatment flight.

The response of LFnorm indicating sympathetic influence (Malliani et al., 1994; Malliani et al., 1991) shows differences between High-Anxious and Moderate-Anxious during specific situations and confirms the influence of anxiety on the sympathetic nervous system. Looking at the first three epochs on the beginning of the recordings of the seminar-days (the first minutes of a seminar-day), only recordings of the first day and third day showed differences between High-Anxious and Moderate-Anxious, thus probably indicating additional anticipatory anxiety and alertness for High-Anxious. Just like the values of mean HR, the simulator does not evoke a sympathetic activation for High-Anxious in LFnorm at the same level as the real flights. Differences in LFnorm between High-Anxious and Moderate-Anxious are evident in the hangar on the third day when visiting an airplane. Remarkable is that Moderate-Anxious showed lower LFnorm than High-Anxious and Controls on the out-going flight during cruising and on the in-coming flight during cruising (Figure 11 and 28). This might be an indication for the better adaptiveness of Moderate-Anxious within the real flight situation. However, the response of LFnorm of Controls does not confirm the relation between augmented LFnorm and the influence of anxiety because LFnorm of High-Anxious does not differ from Controls except during one or two situations as take-off, cruising. The response pattern of Controls suggests that LFnorm depends on emotion, on physical stressors and physical activation. Above finding emphasizes the importance of including Controls in studies of fear of flying with real flights in order to avoid false interpretations.

Differences between High-Anxious and Moderate-Anxious are also evident in the LF/HF balance score during specific situations. The response of log LF/HF reflects the dominant sympathetic activation of High-Anxious on the first day during 4 of the 6 situations, during landing in the simulator on the second day, and during the out-going flight after cruising for 30 minutes, and during the in-coming flight during cruising and before landing, on the third day. At the beginning of the second day log LF/HF of High-Anxious was significantly lower than at the beginning of the first day, indicating that the experience of the first day resulted in anxiety reduction for the High-Anxious.

However, boarding the first real flight involves for Controls a higher LFnorm and a higher log LF/HF ratio (see Figure 30), Controls may have interpreted the onset of ECG recording as stress, in addition to the overall hassle on airports, as reported by Bricker (2008). Also of interest is the fact that Controls show a high LF/HF ratio similar to High-Anxious when moving around, which suggests confirmation of the study of Wilhelm et al. (2006). That study proposes that physical activation may mask the emotion and that context information would be necessary when interpreting physiological response. The present study, however, can rely on clear comparisons of autonomic response related to anxiety by having taken physiological measurements when all subjects had been seated and had put on the seat belts, excluding any artifacts caused by moving.

Taken together, HR is, in accordance to arousal models, a potential indicator for fear of flying as postulated before (Abelson et al., 2001; Haug et al., 1987; Kawachi et al., 1995; Nesse et al., 1995; Roth et al., 1986; Wilhelm & Roth, 1998). The sympathetic driven reactions are expressed by the HR pattern during the overall seminar while the sympathetic driven reactions expressed by LFnorm and log LF/HF balance score are evident only during critical situations. The findings are in accordance to previous studies (Abelson et al., 2001; Hoehn-Saric & McLeod, 2000; Nesse et al., 1985; Roth et al., 1986) but give much more information on time course. The consideration of Controls shows that sympathetic reaction is not only related to anxiety.

4.1.4 Parameters indicating parasympathetic activity

Parasympathetic activity indicated by pNN50, RMSSD and HFnorm reflects the adaptability and sensitivity of the nervous system as proposed by Grossman (1983) and by Saul (1990). Studies regarding anxiety response patterns emphasize the dominant vagal role in anxiety (Albert et al., 2005; Ito et al., 1999; Hoehn-Saric & McLeod, 2000; Piccirillo et al., 1997; Watkins et al., 1998). The attenuated vagal influence is commonly interpreted as behavioral inflexibility, poor attentional control, and ineffective emotional regulation (Friedman & Thayer, 1998a).

Already on the first seminar-day, shortly after the beginning, Moderate-Anxious show higher HFnorm than High-Anxious, combined with a decrease in HR. That is an indication that Moderate-Anxious have more compensation skills from the beginning of the seminar on (see Figures 7 and 12). It seems that Moderate-Anxious benefit from the seminar and the repeated exposure, because their HFnorm is higher than that of High-Anxious during take-off and before landing on the flight-in. During these two situations HFnorm of Moderate-Anxious does not differ from Controls.

HFnorm and pNN50 of High-Anxious and Moderate-Anxious do not differ during the simulator, except during landing, when High-Anxious are probably more afraid as indicated by reduced HFnorm. The increase of HFnorm during relaxation indicates that High-Anxious are able to adapt quickly and confirms the effective respiratory alteration during *Jacobson progressive muscle relaxation.*

The expected vagal withdrawal expressed in HFnorm during the flight-out during take-off and cruising, and during the flight-in during landing (Figure 29), The vagal withdrawal expressed in pNN50 of High-Anxious and Moderate-Anxious compared to Controls was evident during the flight-out during take-off and during the flight-in during cruising after 10 minutes and before landing (Figure 26). This is in accordance with Lovallo (2005) that vagal inhibition is related to anxiety, or that vagal inhibition has an influence on the anxiety pattern of people with fear of flying compared to control subjects. This is also in conformity with anxiety models based on vagal tone as an indicator for autonomic flexibility and adaptability (Friedman, 2007; Friedman & Thayer, 1998b; Kawachi et al., 1995; Klein et al., 1995; Thayer & Lane, 2000; Yeragani et al., 1993; Yeragani et al., 1994).

All three groups showed comparable pNN50 values during the in-coming flight after cruising for 20 minutes, an indication of what may be interpreted as coping and adaptability of High-Anxious and Moderate-Anxious, whereas HR still differed throughout the flight between the groups.

During walking around in the duty free area there is no difference between the three groups neither expressed in pNN50 nor in HR.

The higher autonomic flexibility and adaptability of Controls compared to High-Anxious and Moderate-Anxious is demonstrated by their complex cardiac variability of HR. During boarding Controls are evidently stressed, as is shown by diminished parasympathetic and increased sympathetic activity (LF/HF). However, Controls adapt already during take-off by reaching higher vagal controlled values in HRV (pNN50, HF) compared to High-Anxious and Moderate-Anxious. Such an autonomic response of non-anxious subjects was also described by Hoehn-Saric and McLeod (1988). Hoehn-Saric and McLeod (2000) report that non-anxious individuals respond to stressors with a strong initial response but show a relatively quick return to baseline levels expressing adaptation when conditions seem to be under control. The results go conform with the polyvagal theory (Porges, 2001) that considers the vagally mediated HRV as an index showing how well a person is able to allocate psychophysiological resources in order to meet environmental demands.

The reduced vagal activity as indication of anxiety was shown in High-Anxious at the beginning of the first day (HFnorm), during the flight-out during take-off (HFnorm, pNN50, RMSSD), cruising (HFnorm. pNN50), landing and during the flight-in during take-off (HFnorm, pNN50), cruising (pNN50), and landing (HFnorm, pNN50, RMSSD).

SDNN has a close relation to the total frequency power, see Figures 8, 25, and Tables 11, 24, (Annex 9.2 and 9.15), herewith being an unspecific parameter. An increase of SDNN was evident for High-Anxious and Moderate-Anxious while boarding the simulator and while visiting the airplane in the hangar, in contrast to boarding the real flights, when SDNN shows the lowest values. Up to now SDNN has not yet been included in the studies regarding fear of flying but in this case it might be associated with stress experienced by individuals with flight anxiety when boarding real-flights.

4.1.5 Oxygen saturation and cortisol

The measurement of oxygen saturation (SpO_2) shows no difference between High-Anxious and Moderate-Anxious, differences are only visible in connection with different epochs. When comparing SpO_2 of the real flights with the SpO_2 at 170 m sea level oxygen saturation levels are reduced during the real flights, which has also been described by Gruen et al. (2008) and Roth et al. (2002) as an normal adaptive response of passengers. The response of oxygen saturation decreases equally in High-Anxious, Moderate-Anxious, and in Controls during real flights, confirming a relationship to lowered air pressure with reduced oxygen content in high altitudes. In addition to that, the present study shows that after take-off on the second real flight individuals with fear of flying show lower oxygen saturation values than Controls. This effect, which is even more remarkable due to the small group size, gives a hint that there could be a relation between anxiety and SpO_2. Similarly, hyperventilation during panic may cause the differences in SpO_2 (Roth et al., 2002). The sensitivity for suffocation signals may induce panic respiration, which in turn is related to decreased oxygen saturation. A relation between anxiety sensitivity and reduced level oxygen saturation was suggested by Bogaerde and De Raedt (2007). One might suspect that anxiety sensitivity which is, according to Bogaerde and De Raedt (2011), of relevance in people with fear regarding their somatic sensations. It can be assumed that this makes a person more vulnerable to adapt to high-altitudes. Not only adapting but also recovering might influence SpO_2 level, at least the results in the current study could be a hint that individuals with fear of flying are not as good as control persons without fear in adapting their oxygen saturation level to usual ground level of 97%, only Controls seem to succeed in this.

The hypothesed augmented cortisol level during exposure in real flight can be compared to the study of Bandelow et al. (2000), i.e. there is an increase of cortisol level in persons with acute panic disorder during a naturally evoked panic attack. Bandelow et al. (2000) underlined the importance of a naturalistic setting for the observed increase of cortisol level. For the flight phobics in the current study the exposure to the flight is a naturalistic setting related to their phobia and the exposure to a real flight might either provoke panic or contribute to the increase of cortisol. In accordance with Kirschbaum et al. (1994) an increase of experienced stress during the flight may cause the increase of cortisol level. Flight phobics experience more stress during the real flight that could be a reason why High-Anxious and Moderate-Anxious were characterized by significant higher levels of cortisol in comparison to the Control group.

4.1.6 Psychological response before, during, and after the seminar

Fear of flying is often assessed by considering psychological responses only (e.g. Tortella-Feliu & Rivas., 2001; van Gerwen et al., 2004). Up to now studies mainly compared measurements taken either before or after a real-flight, or considered only one measurement during flight. The present study depicts the time course of the psychological changes during the treatment at 14 situations including real-flights.

At the beginning of the seminar High-Anxious and Moderate-Anxious show differences in their source of anxiety. High-Anxious are characterized by higher *anticipatory anxiety* (FAS) and *cognitive anxiety* (FAM) as shown in Table 5. However, the differences disappear after completion of the seminar (Figures 19 and 20). Items related to *in-flight anxiety* (FAS) and items related to physical symptoms *somatic modality* (FAM) do not differ between High-Anxious and Moderate-Anxious. *Anticipatory flight anxiety*, *in-flight anxiety* and *generalized flight anxiety* (FAS) decreased significantly in High-Anxious and Moderate-Anxious (Figure 19). The ratings of somatic troubles *(modality)* as well as the ratings of fearful cognitions *(cognitive)* of the Flight Anxiety Modality (FAM) questionnaire (van Gerwen et al., 1999) are also significantly reduced in High-Anxious and Moderate-Anxious, as shown in Figure 20.

The scores of the *Body Sensations* Questionnaire (BSQ) and of the *Agoraphobic Cognitions Questionnaire (ACQ)* were significantly reduced in High-Anxious and Moderate-Anxious when pre to post ratings were compared (Figure 22). The self-rated mobility with or without a companion increases in High-Anxious and Moderate-Anxious from pre to post seminar, which can be seen in Figure 23.

State-anxiety and *trait-anxiety* (STAI) decreased in High-Anxious as well as in Moderate-Anxious from pre to post seminar (Figure 21).

Ratings of mood and anxiety showed that High-Anxious were characterized by more cognitive fear than Moderate-Anxious during the simulator session and during both real flights. During the simulator session the cognitive fear of High-Anxious was at nearly the same level as during the first flight, whereas in Moderate-Anxious the cognitive fear was lower during the simulator session. During the second flight cognitive fear attenuated in both anxiety groups (Moderate-Anxious and High-Anxious). Controls rated anxiety only during flights and showed no cognitive fear.

People with fear of flying consider themselves more confident and joyful the longer the seminar went on, but still less confident and joyful than Controls. The ratings on confidence and joy increased during the second flight only, and that was comparable in Moderate-Anxious and High-Anxious.

The displeasing physiological sensations decreased with the duration of the seminar, but did not reach the low level of Controls. During the second flight Moderate-Anxious and High-Anxious also reduced their diffuse fear.

Summarizing the ratings of anxiety and mood, a significant drop in anxiety can be observed, subjective ratings of fear *(physiological sensation, diffuse fear, cognitive fear)* were reduced, and confidence *(unconfidence/joyless)* has increased. The results confirm the hypothesis that subjective ratings mirror the efficiency of the treatment seminar. Cognitions and valence of fear of flying have been modified.

4.1.7 Integration of multiple response

The psychological ratings regarding fearful *cognitions, diffuse fear, physiological sensation* related to anxiety, and *confidence* mirror the improvement in association with the seminar very clearly. But there is no conclusion which parameter of HRV goes conform to subjective ratings. The time course of subjective ratings regarding fearful *cognitions* is comparable with the differences in HR between High-Anxious, Moderate-Anxious, and Controls. High-Anxious are characterized by higher HR and higher self reported anxiety cognitions. However, it is remarkable that the cognition change, thus showing a benefit from the seminar, is not evident in cardiac response patterns.

The real flights obviously showed higher autonomic response than the simulated flight (HR, LFnorm, pNN50) although the simulated flight was the first exposure to the feared situation during the three-day seminar. This is in opposition to the subjective ratings expressed by *physiological sensation*. The ratings on the scale *physiological sensation* differed between High-Anxious and Moderate-Anxious during the simulator most and also during the real flights, when High-Anxious describe more physiological sensations related to anxiety (Figure 15).

Diffuse fear was higher in High-Anxious at the beginning of the seminar and during the first real flight than in Moderate-Anxious (Figure 16). The increase of *joy and confidence* at the completion of the seminar may also influence the autonomic response pattern and deliver an explanation for the increased LFnorm in High-Anxious (Figure 28) during the second flight, especially during landing. The discordance between subjective ratings and the autonomic responding pattern was also described by Bornas et al. (2006), Nesse et al. (1985), Wilhelm and Roth (2001), and Busscher et al. (2010). Wilhelm and Roth (2001) reported only little concordance between HR and self-reported measure of heart pounding, they suggested that fear of flying subsumes a variety of anxiety disorders, that the measuring might have been not adequate, and that self-rated feelings might be memory biased.

The results of this study are conform with the study of Wilhelm and Roth (1998) regarding the HR responses of subjects with fear of flying and of control subjects without fear of flying. HR increases in fearful subjects during the real flights and remains high from pre to post flight, in contrast to self-reported anxiety. However, the results of this study differ in regard to vagal activation. In Wilhelm and Roth's (1998) study the vagal activation (RSA) diminishes during anxiety situations within individuals with fear of flying compared to control subjects. In the present study, diminished vagus as proposed by Friedman and Thayer (1998a), Kawachi et al. (1995), Piccirillo et al. (1997), Prigatano and Johnson (1974), and Thayer and Lane (2000) shows only in few critical situations, namely take-off, cruising of the first flight and landing of the second flight. During these situations the parasympathetic activity (pNN50, HFnorm), was reduced in both anxious groups differing from control group.

4.2 Discussion of Hypothesis 2 - Autonomic Space

HR is a leading index in anxiety research (Nesse et al., 1985; Kawachi et al., 1995). Berntson et al. (1991) emphasized with their model of autonomic space that end-point measures like the HR are ambiguous in respect to the functional state of the heart. Thus, according to their theory, the underlying modes of autonomic response have to be considered for psycho-physiological interpretations and the combinations of sympathetic and parasympathetic activities have to be considered in a bivariate form. The usefulness of the model of autonomic space has been proven in several laboratory studies with human subjects (Berntson et al., 1993b, 1994, 1996).

The descriptive exploration of HRV, LFnorm, and HFnorm representing sympathetic and parasympathetic modes of autonomic control in High-Anxious, Moderate-Anxious, and Controls during the fear of flying seminar is considered as an approach to the model of autonomic space. That exploration showed that there is an association between groups and frequency of prevailing patterns of cardiovascular activity, i.e. *autonomic modes*.

The main mode in High-Anxious was *baseline* indicating no remarkable change neither in LFnorm nor in HFnorm during 20 of 55 epochs, followed by the mode *uncoupled sympathetic activity* during 14 of 55 epochs as shown in Figure 38 and Table 8. Baseline occurred almost constantly on the first day, less frequently on the second day, and frequently on the third day (Figure 37). The noticeably frequent occurrence of baseline for High-Anxious on the third day during real flights may be an indication that the anxiety pattern of High-Anxious remains stable and is not influenced by the seminar compared to Moderate Anxious. The frequent occurrence of the mode uncoupled sympathetic activity during the real flights (cruising and landing) suggests that High-Anxious undergo strong fear which is dominated by sympathetic influence.

The main mode in Moderate-Anxious was *coinhibition* during 21 of 55 epochs, in particular during the return-flight (see Figures 37 and 38). This might be an indication that Moderate-Anxious manage the fear and are able to adapt to the feared situation during the return-flight. Moderate-Anxious also fulfilled the mode *uncoupled parasympathetic withdrawal* during 20 epochs, mainly during the flight-out. That mode emphasizes the close relation between anxiety and diminished vagal influence as described by Friedman (2007), Friedman and Thayer (1998b), Kawachi et al., (1995), Klein et al., (1995), Thayer and Lane, (2000), and Yeragani et al. (1993), and supports the polyvagal theory of Porges (2001).

The main mode in Controls was *uncoupled parasympathetic activation* in 9 of 23 epochs, whereas this mode applied only during three epochs for High-Anxious and during one epoch for Moderate-Anxious. This might confirm the importance of vagal influence on the autonomic control, high vagal capacity being related to cardiac autonomic regulatory capacity as a sign of positive health benefit (Berntson et. al, 2008a; Malliani et al., 1991; Stein & Kleiger, 1999) in opposition to a higher vulnerability of individuals paired with reduced vagal control (Horsten et al., 1999).

The *reciprocal* modes seem to have no influence in relation to anxiety or in Controls. That fact seems to be relevant since it underlines the principles of the model of Berntson et al. (1991) that multiple modes have more influence than reciprocal modes. The functional antagonism of sympathetic and parasympathetic activity is replaced by joined activity, emphasizing the fact that the reciprocal concept of autonomic balance is not sufficient to explain psycho-physiological processes.

The exploration of the autonomic modes after Berntson et al. (1991) emphasizes the different autonomic response patterns of High-Anxious, Moderate-Anxious, and Controls, which is not that clearly shown when only considering the output measurements HR or HRV. Though the usefulness of HR as indicator for fear is confirmed, the underlying activation puts additional light on the sympathetic and parasympathetic influence.

5 Conclusion

This study is a multi-system approach to the problem of fear of flying and was conducted in a natural environment. In reference to the literature that cognition, behavior, and physiology are relevant for the efficient treatment of anxiety (Wilhelm & Roth, 1998), the results in this study support the efficiency of the fear of flying seminar held by Austrian Airlines, since all three levels have improved. The seminar helps effectively to overcome the fear of flying since all participants took the graduate flight.

There is only very little research with ambulatory studies and in the past the analysis of HRV in connection with fear of flying was rare. Most of the studies included mainly HR as an indicator for physiological response (see chapter 1.5.2), which does not allow the systematic differentiation between sympathetic and parasympathetic activation as HRV analyses allow.

The analyses in this study of HRV support both the sympathetic reactivity theories and the vagal influence for fear of flying. The increase in sympathetic activation (HR, LFnorm) as well as the inhibition or withdrawal of vagal activation could be confirmed during some critical situations. Increase of HR and LFnorm during critical situations especially in High-Anxious underline the sympathetic influence. The withdrawal of vagal activity (pNN50, HF, RMSSD) in High-Anxious was evident in critical situations, although sympathetic and parasympathetic activity does not react in a reciprocal way. Therefore the traditional reciprocal model is not supported. There is no evidence for a typical cardiovascular autonomic response neither sympathetic nor vagal explaining the response in Controls compared with High-Anxious and Moderate-Anxious during real flights. Towards the end of the study and during critical situations Moderate-Anxious showed a better adaptation than High-Anxious and High-Anxious still showed higher sympathetic activation (HR, LFnorm).

The consideration of underlying activation for sympathetic and parasympathetic autonomic regulation as proposed by Berntson et al. (1991) provides additional aspects when sympathetic and parasympathetic activities dominate during feared situations. In future studies, also in ambulatory settings, the model of Berntson et al. (1991) should be implemented in order to provide more precise information for the interpretation of autonomic activity.

The subjective rating indicated the decrease of anxiety with the progress of the seminar. Measurements of oxygen saturation showed that Controls having no fear might recuperate more easily and more quickly than individuals with fear of flying. The level of cortisol concentrate during the flight was significantly higher in individuals with fear of flying, underlining the increased anxiety level of people with fear of flying.

5.1 Strengths of this study

This study has some strengths: It was a real field situation, with physiological and psychological measurements taken, including ambulatory recordings within real flights, requiring demanding and complicated organization of obtaining airport cooperation and special authorizations for passing through special security checks within an airport. A further strength is the inclusion of individuals who were motivated by themselves to overcome their fear of flying and wanted to participate in the seminar and who were not attracted by advertisement or payment. A further strength is the analysis of the autonomic respondings over the time course of the seminar, showing the variety within the treatment seminar during a multiplicity of epochs and not only the differences in baselines before and after a period of exposure. A further positive aspect is the inclusion of control subjects. The comparison to control subjects shows that in various situations their response is similar to that of people with fear of flying. This fact may provide relevant persuasive cognitive information in future treatment programs for people with fear of flying.

Even though the real flight avoiders would not take part in such treatment programs, there were participants who had never flown before and had high level of fear. The effectiveness of the seminar should encourage airlines to offer treatment for fear of flying in cooperation with professionals, being aware of the small drop-out rate in comparison with treatment facilities in virtual reality, the cost effectiveness of group treatment (Rothbaum et al., 2000), and the long term effectiveness (van Gerwen et al., 2006).

5.2 Limitations of this study

This study shows the efficiency of the fear of flying seminar based on physiological and psychological parameters measured during the time course of the seminar. However, the analyses during the real flights compared to control subjects are already the outcome of the preceding treatment during theoretical input and flight simulator, so there is no information on the fear ratings and autonomic responding before the beginning of the fear of flying seminar.

A remark has to be made to the size of the sample. This size is remarkable when taking into account the extensive pre-arrangements for real-flight studies, e.g. cooperation arrangements and investment of time and costs. Still, a larger sample size would enable a more reliable interpretation. Individual characteristics as gender and age could not be controlled due to the small sample size and were not systematically considered.

From a clinical point of view it would have been very interesting to explore if there is any comorbidity between fear of flying and other disorders, but in a regular fear of flying seminar it was not considered to go into depth as people were paying for the seminar. The inclusion and recording of a post baseline measurement was not possible, as people did not show enough compliance due to the overall situation. There are measurements from before the real flights available only for participants with fear of flying, which could easily be interpreted as pre-baseline. But when for e.g. the measurements taken just two hours before the flight are considered, which correspond to the epoch in the restaurant and are comparable to the baseline in the study of Wilhelm and Roth (1998), it becomes obvious that measurements vary extremely.

It should also be taken into consideration that the presence of the psychologist in the graduate flight and the overall group situation might be considered as safety signals for the participants since that does not reflect a normal flight situation and such a flight might be rated safer than usual flights taken on their own. It was expected that real avoiders would never participate in such treatment programs as stated by Bornas et al. (2006).

A follow-up of the treatment's success has not yet been undertaken.

The efficiency of the seminar has been proved by altered psychological ratings, but for long-term modifications the behavior has to be trained and long-term studies are necessary to confirm the efficiency.

Future ambulatory studies should also include explorations according to the model of autonomic space of Berntson et al. (1991), considering the individual's variability related to age, aerobic condition, and sex, as these factors contribute to the complexity in analyses of HRV (Berntson et al., 1993b). The present study focused only on group differences. In addition, the model of autonomic space is suggested to be applied by using independent measurements to determine sympathetic and parasympathetic autonomic activity.

6 Abstract

Both, flight anxiety and its treatment occur more frequently due to the increasing mobility of people. Despite the fact that an established fear of flying seminar is known to provide successful intervention, the accompanying physiological and psychological aspects are largely unclear. Lately, besides heart rate, heart rate variability (HRV) has also been used to measure cardiovascular activity related to anxiety with the advantage that parasympathetic activity can be determined relatively independent from sympathetic activity. Theoretically, the traditional reciprocal (antagonistic) regulation model of sympathetic and parasympathetic activity is accompanied by a model which entails coactivity (simultaneous change of sympathetic and parasympathetic activity) and independent activity (change in one system independent from the other) as possible regulation ("Autonomic Space", Berntson et al., 1991). Consequently, the interaction of sympathetic and parasympathetic activity determines in consequence the heart rate. An empirical examination of the relation between anxiety and HRV changes in a field study was missing up to now. Flight anxiety and its treatment were expected to show response patterns corresponding to the model of "Autonomic Space".

ECG recordings were taken from 24 individuals during the entire 3-days of the fear of flying seminar (Austrian Airlines) with exposures in a simulator and two real flights including repeated submitting of questionnaires concerning aspects of flight-anxiety and mood. Fifteen High-Anxious and 9 Moderate-Anxious were defined based on their ratings of flight anxiety assessed with the FAS. Additional data collection was conducted from 9 control persons without flight anxiety during the real flights. SDNN, pNN50, RMSSD, LFnorm, HFnorm, and log LF/HF of 5-minute intervals were calculated as HRV indicators.

The ratings of anxiety (FAS) showed remarkable reductions in High-Anxious (from 62 +/-10 to 15 +/-17) as well as in Moderate-Anxious (from 46 +/-13 to 12 +/-11). Similar effects were found for the subscales and for the ratings of mood.

Physiological data showed that heart rate increased in all groups during the real flights. However, significant differences between High-Anxious and Control persons were found for most of the flight time and between all groups during take-off. High-Anxious showed the highest values during boarding (M=115 bpm) and during take-off (M=111 bpm). LFnorm showed higher values for High-Anxious than for Moderate-Anxious, though the autonomic balance indicator (log LF/HF) showed no significant differences between the groups. Vagal activity (RMSSD, pNN50, HFnorm) showed no difference between groups.

In a further step the prevailing patterns of cardiovascular activity were analyzed and compared to baseline values. The results showed that cardiovascular activity during anxiety did not correspond to the traditional reciprocal model but the results could be interpreted according to the autonomic space model. In High-Anxious the patterns found were either *not changed* ("stable baseline") or sympathetic activation was accompanied by no parasympathetic activity (*uncoupled sympathetic activation*). In Moderate-Anxious mainly two patterns were found, a decrease of both parasympathetic and sympathetic activity (*coinhibiton*) and a decrease of parasympathetic activity in combination with no change in sympathetic activity (*uncoupled parasympathetic withdrawal*). Control persons mainly showed parasympathetic activity combined with unchanged sympathetic activity (*uncoupled parasympathetic activation*), whereas that pattern that was found only once in anxious groups.

Summing up, it can be said that as all participants succeeded in taking 2 real flights and showed a remarkable decrease of anxiety, the fear of flying seminar provides an efficient intervention both on behavioral response as well as towards subjective ratings. The accompanying cardiovascular activity shows, depending on the degree of anxiety, different response patterns in sympathetic and parasympathetic activity and therefore requires a more differentiated consideration in order to be related to anxiety.

7 Zusammenfassung

Sowohl Flugangst als auch deren Behandlung tritt mit zunehmender Mobilität der Menschen vermehrt auf. Obwohl ein etabliertes Flugangstseminar eine sehr erfolgreiche Intervention darstellt, sind die begleitenden physiologischen und zum Teil psychologischen Aspekte weithin unklar. Neben der Herzrate wird in letzter Zeit auch die Herzratenvariabilität (HRV) zur Messung kardiovaskulärer Aktivität in Zusammenhang mit Angst eingesetzt, weil sie den Vorzug bietet, parasympathische Aktivität relativ unabhängig von der sympathischen erfassen zu können. Theoretisch stehen sich das traditionelle „Gegenregulationsmodell" von sympathischer und parasympathischer Aktivität und die Erweiterung des Modells, wonach auch eine „Koaktivierung" (simultane Veränderung von Sympathikus- und Parasympathikusaktivität), aber auch eine unabhängige Aktivierung (Veränderung in einem System bei unverändertem anderen) möglich sei („Autonomic Space"; Berntson et al., 1991), gegenüber. Das Zusammenspiel beider Aktivitäten bestimmt dann die Herzrate. Eine empirische Prüfung des Zusammenhangs von Angst und der HRV Veränderungen im Feldversuch stand bis jetzt aus. Am Modell von Flugangst und deren Behandlung wurde erwartet, dass sich Reaktionsmuster entsprechend dem „Autonomic Space" beobachten lassen.

Im Rahmen von drei 3-tägigen Flugangstseminaren (angeboten von *Austrian Airlines*) mit Simulatorexposition und zwei Realflügen wurde von 24 Personen während des gesamten Seminars das EKG aufgezeichnet und es wurden wiederholt Fragebögen zu Aspekten der Flugangst und dem Befinden vorgegeben. Aufgrund der generalisierten Flugangst (FAS) wurden 15 Hochängstliche und 9 Moderatängstliche identifiziert. Bei den Realflügen erfolgte zusätzlich eine Datenerhebung an 9 Kontrollpersonen ohne Flugangst. Als Indikatoren der HRV wurden SDNN, pNN50, RMSSD, LFnorm, HFnorm und log LF/HF von 5-Minutenintervallen berechnet.

Die Skalierungen der Angst (FAS) zeigten sowohl bei Hochängstlichen (von 62 +/-10 auf 15 +/-17) als auch bei Moderatängstlichen (von 46 +/-13 auf 12 +/-11) eine deutliche Reduktion. Vergleichbare Effekte wurden auch in den Subskalen und in den Skalierungen des Befindens gefunden.

Die physiologischen Daten zeigten, dass die Herzrate bei den Realflügen zwar bei allen Gruppen anstieg, aber dennoch signifikante Unterschiede zwischen Hochängstlichen und Kontrollpersonen über die meiste Zeit der Flüge und zwischen allen Gruppen beim Take-off auftraten. Die höchsten Werte hatten Hochängstliche während des Boardings (M = 115 bpm) und beim Take-Off (M = 111 bpm). Die LFnorm zeigte höhere Werte bei den Hochängstlichen als den Moderatängstlichen, dennoch fand sich im Indikator der autonomen Balance (log LF/HF) zwischen den Gruppen kein signifikanter Unterschied. Auch in der vagalen Aktivität (RMSSD, pNN50, HFnorm) fanden sich keine Gruppenunterschiede.

In einem weiteren Analyseschritt wurden die vorherrschenden Muster der kardiovaskulären Aktivierungen während des Fluges mit Ausgangswerten verglichen. Die Ergebnisse zeigen, dass die kardiovaskuläre Aktivität unter Angst dem traditionellen Gegenregulationsmodell nicht entspricht, aber die Ergebnisse nach dem „Autonomic Space“ Modell interpretierbar sind. Bei Hochängstlichen findet sich vorwiegend entweder keine Veränderungen („stabil“) oder eine sympathische Aktivierung verbunden mit keiner parasympathischen Veränderung (*uncoupled sympathetic activation*). Bei Moderatängstlichen zeigten sich vorwiegend zwei Muster, eine Abnahme der parasympathischen und der sympathischen Aktivierung (*coinhibition*) bzw. eine Abnahme der parasympathischen Aktivierung und keine Veränderung in der sympathischen Aktivierung (*uncoupled parasympathetic withdrawal*). Bei Kontrollpersonen zeigte sich vorwiegend eine parasympathische Aktivierung verbunden mit einer unveränderte sympathische Aktivierung (*uncoupled parasympathic activation*), ein Muster, das bei Ängstlichen nur einmal auftrat.

Zusammenfassend lässt sich feststellen, dass das Flugangstseminar sowohl auf Verhaltensebene (alle Teilnehmer absolvierten 2 Realflüge) als auch im Empfinden (starke Reduktion der Angst) eine sehr wirksame Intervention darstellt. Die begleitende kardiovaskuläre Aktivierung zeigt je nach

Angstausmaß unterschiedliche Reaktionsmuster in sympathischer und parasympathischer Aktivität und bedarf somit einer differenzierteren Betrachtung, um mit Angst in einen Zusammenhang gebracht werden zu können.

8 Literature

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9 Annexes

9.1 Table 10. Mean heart rate

Table 10. Means, standard deviations and confidence intervals of heart rate during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls.

		Mean Heart Rate (BpM)														
Epoch	Marker	High-Anxious (HA) (N=9)				Moderate-Anxious (MA), (N=15)				Controls (C), (N=9)				Confidential Interval		
		M	SD	-0.95	†0,95	M	SD	-0.95	†0,95	M	SD	-0.95	†0,95	C vs MA	C vs HA	HA vs MA
1	Begin 1st day 1	95.65	7.07	90.22	101.09	91.56	13.15	84.27	98.84							
2	Begin 1st day 2	95.18	16.85	82.23	108.13	84.46	9.79	79.04	89.88							*
3	Psychologist 1	85.66	11.88	76.53	94.79	75.72	9.06	70.70	80.74							*
4	Psychologist 2	87.38	11.61	78.46	96.31	75.29	10.54	69.46	81.13							*
5	Captain	85.48	15.47	73.59	97.37	74.72	8.65	69.93	79.51							*
6	End 1st day 1	84.61	15.47	72.72	96.51	74.94	9.16	69.87	80.01							*
7	End 1st day 2	87.26	17.46	73.84	100.68	76.22	8.88	71.30	81.13							*
8	Begin 2nd day 1	88.34	20.01	72.97	103.72	84.12	16.51	74.98	93.27							
9	Begin 2nd day 2	84.50	17.90	70.74	98.25	81.86	13.61	74.33	89.40							
10	Simulator boarding	96.10	17.04	83.00	109.20	87.33	13.27	79.98	94.68							
11	Seating	88.93	13.31	78.70	99.16	84.25	10.62	78.37	90.14							
12	Take-off	85.70	12.21	76.31	95.08	76.93	9.23	71.82	82.04							*
13	Turbulence	83.53	11.45	74.73	92.33	78.46	9.40	73.26	83.67							
14	Cruising	83.34	13.29	73.12	93.55	74.64	9.22	69.54	79.75							*
15	Relaxing	80.94	18.47	66.74	95.14	72.08	9.41	66.87	77.30							*
16	Descent	82.21	13.26	72.02	92.40	79.00	9.00	74.02	83.99							
17	Landing	87.58	20.54	71.79	103.36	78.67	16.83	69.35	87.99							
18	Restaurant 1	94.52	18.26	80.48	108.56	85.67	16.65	76.45	94.89							
19	Restaurant 2	87.61	13.54	77.21	98.02	83.01	13.54	75.51	90.50							
20	End 2nd day	87.88	15.83	75.71	100.05	81.17	10.15	75.54	86.79							
21	Begin 3rd day 1	95.23	21.57	78.65	111.81	86.12	9.82	80.67	91.56							†
22	Begin 3rd day 2	91.62	20.44	75.90	107.33	83.56	10.02	78.01	89.11							†
23	Hangar	93.91	18.25	79.88	107.94	85.86	9.77	80.45	91.27							*
24	Airplane Visit	89.43	13.49	79.07	99.80	86.85	9.51	81.58	92.12							
25	Restaurant 1	90.33	12.04	81.08	99.58	85.68	7.91	81.30	90.06							†
26	Restaurant 2	88.86	9.49	81.57	96.16	84.68	10.73	78.73	90.62							
27	Crew 1	92.42	15.31	80.65	104.19	91.84	11.49	85.47	98.20							†
28	Crew 2	94.70	15.25	82.97	106.42	91.50	12.57	84.53	98.46							
29	Briefing	90.26	13.35	80.00	100.52	89.35	10.02	83.80	94.90							
30	Lounge 1	102.82	16.54	90.10	115.53	97.75	9.59	92.45	103.06	85.62	0.05	85.18	86.05			†
31	Lounge 2	99.69	20.08	84.25	115.12	93.99	11.98	87.36	100.63	92.51	8.98	70.20	114.81			
32	Boarding out	115.43	17.48	101.99	128.86	105.65	13.99	97.91	113.40	108.81	10.47	100.76	116.87			*
33	Seating out	103.57	14.40	92.51	114.64	96.40	12.70	89.37	103.44	89.96	7.28	84.36	95.56	†	*	
34	Engines on	101.74	14.88	90.30	113.18	93.47	12.12	86.75	100.18	82.75	8.76	76.02	89.48	*	*	*
35	Take-off	111.27	15.40	99.44	123.11	96.43	15.08	88.08	104.78	81.80	9.06	74.83	88.76	*	*	*
36	Cruising 10 min	99.12	12.15	89.79	108.46	92.51	13.51	85.03	99.99	81.80	8.08	75.59	88.01	*	*	
37	Cruising 20 min	98.32	13.48	87.96	108.68	93.01	12.60	86.03	99.98	84.75	8.71	78.05	91.45	†	*	
38	Cruising 30 min	99.09	11.43	90.31	107.88	91.29	13.29	83.93	98.65	84.87	9.31	77.72	92.03	†	*	†
39	Descent	95.65	9.31	88.49	102.80	87.83	14.88	79.59	96.07	80.21	6.14	75.48	84.93	†	*	†
40	10 min to landing	94.14	10.00	86.45	101.82	88.05	15.80	79.29	96.80	79.40	7.43	73.69	85.11	†	*	
41	5 min to landing	95.31	9.82	87.76	102.86	87.23	15.68	78.55	95.92	79.63	7.55	73.82	85.43	†	*	†
42	Landing	94.76	10.10	87.00	102.53	87.45	14.38	79.49	95.42	80.19	6.77	74.98	85.39	†	*	
43	Duty Free 1	102.72	16.00	90.43	115.02	95.62	11.54	89.23	102.01	92.50	10.38	84.52	100.48		*	†
44	Duty Free 2	108.40	13.36	98.13	118.66	100.39	13.07	93.15	107.63	100.39	12.48	90.80	109.99			†
45	Boarding In	109.49	18.17	95.52	123.46	101.22	15.73	92.51	109.94	98.39	11.96	89.20	107.58		*	
46	Seating In	102.76	15.34	90.97	114.55	94.20	16.30	85.18	103.23	89.44	8.59	82.84	96.04		*	
47	Engines on	93.54	13.08	83.48	103.60	89.97	14.01	82.21	97.73	83.53	8.71	76.84	90.22		*	
48	Take-off	103.77	16.50	91.09	116.45	89.86	15.39	81.34	98.39	78.52	7.69	72.61	84.43	*	*	*
49	Cruising 10 min	95.18	11.22	86.55	103.80	86.86	13.71	79.27	94.45	80.08	7.66	74.19	85.96	†	*	*
50	Cruising 20 min	92.72	11.90	83.57	101.87	87.63	12.71	80.59	94.67	81.68	7.66	75.78	87.57		*	
51	Cruising 30 min	93.94	12.64	84.22	103.65	87.94	11.17	81.75	94.13	83.91	6.45	78.94	88.87		*	
52	Descent	96.33	14.68	85.05	107.62	87.72	12.10	81.01	94.42	81.35	5.42	77.18	85.51	†	*	*
53	10 min to landing	94.29	12.54	84.65	103.93	85.83	11.34	79.55	92.11	78.17	6.99	72.79	83.54	*	*	*
54	5 min to landing	95.13	10.49	87.06	103.19	85.29	12.51	78.36	92.22	75.15	5.24	71.12	79.18	*	*	*
55	Landing	96.86	13.12	86.78	106.95	84.68	11.06	78.55	90.80	74.82	6.42	69.88	79.76	*	*	*

Beats per Minute (bpm); Confidence intervals between Controls (C) vs High-Anxious (HA) or Moderate-Anxious (MA). * $p < 0.05$, † $p < 0.10$

9.2 *Table 11. SDNN*

Table 11. Means, standard deviations and confidence intervals of SDNN (ms) during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls.

		SDNN (ms9														
Epoch	Marker	High-Anxious (HA) (N=9)				Moderate-Anxious (MA), (N=15)				Controls (C), (N=9)				Confidential Interval		
		M	SD	-0.95	†0,95	M	SD	-0.95	†0,95	M	SD	-0.95	†0,95	C vs MA	C vs HA	HA vs MA
1	Begin 1st day 1	69.46	18.20	55.46	83.45	58.65	19.31	47.95	69.34							*
2	Begin 1st day 2	67.76	16.68	54.93	80.58	50.09	16.88	40.74	59.43							*
3	Psychologist 1	63.07	22.83	45.52	80.61	49.73	12.91	42.58	56.88							
4	Psychologist 2	57.27	25.07	38.00	76.54	47.89	13.11	40.63	55.16							
5	Captain	56.06	30.72	32.44	79.67	52.23	13.37	44.83	59.64							
6	End 1st day 1	61.20	24.08	42.69	79.71	54.92	12.77	47.85	61.99							
7	End 1st day 2	59.20	27.17	38.32	80.08	56.69	9.91	51.21	62.18							
8	Begin 2nd day 1	73.62	37.61	44.71	102.53	58.48	20.28	47.25	69.71							
9	Begin 2nd day 2	69.14	32.01	44.54	93.75	59.39	20.73	47.91	70.87							
10	Simulator boarding	84.68	42.50	52.01	117.35	73.58	24.25	60.15	87.01							
11	Seating	96.82	26.67	76.33	117.32	75.06	18.96	64.56	85.56							*
12	Take-off	86.57	30.90	62.81	110.32	61.18	15.57	52.56	69.80							*
13	Turbulence	75.27	15.94	63.01	87.52	62.29	16.74	53.02	71.56							*
14	Cruising	80.82	31.70	56.46	105.19	54.98	14.22	47.10	62.86							*
15	Relaxing	63.98	41.65	31.96	95.99	63.68	17.45	54.02	73.34							
16	Descent	82.24	32.15	57.54	106.95	71.79	21.40	59.94	83.64							†
17	Landing	79.78	45.28	44.97	114.59	60.35	12.96	53.18	67.53							
18	Restaurant 1	50.33	32.13	25.64	75.03	43.60	12.75	36.54	50.66							
19	Restaurant 2	71.60	41.94	39.36	103.84	57.83	16.19	48.87	66.80							
20	End 2nd day	64.99	41.04	33.44	96.54	50.10	13.54	42.60	57.60							
21	Begin 3rd day 1	63.48	22.93	45.85	81.10	62.36	11.97	55.73	68.99							
22	Begin 3rd day 2	62.03	34.11	35.81	88.25	54.25	10.94	48.19	60.30							
23	Hangar	51.40	23.91	33.02	69.78	49.51	15.77	40.77	58.24							
24	Airplane Visit	94.87	39.77	64.29	125.44	82.79	31.24	65.49	100.09							
25	Restaurant 1	64.38	23.36	46.42	82.33	54.53	22.18	42.24	66.81							
26	Restaurant 2	59.46	31.55	35.20	83.71	52.39	20.86	40.84	63.94							
27	Crew 1	50.77	20.20	35.24	66.29	36.66	15.64	28.00	45.32							†
28	Crew 2	60.27	30.10	37.13	83.41	45.40	20.89	33.83	56.97							†
29	Briefing	52.63	20.98	36.51	68.76	38.76	15.95	29.93	47.59							†
30	Lounge 1	59.37	31.45	35.19	83.54	53.34	19.56	42.51	64.17	50.25	22.98	-156.23	256.73			
31	Lounge 2	53.19	20.43	37.49	68.89	46.31	17.66	36.53	56.09	48.83	12.20	18.53	79.14			
32	Boarding out	41.26	17.03	28.16	54.35	39.71	17.82	29.84	49.58	51.46	19.95	36.12	66.79	†		
33	Seating out	57.21	13.00	47.22	67.20	45.45	16.71	36.20	54.71	49.40	16.18	36.97	61.83			*
34	Engines on	49.49	19.92	34.17	64.80	41.94	14.37	33.98	49.90	43.87	13.72	33.32	54.41			
35	Take-off	53.59	19.42	38.66	68.52	45.60	11.67	39.14	52.06	48.10	20.64	32.23	63.97			
36	Cruising 10 min	56.00	19.31	41.16	70.84	45.58	14.69	37.45	53.71	51.76	15.04	40.20	63.31			†
37	Cruising 20 min	63.44	18.94	48.88	78.00	46.03	15.13	37.65	54.41	48.86	13.93	38.15	59.56		*	*
38	Cruising 30 min	58.39	16.84	45.45	71.33	55.33	17.21	45.80	64.86	51.18	22.32	34.02	68.33			
39	Descent	50.93	21.18	34.66	67.21	45.35	14.07	37.55	53.14	51.88	18.73	37.48	66.28			
40	10 min to landing	54.49	11.15	45.92	63.06	44.80	16.33	35.76	53.84	48.99	14.69	37.70	60.28			*
41	5 min to landing	54.83	7.49	49.07	60.59	39.50	12.88	32.37	46.63	49.12	15.45	37.24	61.00	*		*
42	Landing	54.26	14.47	43.13	65.38	42.25	13.41	34.82	49.67	50.17	19.32	35.32	65.02			*
43	Duty Free 1	51.79	15.63	39.77	63.81	42.99	13.09	35.74	50.24	45.04	10.12	37.27	52.82			
44	Duty Free 2	39.70	12.89	29.79	49.61	39.12	14.44	31.12	47.12	45.20	19.14	30.49	59.91			
45	Boarding In	53.00	32.94	27.68	78.32	48.84	17.93	38.91	58.77	47.63	20.77	31.67	63.60			
46	Seating In	54.88	22.91	37.27	72.49	48.05	20.84	36.51	59.59	54.01	11.16	45.43	62.59			
47	Engines on	56.77	22.67	39.34	74.19	39.29	15.81	30.54	48.05	46.91	15.89	34.70	59.12			*
48	Take-off	52.96	22.57	35.61	70.30	45.37	20.15	34.21	56.53	45.50	16.62	32.72	58.28			
49	Cruising 10 min	49.00	10.85	40.66	57.34	41.73	13.33	34.34	49.11	54.63	24.77	35.59	73.67	*		
50	Cruising 20 min	58.30	23.08	40.56	76.04	47.05	20.33	35.80	58.31	50.90	14.78	39.54	62.26			
51	Cruising 30 min	58.91	30.59	35.40	82.43	51.65	22.19	39.36	63.94	45.70	9.16	38.66	52.74			
52	Descent	59.87	28.33	38.09	81.64	54.67	25.46	40.57	68.76	55.11	17.78	41.44	68.78			
53	10 min to landing	51.22	16.50	38.54	63.91	47.21	16.22	38.23	56.19	61.18	16.95	48.15	74.20	*		
54	5 min to landing	45.24	17.65	31.68	58.81	42.75	13.78	35.12	50.38	54.92	26.84	34.29	75.56	†		
55	Landing	51.29	22.09	34.31	68.27	44.60	16.39	35.53	53.67	58.51	28.21	36.83	80.19	†		

Confidence intervals between Controls (C) vs Moderate-Anxious (MA) or High-Anxious (HA). * $p < 0.05$, † $p < 0.10$.

9.3 Table 12. PNN50

Table 12. Means, standard deviations and confidence intervals of pNN50 during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls.

		pNN50 %														
Epoch	Marker	High-Anxious (HA) (N=9)				Moderate-Anxious (MA), (N=15)				Controls (C), (N=9)				Confidential Interval		
		M	SD	-0.95	†0,95	M	SD	-0.95	†0,95	M	SD	-0.95	†0,95	C vs MA	C vs HA	HA vs MA
1	Begin 1st day 1	0.06	0.05	0.02	0.10	0.08	0.15	0.00	0.16							
2	Begin 1st day 2	0.09	0.07	0.03	0.14	0.06	0.05	0.03	0.08							†
3	Psychologist 1	0.10	0.12	0.01	0.20	0.09	0.08	0.04	0.13							
4	Psychologist 2	0.08	0.09	0.01	0.15	0.08	0.08	0.03	0.13							
5	Captain	0.10	0.13	0.00	0.20	0.09	0.07	0.05	0.13							
6	End 1st day 1	0.10	0.13	0.00	0.20	0.09	0.07	0.05	0.13							†
7	End 1st day 2	0.09	0.11	0.01	0.18	0.09	0.08	0.04	0.13							
8	Begin 2nd day 1	0.17	0.15	0.05	0.28	0.10	0.11	0.04	0.17							
9	Begin 2nd day 2	0.15	0.16	0.03	0.28	0.10	0.13	0.04	0.17							
10	Simulator boarding	0.12	0.13	0.02	0.21	0.08	0.14	0.00	0.16							
11	Seating	0.17	0.11	0.09	0.26	0.13	0.12	0.06	0.20							
12	Take-off	0.17	0.14	0.06	0.27	0.11	0.07	0.07	0.15							†
13	Turbulence	0.16	0.11	0.07	0.24	0.12	0.10	0.06	0.17							
14	Cruising	0.14	0.14	0.03	0.25	0.11	0.06	0.07	0.14							
15	Relaxing	0.15	0.17	0.02	0.28	0.12	0.08	0.07	0.17							
16	Descent	0.13	0.12	0.03	0.22	0.10	0.07	0.06	0.14							
17	Landing	0.14	0.16	0.02	0.27	0.10	0.09	0.05	0.15							
18	Restaurant 1	0.08	0.12	-0.02	0.17	0.05	0.05	0.03	0.08							
19	Restaurant 2	0.09	0.12	0.01	0.18	0.08	0.05	0.05	0.11							
20	End 2nd day	0.09	0.13	-0.01	0.19	0.07	0.06	0.04	0.10							
21	Begin 3rd day 1	0.10	0.11	0.02	0.19	0.10	0.10	0.05	0.16							
22	Begin 3rd day 2	0.11	0.12	0.02	0.20	0.08	0.10	0.03	0.14							
23	Hangar	0.06	0.09	-0.01	0.13	0.07	0.13	0.00	0.14							
24	Airplane Visit	0.11	0.09	0.04	0.18	0.10	0.14	0.02	0.18							
25	Restaurant 1	0.06	0.07	0.01	0.12	0.08	0.11	0.02	0.14							
26	Restaurant 2	0.06	0.05	0.02	0.09	0.09	0.13	0.02	0.16							
27	Crew 1	0.06	0.10	-0.02	0.14	0.06	0.14	-0.01	0.14							
28	Crew 2	0.06	0.10	-0.01	0.14	0.04	0.07	0.00	0.08							
29	Briefing	0.08	0.10	0.00	0.15	0.04	0.07	0.00	0.08							
30	Lounge 1	0.07	0.09	0.00	0.14	0.06	0.10	0.01	0.12	0.05	0.06	-0.52	0.61			
31	Lounge 2	0.07	0.11	-0.01	0.15	0.08	0.11	0.02	0.14	0.03	0.03	-0.05	0.12			
32	Boarding out	0.07	0.11	-0.01	0.15	0.06	0.10	0.00	0.11	0.02	0.02	0.01	0.04			
33	Seating out	0.06	0.05	0.02	0.10	0.06	0.06	0.02	0.09	0.05	0.05	0.01	0.09			
34	Engines on	0.07	0.06	0.02	0.11	0.03	0.02	0.02	0.04	0.07	0.08	0.01	0.13	*	†	†
35	Take-off	0.04	0.06	-0.01	0.09	0.04	0.04	0.01	0.06	0.10	0.11	0.02	0.18	*	*	
36	Cruising 10 min	0.05	0.03	0.03	0.07	0.06	0.05	0.03	0.09	0.08	0.07	0.03	0.13		†	
37	Cruising 20 min	0.08	0.09	0.01	0.15	0.05	0.06	0.02	0.08	0.10	0.10	0.02	0.17	†		
38	Cruising 30 min	0.06	0.04	0.03	0.09	0.08	0.07	0.04	0.12	0.07	0.09	0.01	0.14			
39	Descent	0.06	0.06	0.02	0.11	0.05	0.03	0.03	0.06	0.08	0.09	0.01	0.15			
40	10 min to landing	0.08	0.05	0.03	0.12	0.05	0.04	0.03	0.07	0.10	0.10	0.02	0.17	*		†
41	5 min to landing	0.06	0.05	0.03	0.10	0.04	0.05	0.02	0.07	0.09	0.11	0.01	0.17	*		
42	Landing	0.07	0.06	0.03	0.12	0.04	0.03	0.02	0.05	0.09	0.09	0.02	0.16	*		*
43	Duty Free 1	0.06	0.04	0.03	0.09	0.04	0.03	0.02	0.06	0.03	0.03	0.01	0.05		*	†
44	Duty Free 2	0.03	0.02	0.01	0.05	0.05	0.08	0.01	0.10	0.02	0.03	0.00	0.05			
45	Boarding In	0.05	0.06	0.00	0.09	0.05	0.05	0.03	0.08	0.02	0.03	0.00	0.04	†		
46	Seating In	0.05	0.07	-0.01	0.10	0.05	0.05	0.02	0.08	0.04	0.03	0.02	0.07			
47	Engines on	0.08	0.10	0.01	0.16	0.07	0.12	0.00	0.14	0.07	0.08	0.01	0.13			
48	Take-off	0.03	0.03	0.01	0.05	0.05	0.05	0.02	0.08	0.08	0.10	0.01	0.16		*	
49	Cruising 10 min	0.03	0.03	0.01	0.05	0.04	0.03	0.03	0.06	0.08	0.10	0.01	0.15	*	*	
50	Cruising 20 min	0.07	0.07	0.02	0.13	0.08	0.15	0.00	0.16	0.08	0.07	0.02	0.13			
51	Cruising 30 min	0.07	0.10	0.00	0.15	0.04	0.05	0.02	0.07	0.04	0.03	0.02	0.06			
52	Descent	0.08	0.08	0.02	0.14	0.06	0.05	0.04	0.09	0.08	0.08	0.02	0.15			
53	10 min to landing	0.08	0.08	0.03	0.14	0.05	0.07	0.02	0.09	0.13	0.12	0.04	0.22	*		
54	5 min to landing	0.05	0.05	0.01	0.08	0.06	0.07	0.02	0.10	0.14	0.14	0.03	0.25	*	*	
55	Landing	0.06	0.05	0.02	0.10	0.06	0.08	0.01	0.10	0.15	0.15	0.03	0.26	*	*	

Confidence intervals between Controls (C) vs Moderate-Anxious (MA) or High-Anxious (HA).
* $p < 0.05$, † $p < 0.10$.

9.4 Table 13. RMSSD

Table 13. Means, standard deviations and confidence intervals of RMSSD (ms) during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls.

		RMSSD (ms)														
Epoch	Marker	High-Anxious (HA) (N=9)				Moderate-Anxious (MA), (N=15)				Controls (C), (N=9)				Confidential Interval		
		M	SD	-0.95	†0,95	M	SD	-0.95	†0,95	M	SD	-0.95	†0,95	C vs MA	C vs. HA	HA vs MA
1	Begin 1st day 1	25.59	9.80	18.05	33.13	27.83	19.17	17.22	38.45							
2	Begin 1st day 2	27.78	12.49	18.18	37.38	27.09	9.19	22.00	32.17							
3	Psychologist 1	28.40	16.18	15.96	40.84	31.14	12.16	24.41	37.87							
4	Psychologist 2	26.26	12.52	16.63	35.88	28.71	9.17	23.63	33.79							
5	Captain	29.09	15.20	17.40	40.77	30.59	9.84	25.15	36.04							
6	End 1st day 1	29.31	14.92	17.84	40.78	32.42	9.72	27.04	37.80							
7	End 1st day 2	28.70	13.42	18.38	39.02	30.35	9.77	24.94	35.76							
8	Begin 2nd day 1	38.21	19.91	22.91	53.51	32.46	14.80	24.26	40.66							
9	Begin 2nd day 2	37.90	19.67	22.78	53.02	30.94	17.01	21.52	40.36							
10	Simulator boarding	34.60	17.60	21.07	48.13	28.20	18.22	18.11	38.29							
11	Seating	40.02	12.05	30.76	49.28	33.79	14.82	25.58	41.99							
12	Take-off	39.62	18.34	25.53	53.72	34.19	10.01	28.65	39.74							
13	Turbulence	38.20	13.39	27.91	48.49	35.36	14.09	27.56	43.16							
14	Cruising	37.72	17.44	24.31	51.13	32.99	8.36	28.36	37.62							
15	Relaxing	34.28	21.59	17.68	50.87	34.41	10.19	28.76	40.05							
16	Descent	35.03	15.18	23.37	46.70	33.49	13.11	26.23	40.76							
17	Landing	36.06	21.64	19.42	52.69	32.88	11.27	26.64	39.12							
18	Restaurant 1	26.51	16.29	13.99	39.03	24.87	8.56	20.13	29.62							
19	Restaurant 2	32.10	16.94	19.08	45.12	29.99	7.69	25.73	34.25							
20	End 2nd day	29.96	14.99	18.43	41.48	28.45	11.03	22.34	34.55							
21	Begin 3rd day 1	29.87	15.78	17.74	42.00	31.80	12.77	24.73	38.87							
22	Begin 3rd day 2	31.20	16.65	18.40	44.00	29.03	15.59	20.39	37.66							
23	Hangar	24.84	12.03	15.60	34.09	28.20	18.85	17.76	38.64							
24	Airplane Visit	31.26	11.93	22.08	40.43	32.49	19.00	21.97	43.01							
25	Restaurant 1	26.88	7.91	20.80	32.95	28.71	16.55	19.55	37.88							
26	Restaurant 2	26.01	7.47	20.27	31.76	31.21	18.69	20.86	41.55							
27	Crew 1	22.88	12.92	12.94	32.81	24.41	22.13	12.16	36.67							
28	Crew 2	23.39	14.29	12.40	34.38	22.51	12.47	15.60	29.41							
29	Briefing	25.97	13.12	15.88	36.05	23.02	14.26	15.12	30.92							
30	Lounge 1	24.09	12.83	14.23	33.95	26.49	14.37	18.53	34.44	23.25	10.39	-70.14	116.64			
31	Lounge 2	24.92	15.26	13.19	36.65	27.53	15.50	18.95	36.12	21.20	8.33	0.51	41.89			
32	Boarding out	23.49	16.08	11.13	35.85	22.37	17.24	12.82	31.92	15.81	5.30	11.74	19.89			
33	Seating out	25.86	7.01	20.47	31.24	26.31	12.81	19.22	33.41	24.86	6.85	19.59	30.12			
34	Engines on	25.28	9.10	18.29	32.27	21.98	7.29	17.94	26.02	26.96	10.59	18.81	35.10			
35	Take-off	19.58	11.91	10.42	28.73	22.49	10.19	16.85	28.14	28.68	13.72	18.13	39.23		*	†
36	Cruising 10 min	24.52	6.71	19.36	29.68	28.15	9.64	22.81	33.49	28.68	7.94	22.57	34.78			
37	Cruising 20 min	28.84	10.40	20.85	36.84	25.51	12.55	18.56	32.46	28.97	9.83	21.41	36.52			
38	Cruising 30 min	25.69	7.43	19.98	31.40	31.89	12.30	25.08	38.71	25.96	13.38	15.67	36.24			†
39	Descent	25.69	10.83	17.37	34.01	26.25	7.35	22.18	30.33	28.53	12.34	19.05	38.02			
40	10 min to landing	28.32	9.01	21.40	35.25	27.16	10.77	21.20	33.12	28.97	12.26	19.54	38.39			
41	5 min to landing	27.04	6.70	21.90	32.19	25.19	12.45	18.30	32.09	27.24	12.02	18.00	36.49			
42	Landing	27.28	10.41	19.27	35.28	25.35	6.14	21.95	28.74	28.19	11.93	19.02	37.36			
43	Duty Free 1	26.47	6.09	21.78	31.15	24.24	7.75	19.95	28.53	20.26	6.02	15.63	24.88		*	
44	Duty Free 2	20.24	7.09	14.80	25.69	24.13	14.62	16.03	32.23	17.76	8.05	11.57	23.94			
45	Boarding In	21.73	11.60	12.81	30.65	24.53	10.85	18.52	30.54	17.98	6.75	12.79	23.16			
46	Seating In	22.22	11.58	13.32	31.12	24.42	9.80	19.00	29.84	23.18	6.10	18.49	27.87			
47	Engines on	27.57	10.48	19.51	35.62	26.33	17.80	16.47	36.19	26.30	8.48	19.78	32.82			
48	Take-off	20.20	6.78	14.99	25.41	25.29	7.19	21.31	29.27	26.86	11.16	18.28	35.44		*	
49	Cruising 10 min	21.81	6.10	17.12	26.50	24.82	10.32	19.10	30.54	27.29	12.25	17.87	36.71			
50	Cruising 20 min	27.90	11.28	19.23	36.57	29.52	22.83	16.88	42.16	27.48	8.91	20.63	34.33			
51	Cruising 30 min	27.29	11.54	18.41	36.16	24.91	9.92	19.42	30.41	23.41	4.37	20.06	26.77			
52	Descent	28.87	10.83	20.55	37.19	28.46	8.91	23.53	33.39	27.73	11.02	19.26	36.21			
53	10 min to landing	28.86	10.32	20.92	36.79	26.61	11.53	20.23	33.00	34.48	11.51	25.63	43.33			
54	5 min to landing	22.68	8.41	16.21	29.14	27.89	10.53	22.06	33.72	33.60	19.14	18.89	48.31		*	
55	Landing	26.68	8.60	20.06	33.29	27.13	12.92	19.98	34.29	35.61	20.52	19.84	51.38			

Confidence intervals between Controls (C) vs Moderate-Anxious (MA) or High-Anxious (HA).
* $p < 0.05$, † $p < 0.10$.

9.5 Table 14. LFnorm

Table 14. Means, standard deviations and confidence intervals of LFnorm during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls. LFnorm=LF(ms²)/[(TP(ms²)-VLF(ms²)]x100 (see Tables 24, 25, and 26 for underlying data)

		LFnu														
Epoch	Marker	High-Anxious (HA), (N=9)				Moderate-Anxious (MA), (N=15)				Controls (C), (N=9)				Confidential Interval		
		M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	C vs. MA	C vs HA	HA vs MA
1	Begin 1st day 1	56.06	7.10	41.34	70.78	32.26	5.50	20.85	43.66							*
2	Begin 1st day 2	47.61	6.92	33.26	61.96	47.39	5.36	36.28	58.51							*
3	Psychologist 1	52.82	4.78	42.92	62.73	53.56	3.70	45.89	61.24							
4	Psychologist 2	57.08	6.94	42.69	71.46	51.33	5.37	40.18	62.47							
5	Captain	61.80	4.19	53.12	70.49	48.20	3.24	41.48	54.93							*
6	End 1st day 1	68.30	5.11	57.70	78.91	56.02	3.96	47.81	64.23							*
7	End 1st day 2	58.44	6.06	45.87	71.01	55.32	4.70	45.58	65.05							
8	Begin 2nd day 1	44.15	6.22	31.25	57.04	51.56	4.82	41.57	61.55							
9	Begin 2nd day 2	57.50	6.90	43.19	71.81	47.71	5.34	36.63	58.80							†
10	Simulator boarding	37.88	6.59	24.22	51.54	32.28	5.10	21.70	42.86							
11	Seating	37.75	7.78	21.62	53.88	32.44	6.03	19.95	44.94							
12	Take-off	53.64	6.10	40.98	66.30	52.97	4.73	43.17	62.78							
13	Turbulence	59.67	6.49	46.22	73.12	51.85	5.02	41.43	62.27							
14	Cruising	51.70	4.88	41.57	61.82	58.29	3.78	50.44	66.13							
15	Relaxing	51.78	5.88	39.58	63.97	55.45	4.55	46.01	64.90							
16	Descent	55.98	7.00	41.47	70.50	51.05	5.42	39.80	62.29							
17	Landing	36.96	8.16	20.05	53.88	41.27	6.32	28.17	54.38							
18	Restaurant 1	59.73	5.47	48.38	71.07	52.52	4.24	43.73	61.31							
19	Restaurant 2	58.02	7.45	42.58	73.46	51.27	5.77	39.31	63.23							
20	End 2nd day	63.80	4.38	54.72	72.88	67.57	3.39	60.54	74.60							
21	Begin 3rd day 1	43.80	8.09	27.02	60.58	50.61	6.27	37.61	63.61							*
22	Begin 3rd day 2	62.69	6.69	48.82	76.55	41.90	5.18	31.16	52.64							
23	Hangar	67.58	4.90	57.43	77.74	56.57	3.79	48.70	64.44							*
24	Airplane Visit	38.42	6.88	24.16	52.69	25.46	5.33	14.41	36.51							†
25	Restaurant 1	60.66	6.58	47.02	74.30	53.25	5.10	42.69	63.82							
26	Restaurant 2	60.00	5.33	48.95	71.05	56.87	4.13	48.32	65.43							
27	Crew 1	55.68	6.28	42.66	68.70	46.87	4.86	36.79	56.95							†
28	Crew 2	41.30	7.11	26.55	56.04	45.17	5.51	33.75	56.59							
29	Briefing	63.38	5.84	51.27	75.48	52.96	4.52	43.58	62.34							†
30	Lounge 1	56.74	7.13	41.94	71.53	44.93	5.53	33.47	56.39							
31	Lounge 2	58.95	6.21	46.06	71.84	51.20	4.81	41.22	61.18							
32	Boarding out	41.45	7.18	26.56	56.34	43.28	5.56	31.75	54.82	51.69	7.97	35.42	67.97			
33	Seating out	52.93	5.34	41.86	64.01	49.65	4.14	41.07	58.23	54.48	5.19	43.89	65.08			
34	Engines on	54.73	4.08	46.27	63.19	53.85	3.16	47.30	60.41	64.50	3.86	56.62	72.39	*	*	
35	Take-off	35.99	7.05	21.37	50.62	39.09	5.46	27.76	50.41	64.32	6.28	51.50	77.14	*	*	
36	Cruising 10 min	52.14	7.53	36.52	67.76	50.96	5.83	38.87	63.06	58.37	7.05	43.96	72.77			
37	Cruising 20 min	57.87	7.50	42.32	73.42	51.32	5.81	39.27	63.36	61.63	6.66	48.04	75.23	†		
38	Cruising 30 min	69.26	6.01	56.80	81.72	41.41	4.65	31.76	51.06	56.01	6.05	43.65	68.37	*	*	*
39	Descent	58.74	7.38	43.44	74.04	45.43	5.71	33.58	57.28	56.29	6.85	42.31	70.27			+
40	10 min to landing	61.79	6.09	49.17	74.41	54.61	4.71	44.83	64.38	58.73	5.84	46.80	70.67			
41	5 min to landing	61.12	6.41	47.84	74.41	51.90	4.96	41.61	62.19	55.31	6.34	42.35	68.26			
42	Landing	66.71	6.96	52.27	81.14	49.09	5.39	37.91	60.28	62.14	6.54	48.79	75.49	*		*
43	Duty Free 1	52.21	7.23	37.21	67.20	55.39	5.60	43.77	67.00	60.32	6.63	46.79	73.86			
44	Duty Free 2	48.48	6.80	34.38	62.59	41.37	5.27	30.45	52.30	47.20	6.59	33.74	60.67			
45	Boarding In	49.15	8.32	31.88	66.41	31.74	6.45	18.37	45.12	43.04	8.00	26.70	59.37			*
46	Seating In	45.02	7.39	29.70	60.35	32.44	5.72	20.57	44.32	62.71	7.04	48.33	77.09	*	*	+
47	Engines on	59.63	5.99	47.22	72.05	51.46	4.64	41.84	61.07	65.64	5.57	54.26	77.01	*		
48	Take-off	32.27	7.00	17.75	46.79	54.06	5.42	42.82	65.31	61.54	6.28	48.71	74.37		*	*
49	Cruising 10 min	69.05	4.70	59.31	78.80	57.30	3.64	49.76	64.85	47.10	5.11	36.67	57.53	†	*	*
50	Cruising 20 min	69.12	7.05	54.50	83.74	42.28	5.46	30.96	53.61	59.58	6.65	45.99	73.17	*		*
51	Cruising 30 min	60.51	6.64	46.74	74.28	40.21	5.14	29.54	50.88	68.43	6.13	55.90	80.95	*		*
52	Descent	49.99	8.01	33.38	66.60	45.89	6.20	33.02	58.76	50.79	7.78	34.89	66.68			
53	10 min to landing	65.07	5.11	54.48	75.66	47.57	3.96	39.36	55.77	48.23	5.05	37.92	58.53		*	*
54	5 min to landing	57.37	7.31	42.21	72.53	51.61	5.66	39.86	63.35	64.94	6.55	51.57	78.32	*		
55	Landing	56.25	7.52	40.65	71.85	43.09	5.83	31.00	55.17	59.79	6.91	45.67	73.91	*		*
	Average SD		6.47				5.01				6.37					

Confidence intervals between Controls (C) vs Moderate-Anxious (MA) or High-Anxious (HA).
* $p < 0.05$, † $p < 0.10$.

9.6 Table 15. HFnorm

Table 15. Means, standard deviations and confidence intervals of HFnorm during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls. HFnorm=HF(ms²)/[(TP(ms²)-VLF(ms²)]x100 (see Tables 24, 25, and 27 for underlying data).

		HF norm														
Epoch	Marker	High-Anxious (HA), (N=9)				Moderate-Anxious (MA), (N=15)				Controls (C), (N=9)				Confidential Interval		
		M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	C vs. MA	C vs. HA	HA vs MA
1	Begin 1st day 1	11.79	2.66	6.27	17.31	8.59	2.06	4.31	12.86							
2	Begin 1st day 2	9.57	2.33	4.74	14.41	15.60	1.81	11.86	19.35							*
3	Psychologist 1	11.94	2.83	6.07	17.81	17.39	2.19	12.84	21.93							†
4	Psychologist 2	13.84	3.69	6.19	21.49	18.22	2.86	12.29	24.15							
5	Captain	15.29	2.84	9.41	21.18	17.21	2.20	12.65	21.77							
6	End 1st day 1	13.29	2.54	8.04	18.55	15.21	1.96	11.14	19.29							
7	End 1st day 2	14.08	2.18	9.57	18.59	13.30	1.69	9.80	16.79							
8	Begin 2nd day 1	15.83	3.48	8.60	23.05	16.56	2.70	10.97	22.16							
9	Begin 2nd day 2	17.64	4.07	9.21	26.08	13.93	3.15	7.40	20.46							
10	Simulator boarding	11.01	2.33	6.18	15.84	8.92	1.80	5.17	12.66							
11	Seating	13.60	3.42	6.51	20.69	10.93	2.65	5.44	16.43							
12	Take-off	11.47	2.63	6.01	16.92	16.90	2.04	12.68	21.12							
13	Turbulence	13.63	3.11	7.19	20.07	14.07	2.41	9.09	19.06							
14	Cruising	13.46	2.59	8.08	18.84	18.09	2.01	13.93	22.26							
15	Relaxing	21.54	3.46	14.36	28.72	14.11	2.68	8.55	19.67							†
16	Descent	12.37	2.40	7.39	17.35	11.13	1.86	7.27	14.98							
17	Landing	7.80	2.82	1.94	13.66	13.51	2.19	8.97	18.05							†
18	Restaurant 1	16.55	2.79	10.76	22.34	14.99	2.16	10.51	19.47							
19	Restaurant 2	11.73	2.22	7.13	16.33	13.33	1.72	9.77	16.90							
20	End 2nd day	13.70	2.33	8.86	18.54	16.07	1.81	12.32	19.82							
21	Begin 3rd day 1	9.78	1.93	5.77	13.79	11.75	1.50	8.64	14.85							
22	Begin 3rd day 2	13.80	2.57	8.46	19.13	10.21	1.99	6.08	14.35							
23	Hangar	13.67	2.84	7.79	19.55	12.48	2.20	7.92	17.03							
24	Airplane Visit	8.15	2.45	3.07	13.24	7.24	1.90	3.30	11.18							
25	Restaurant 1	13.28	2.98	7.10	19.46	12.77	2.31	7.99	17.56							
26	Restaurant 2	14.78	2.88	8.80	20.76	13.63	2.23	9.00	18.26							
27	Crew 1	13.98	4.36	4.93	23.04	18.26	3.38	11.25	25.27							
28	Crew 2	15.77	4.20	7.06	24.48	14.99	3.25	8.24	21.74							
29	Briefing	16.94	3.33	10.03	23.85	19.76	2.58	14.40	25.11							
30	Lounge 1	12.22	1.66	8.77	15.66	9.95	1.29	7.28	12.62							
31	Lounge 2	13.51	3.17	6.94	20.09	14.21	2.46	9.12	19.30							
32	Boarding out	14.64	4.26	5.80	23.48	12.92	3.30	6.08	19.77	8.35	3.78	0.63	16.08			
33	Seating out	13.99	2.65	8.48	19.49	16.90	2.05	12.64	21.16	14.39	2.48	9.32	19.46	*	*	
34	Engines on	16.15	1.89	12.23	20.06	12.78	1.46	9.75	15.82	19.75	2.26	15.14	24.37	*	*	
35	Take-off	11.92	2.68	6.36	17.48	10.97	2.08	6.66	15.27	19.15	3.02	12.99	25.32			
36	Cruising 10 min	11.60	2.94	5.51	17.69	14.10	2.27	9.38	18.81	15.75	2.75	10.13	21.37	*	*	
37	Cruising 20 min	11.53	1.69	8.04	15.03	10.76	1.31	8.06	13.47	16.37	1.74	12.82	19.92			
38	Cruising 30 min	10.64	1.17	8.20	13.07	11.23	0.91	9.35	13.12	12.19	1.26	9.61	14.77	*		
39	Descent	13.48	1.90	9.54	17.42	11.89	1.47	8.84	14.94	15.61	2.14	11.23	19.98	*		
40	10 min to landing	13.90	1.69	10.40	17.40	13.37	1.31	10.66	16.09	16.08	1.87	12.25	19.90			
41	5 min to landing	14.81	2.25	10.15	19.47	13.40	1.74	9.79	17.00	14.70	2.21	10.18	19.22			
42	Landing	14.33	2.35	9.46	19.21	13.03	1.82	9.25	16.81	15.45	2.33	10.69	20.22			
43	Duty Free 1	11.92	1.97	7.83	16.00	12.28	1.52	9.12	15.44	10.07	1.88	6.22	13.92	*		
44	Duty Free 2	9.05	4.12	0.50	17.61	15.02	3.20	8.39	21.64	7.74	3.57	0.46	15.02			
45	Boarding In	8.76	3.03	2.48	15.03	9.57	2.34	4.71	14.43	7.06	2.78	1.39	12.74			
46	Seating In	8.88	2.22	4.28	13.47	10.69	1.72	7.13	14.25	9.59	2.03	5.44	13.73			
47	Engines on	13.80	3.65	6.23	21.37	17.78	2.83	11.91	23.64	14.96	3.33	8.16	21.76		*	
48	Take-off	8.11	2.69	2.54	13.68	15.34	2.08	11.02	19.65	17.96	2.46	12.94	22.99			*
49	Cruising 10 min	12.29	1.68	8.80	15.77	14.29	1.30	11.59	16.99	12.82	1.80	9.15	16.49	*		
50	Cruising 20 min	12.44	1.84	8.62	16.26	10.10	1.43	7.14	13.06	16.08	1.73	12.56	19.60			
51	Cruising 30 min	13.16	3.43	6.05	20.27	11.76	2.66	6.25	17.27	13.42	3.01	7.27	19.58			
52	Descent	12.32	2.77	6.57	18.07	13.55	2.15	9.10	18.00	13.43	2.74	7.83	19.03			
53	10 min to landing	12.66	2.03	8.45	16.87	13.16	1.57	9.90	16.42	16.89	2.02	12.77	21.00		*	
54	5 min to landing	10.80	2.61	5.39	16.21	16.72	2.02	12.53	20.91	19.30	2.58	14.04	24.57	*	*	*
55	Landing	13.13	2.69	7.54	18.72	12.81	2.09	8.49	17.14	19.11	2.56	13.87	24.34	†		
	Average SD		2.71				2.10				2.43					

Confidence intervals between Controls (C) vs Moderate-Anxious (MA) or High-Anxious (HA). * $p < 0.05$, † $p < 0.10$.

9.7 Table 16. Log LF/HF

Table 16. Means, standard deviations and confidence intervals of log LF/HF during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls.

		LF/HF														
Epoch	Marker	High-Anxious (HA) (N=9)				Moderate-Anxious (MA), (N=15)				Controls (C), (N=9)				Confidential Interval		
		M	SD	-0.95	†0,95	M	SD	-0.95	†0,95	M	SD	-0.95	†0,95	C vs. MA	C vs. HA	HA vs MA
1	Begin 1st day 1	0.74	0.25	0.55	0.93	0.60	0.23	0.47	0.73							†
2	Begin 1st day 2	0.71	0.17	0.58	0.84	0.49	0.25	0.35	0.63							*
3	Psychologist 1	0.72	0.21	0.55	0.88	0.52	0.26	0.37	0.66							*
4	Psychologist 2	0.66	0.27	0.45	0.86	0.53	0.29	0.37	0.70							
5	Captain	0.67	0.29	0.45	0.89	0.48	0.26	0.34	0.62							†
6	End 1st day 1	0.75	0.20	0.60	0.90	0.60	0.22	0.48	0.72							†
7	End 1st day 2	0.63	0.21	0.47	0.80	0.65	0.20	0.54	0.76							
8	Begin 2nd day 1	0.45	0.28	0.23	0.66	0.52	0.29	0.36	0.68							
9	Begin 2nd day 2	0.55	0.25	0.36	0.74	0.64	0.30	0.48	0.80							
10	Simulator boarding	0.57	0.14	0.46	0.68	0.59	0.23	0.46	0.71							
11	Seating	0.54	0.26	0.34	0.74	0.48	0.33	0.30	0.67							
12	Take-off	0.68	0.22	0.51	0.84	0.53	0.25	0.39	0.67							
13	Turbulence	0.67	0.18	0.53	0.80	0.60	0.31	0.43	0.77							
14	Cruising	0.59	0.20	0.44	0.75	0.56	0.27	0.41	0.71							
15	Relaxing	0.44	0.32	0.19	0.69	0.64	0.34	0.45	0.83							†
16	Descent	0.65	0.26	0.45	0.86	0.72	0.27	0.57	0.87							
17	Landing	0.66	0.18	0.53	0.80	0.48	0.21	0.37	0.59							*
18	Restaurant 1	0.60	0.26	0.40	0.79	0.56	0.21	0.45	0.68							
19	Restaurant 2	0.69	0.25	0.50	0.88	0.59	0.15	0.51	0.67							
20	End 2nd day	0.68	0.21	0.52	0.85	0.66	0.24	0.53	0.79							
21	Begin 3rd day 1	0.62	0.27	0.40	0.83	0.64	0.28	0.48	0.79							
22	Begin 3rd day 2	0.68	0.27	0.48	0.89	0.70	0.29	0.54	0.86							
23	Hangar	0.73	0.22	0.56	0.90	0.72	0.31	0.56	0.89							
24	Airplane Visit	0.64	0.14	0.53	0.75	0.62	0.25	0.49	0.76							
25	Restaurant 1	0.68	0.15	0.57	0.79	0.66	0.31	0.49	0.84							
26	Restaurant 2	0.65	0.25	0.46	0.84	0.66	0.30	0.49	0.83							
27	Crew 1	0.66	0.24	0.47	0.85	0.48	0.32	0.30	0.66							*
28	Crew 2	0.50	0.31	0.26	0.74	0.53	0.26	0.38	0.67							
29	Briefing	0.62	0.27	0.41	0.82	0.45	0.25	0.31	0.59							†
30	Lounge 1	0.67	0.18	0.53	0.81	0.65	0.17	0.56	0.74	0.91	0.06	0.33	1.48			
31	Lounge 2	0.67	0.14	0.56	0.77	0.61	0.34	0.42	0.79	0.64	0.18	0.20	1.09			
32	Boarding out	0.54	0.34	0.28	0.80	0.58	0.39	0.36	0.80	0.83	0.19	0.68	0.97	*	*	
33	Seating out	0.58	0.26	0.38	0.78	0.50	0.22	0.38	0.62	0.59	0.26	0.39	0.79			
34	Engines on	0.55	0.20	0.40	0.70	0.66	0.24	0.52	0.79	0.56	0.28	0.35	0.77			
35	Take-off	0.58	0.20	0.43	0.74	0.58	0.26	0.43	0.72	0.57	0.25	0.38	0.76			
36	Cruising 10 min	0.66	0.15	0.54	0.77	0.59	0.26	0.44	0.73	0.60	0.17	0.46	0.73			
37	Cruising 20 min	0.70	0.23	0.53	0.88	0.64	0.22	0.52	0.76	0.59	0.16	0.47	0.71			
38	Cruising 30 min	0.82	0.19	0.68	0.96	0.54	0.29	0.39	0.70	0.66	0.23	0.49	0.84			*
39	Descent	0.64	0.16	0.52	0.77	0.57	0.14	0.49	0.65	0.60	0.26	0.40	0.80			
40	10 min to landing	0.69	0.18	0.55	0.83	0.59	0.18	0.49	0.69	0.59	0.26	0.39	0.79			
41	5 min to landing	0.61	0.16	0.49	0.74	0.63	0.25	0.49	0.77	0.58	0.21	0.42	0.74			
42	Landing	0.70	0.15	0.59	0.82	0.59	0.16	0.50	0.68	0.63	0.17	0.50	0.76			†
43	Duty Free 1	0.62	0.22	0.46	0.79	0.70	0.23	0.57	0.82	0.81	0.22	0.64	0.98		*	
44	Duty Free 2	0.75	0.25	0.55	0.94	0.55	0.34	0.36	0.74	0.79	0.22	0.63	0.96	*		†
45	Boarding In	0.74	0.21	0.58	0.90	0.58	0.33	0.40	0.77	0.82	0.32	0.57	1.06	*		
46	Seating In	0.65	0.31	0.42	0.89	0.49	0.25	0.35	0.63	0.84	0.32	0.59	1.08	*		†
47	Engines on	0.64	0.25	0.45	0.83	0.51	0.33	0.32	0.69	0.66	0.18	0.53	0.80	†		
48	Take-off	0.68	0.21	0.51	0.84	0.58	0.22	0.46	0.71	0.54	0.17	0.41	0.67			
49	Cruising 10 min	0.76	0.08	0.69	0.82	0.63	0.22	0.51	0.75	0.58	0.17	0.45	0.71		*	*
50	Cruising 20 min	0.74	0.04	0.71	0.78	0.65	0.25	0.52	0.79	0.56	0.16	0.44	0.69		*	
51	Cruising 30 min	0.68	0.22	0.51	0.85	0.61	0.26	0.46	0.75	0.72	0.21	0.56	0.88			
52	Descent	0.65	0.35	0.38	0.91	0.52	0.17	0.43	0.61	0.60	0.17	0.46	0.73			
53	10 min to landing	0.72	0.17	0.59	0.86	0.59	0.19	0.49	0.70	0.46	0.12	0.36	0.55	*	*	†
54	5 min to landing	0.68	0.23	0.50	0.86	0.53	0.23	0.40	0.66	0.55	0.20	0.40	0.70			†
55	Landing	0.60	0.26	0.41	0.80	0.57	0.24	0.43	0.70	0.51	0.23	0.33	0.69			

Confidence intervals between Controls (C) vs Moderate-Anxious (MA) or High-Anxious (HA).
* $p < 0.05$, † $p < 0.10$.

9.8 Table 17. SpO_2

Table 17. Means, standard deviations and confidence intervals of SpO_2 during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls.

		SpO_2														
Epoch	Marker	High-Anxious (HA) (N=9)				Moderate-Anxious (MA), (N=15)				Controls (C), (N=9)				Confidential Interval		
		M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	C vs. MA	C vs. HA	HA vs MA
1	Begin 1st day1	97.44	1.01	96.67	98.22	97.53	1.41	96.75	98.31							
6	End 1st day1	97.78	2.39	95.94	99.61	97.87	1.13	97.24	98.49							
8	Begin 2nd day1	98.00	1.22	97.06	98.94	97.33	1.68	96.41	98.26							
14	Simulator cruising	97.22	1.99	95.70	98.75	97.40	1.06	96.82	97.98							
22	Begin 3rd day1	96.67	1.80	95.28	98.05	96.80	1.32	96.07	97.53							
30	Lounge1	97.44	1.24	96.49	98.39	97.00	1.46	96.19	97.81	97.11	1.05	96.30	97.92			
36	Cruising 10 min OUT	96.11	2.15	94.46	97.76	96.20	1.78	95.21	97.19	96.44	1.42	95.35	97.54			
39	Descent OUT	95.44	2.01	93.90	96.99	95.40	3.36	93.54	97.26	95.22	1.48	94.08	96.36			
49	Cruising 10 min IN	94.44	3.00	92.13	96.75	95.47	2.61	94.02	96.91	96.89	0.93	96.18	97.60	†	*	
52	Descent IN	94.56	1.74	93.22	95.89	94.27	2.40	92.94	95.60	95.67	2.00	94.13	97.20	†		

Confidence intervals between Controls (C) vs Moderate-Anxious (MA) or High-Anxious (HA).
* $p < 0.05$, † $p < 0.10$

9.9 Table 18. Physiological sensation

Table 18. Means, standard deviations and confidence intervals of ratings during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls regarding physiological sensation.

		Physiological Sensation														
Epoch	Marker	High-Anxious (HA) (N=9)				Moderate-Anxious (MA), (N=15)				Controls (C), (N=9)				Confidential Interval		
		M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	C vs. MA	C vs. HA	HA vs MA
3	Psychologist 1	1.75	0.73	1.19	2.31	1.53	0.89	1.04	2.03							
6	End 1st day 1	2.11	1.13	1.25	2.98	1.57	1.00	1.01	2.12							
9	Begin 2nd day 2	1.56	0.80	0.94	2.17	1.60	0.76	1.18	2.02							
11	Seating Simulator	3.64	1.04	2.84	4.44	2.45	0.98	1.91	2.99							*
17	Landing Simulator	2.75	1.47	1.62	3.88	2.00	1.17	1.35	2.65							
22	Begin 3rd day 2	1.86	1.15	0.98	2.74	1.90	1.03	1.33	2.47							
25	Restaurant 1	2.08	1.13	1.22	2.95	2.22	1.53	1.37	3.06							
28	Crew 2	2.50	1.23	1.55	3.45	2.30	1.28	1.59	3.01							
33	Seating OUT	3.28	1.25	2.32	4.24	2.57	1.38	1.80	3.33	1.00	0.00	1.00	1.00	*	*	
36	Cruising 10 min OUT	2.53	1.11	1.68	3.38	1.83	1.05	1.25	2.41	1.00	0.00	1.00	1.00	*	*	†
39	Descent OUT	2.47	1.28	1.49	3.45	1.53	0.71	1.14	1.93	1.00	0.00	1.00	1.00	†	*	*
46	Seating IN	2.14	1.01	1.36	2.91	1.50	0.52	1.21	1.79	1.00	0.00	1.00	1.00	*	*	*
49	Cruising 10 min IN	1.72	0.55	1.30	2.15	1.30	0.52	1.01	1.59	1.00	0.00	1.00	1.00	†	*	*
52	Descent IN	1.61	0.71	1.07	2.16	1.30	0.58	0.98	1.62	1.00	0.00	1.00	1.00		*	

Confidence intervals between Controls (C) vs Moderate-Anxious (MA) or High-Anxious (HA).
* $p < 0.05$, † $p < 0.10$

9.10 Table 19. Diffuse fear

Table 19. Means, standard deviations and confidence intervals of ratings during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls regarding diffuse fear.

		Diffuse Fear														
Epoch	Marker	High-Anxious (HA) (N=9)				Moderate-Anxious (MA), (N=15)				Controls (C), (N=9)				Confidential Interval		
		M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	C vs. MA	C vs. HA	HA vs MA
3	Psychologist 1	3.41	1.05	2.60	4.22	2.51	1.01	1.95	3.07							*
6	End 1st day 1	3.22	1.27	2.25	4.20	2.56	1.08	1.96	3.15							
9	Begin 2nd day 2	3.00	0.88	2.32	3.68	2.56	1.38	1.79	3.32							
11	Seating Simulator	4.04	0.84	3.39	4.68	3.33	1.33	2.60	4.07							†
17	Landing Simulator	3.67	1.38	2.60	4.73	2.78	1.33	2.04	3.51							†
22	Begin 3rd day 2	3.22	0.96	2.49	3.96	2.93	1.67	2.01	3.86							
25	Restaurant 1	2.85	1.21	1.92	3.79	3.16	1.33	2.42	3.89							
28	Crew 2	3.81	1.20	2.89	4.74	3.60	1.11	2.98	4.22							
33	Seating OUT	4.41	1.12	3.55	5.26	3.51	1.17	2.86	4.16	1.26	0.36	0.98	1.54	*	*	*
36	Cruising 10 min OUT	4.04	1.03	3.24	4.83	3.29	0.82	2.83	3.75	1.11	0.24	0.93	1.29	*	*	*
39	Descent OUT	2.96	1.17	2.06	3.86	2.42	0.82	1.97	2.88	1.48	0.87	0.81	2.15	*	*	†
46	Seating IN	3.15	1.19	2.23	4.06	2.73	1.49	1.91	3.56	1.00	0.00	1.00	1.00	*	*	
49	Cruising 10 min IN	2.26	0.89	1.57	2.95	1.96	0.68	1.58	2.33	1.07	0.15	0.96	1.19	*	*	
52	Descent IN	2.33	1.29	1.34	3.33	1.93	0.74	1.53	2.34	1.00	0.00	1.00	1.00	*	*	

Confidence intervals between Controls (C) vs Moderate-Anxious (MA) or High-Anxious (HA).
* $p < 0.05$, † $p < 0.10$

9.11 Table 20. Cognitive fear

Table 20. Means, standard deviations and confidence intervals of ratings during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls regarding cognitive fear.

		Cognitive Fear															
Epoch	Marker	High-Anxious (HA) (N=9)				Moderate-Anxious (MA), (N=15)				Controls (C), (N=9)					Confidential Interval		
		M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	C vs. A	C vs. MA	C vs. HA	HA vs MA
3	Psychologist 1	2.89	1.05	2.08	3.70	1.97	1.01	1.41	2.53							*	
6	End 1st day 1	3.17	1.30	2.17	4.17	2.03	1.20	1.37	2.70							*	
9	Begin 2nd day 2	2.50	0.97	1.76	3.24	1.97	0.97	1.43	2.51								
11	Seating Simulator	4.00	1.22	3.06	4.94	2.70	1.44	1.90	3.50							*	
17	Landing Simulator	3.39	1.75	2.05	4.73	2.13	1.34	1.39	2.88							*	
22	Begin 3rd day 2	2.83	1.32	1.82	3.85	2.53	1.67	1.61	3.46								
25	Restaurant 1	2.72	1.64	1.46	3.98	2.87	1.54	2.01	3.72								
28	Crew 2	3.78	1.35	2.74	4.81	2.87	1.33	2.13	3.60								†
33	Seating OUT	4.17	2.08	2.57	5.76	3.23	1.43	2.44	4.02	1.00	0.00	1.00	1.00	*	*		
36	Cruising 10 min OUT	3.28	1.25	2.31	4.24	2.27	1.08	1.67	2.87	1.00	0.00	1.00	1.00	*	*	*	
39	Descent OUT	3.11	1.82	1.72	4.51	2.07	0.94	1.54	2.59	1.00	0.00	1.00	1.00	*	*	*	
46	Seating IN	2.83	1.54	1.65	4.02	2.20	0.86	1.72	2.68	1.00	0.00	1.00	1.00	*	*		
49	Cruising 10 min IN	2.11	0.93	1.40	2.82	1.63	0.72	1.24	2.03	1.00	0.00	1.00	1.00	*	*		†
52	Descent IN	2.06	1.21	1.13	2.99	1.60	0.76	1.18	2.02	1.00	0.00	1.00	1.00	*	*		

Confidence intervals between Controls (C) vs Moderate-Anxious (MA) or High-Anxious (HA).
* $p < 0.05$, † $p < 0.10$

9.12 Table 21. Unconfident/Joyless

Table 21. Means, standard deviations and confidence intervals of ratings during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls regarding unconfident/joyless.

		Un-confindent/Joyless														
Epoch	Marker	High-Anxious (HA), (N=9)				Moderate-Anxious (MA), (N=15)				Controls (C), (N=9)				Confidential Interval		
		M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	M	S.D.	-0.95	†0,95	C vs. MA	C vs. HA	HA vs MA
3	Psychologist 1	4.11	2.03	2.55	5.67	4.00	1.32	3.27	4.73							
6	End 1st day 1	4.44	1.49	3.30	5.59	4.17	1.26	3.47	4.87							
9	Begin 2nd day 2	3.94	1.42	2.85	5.04	4.10	1.28	3.39	4.81							
11	Seating Simulator	4.44	1.51	3.28	5.60	4.53	1.47	3.72	5.35							
17	Landing Simulator	3.83	1.30	2.83	4.83	3.80	1.49	2.98	4.62							
22	Begin 3rd day 2	3.56	1.79	2.18	4.93	4.13	1.72	3.18	5.08							
25	Restaurant 1	3.61	2.23	1.89	5.33	4.37	1.63	3.46	5.27							
28	Crew 2	3.78	1.92	2.30	5.26	4.57	1.49	3.74	5.39							
33	Seating OUT	4.39	2.00	2.85	5.92	4.77	1.71	3.82	5.71	1.33	0.25	1.14	1.53	*	*	
36	Cruising 10 min OUT	3.78	1.87	2.34	5.22	4.17	1.40	3.39	4.94	1.22	0.26	1.02	1.42	*	*	
39	Descent OUT	3.28	1.56	2.08	4.48	3.80	1.69	2.87	4.73	2.06	1.47	0.93	3.18	*	*	
46	Seating IN	3.83	1.90	2.37	5.30	3.73	1.49	2.91	4.56	1.22	0.26	1.02	1.42	*	*	
49	Cruising 10 min IN	2.94	1.55	1.75	4.14	2.47	0.92	1.96	2.97	1.22	0.26	1.02	1.42	*	*	
52	Descent IN	2.89	1.90	1.43	4.35	2.53	1.37	1.78	3.29	1.11	0.22	0.94	1.28	*	*	

Confidence intervals between Controls (C) vs Moderate-Anxious (MA) or High-Anxious (HA).
* $p < 0.05$, † $p < 0.10$.

9.13 Table 22. Classification of change in LFnorm

Table 22. Increased (I), Decreased (D), Not changed (N) LFnorm at the epochs 1-55 compared to epoch 3 in High-Anxious (HA) and Moderate-Anxious (MA). Increased (I), Decreased (D), Not changed (N) LFnorm at the epochs 32-55 compared to epoch 38 in Controls (C). A change was counted if the actual values exceeded the average SD per group as computed in table 14 (+/- 6.47 for HA, 5.01 for MA, 6.37 for C).

Epoch	Marker	LFnorm								
		High-Anxious (N=9)			Moderate-Anxious (N=15)			Controls (N=9)		
		M	Change	Class	M	Change	Class	M	Change	Class
1	Begin 1st day 1	56.06	3.23	N	32.26	-21.30	D			
2	Begin 1st day 2	47.61	-5.21	N	47.39	-6.17	D			
3	**Psychologist 1**	**52.82**	**0.00**	N	**53.56**	**0.00**	N			
4	Psychologist 2	57.08	4.25	N	51.33	-2.23	N			
5	Captain	61.80	8.98	I	48.20	-5.36	D			
6	End 1st day 1	68.30	15.48	I	56.02	2.46	N			
7	End 1st day 2	58.44	5.62	N	55.32	1.76	N			
8	Begin 2nd day 1	44.15	-8.68	D	51.56	-2.00	N			
9	Begin 2nd day 2	57.50	4.67	N	47.71	-5.85	D			
10	Simulator boarding	37.88	-14.94	D	32.28	-21.29	D			
11	Seating	37.75	-15.08	D	32.44	-21.12	D			
12	Take-off	53.64	0.82	N	52.97	-0.59	N			
13	Turbulence	59.67	6.85	I	51.85	-1.71	N			
14	Cruising	51.70	-1.13	N	58.29	4.73	N			
15	Relaxing	51.78	-1.05	N	55.45	1.89	N			
16	Descent	55.98	3.16	N	51.05	-2.51	N			
17	Landing	36.96	-15.86	D	41.27	-12.29	D			
18	Restaurant 1	59.73	6.90	I	52.52	-1.04	N			
19	Restaurant 2	58.02	5.20	N	51.27	-2.29	N			
20	End 2nd day	63.80	10.98	I	67.57	14.01	I			
21	Begin 3rd day 1	43.80	-9.02	D	50.61	-2.95	N			
22	Begin 3rd day 2	62.69	9.87	I	41.90	-11.66	D			
23	Hangar	67.58	14.76	I	56.57	3.01	N			
24	Airplane Visit	38.42	-14.40	D	25.46	-28.10	D			
25	Restaurant 1	60.66	7.84	I	53.25	-0.31	N			
26	Restaurant 2	60.00	7.18	I	56.87	3.31	N			
27	Crew 1	55.68	2.86	N	46.87	-6.69	D			
28	Crew 2	41.30	-11.53	D	45.17	-8.39	D			
29	Briefing	63.38	10.55	I	52.96	-0.60	N			
30	Lounge 1	56.74	3.91	N	44.93	-8.63	D			
31	Lounge 2	58.95	6.13	N	51.20	-2.36	N			
32	Boarding out	41.45	-11.38	D	43.28	-10.28	D	51.69	-4.31	N
33	Seating out	52.93	0.11	N	49.65	-3.91	N	54.48	-1.52	N
34	Engines on	54.73	1.91	N	53.85	0.29	N	64.50	8.49	I
35	Take-off	35.99	-16.83	D	39.09	-14.47	D	64.32	8.31	I
36	Cruising 10 min	52.14	-0.68	N	50.96	-2.60	N	58.37	2.36	N
37	Cruising 20 min	57.87	5.05	N	51.32	-2.24	N	61.63	5.63	N
38	**Cruising 30 min**	69.26	16.44	I	41.41	-12.15	D	**56.01**	**0.00**	N
39	Descent	58.74	5.92	N	45.43	-8.13	D	56.29	0.28	N
40	10 min to landing	61.79	8.96	I	54.61	1.05	N	58.73	2.73	N
41	5 min to landing	61.12	8.30	I	51.90	-1.66	N	55.31	-0.70	N
42	Landing	66.71	13.89	I	49.09	-4.47	N	62.14	6.13	N
43	Duty Free 1	52.21	-0.62	N	55.39	1.83	N	60.32	4.32	N
44	Duty Free 2	48.48	-4.34	N	41.37	-12.19	D	47.20	-8.80	D
45	Boarding In	49.15	-3.68	N	31.74	-21.82	D	43.04	-12.97	D
46	Seating In	45.02	-7.80	D	32.44	-21.12	D	62.71	6.71	I
47	Engines on	59.63	6.81	I	51.46	-2.10	N	65.64	9.63	I
48	Take-off	32.27	-20.55	D	54.06	0.50	N	61.54	5.53	N
49	Cruising 10 min	69.05	16.23	I	57.30	3.74	N	47.10	-8.91	D
50	Cruising 20 min	69.12	16.30	I	42.28	-11.28	D	59.58	3.57	N
51	Cruising 30 min	60.51	7.69	I	40.21	-13.35	D	68.43	12.42	I
52	Descent	49.99	-2.83	N	45.89	-7.67	D	50.79	-5.22	N
53	10 min to landing	65.07	12.25	I	47.57	-5.99	D	48.23	-7.78	D
54	5 min to landing	57.37	4.55	N	51.61	-1.95	N	64.94	8.93	I
55	Landing	56.25	3.43	N	43.09	-10.47	D	59.79	3.78	N

Note: Bold numbers indicate the reference value for calculation of change.

9.14 Table 23. Classification of change in HFnorm

Table 23. Increased (I), Decreased (D), Not changed (N) HFnorm at the epochs 1-55 compared to epoch 3 in High-Anxious (HA) and Moderate-Anxious (MA). Increased (I), Decreased (D), Not changed (N) HFnorm at the epochs 32-55 compared to epoch 38 in Controls (C). A change was counted if the actual values exceeded the average SD per group as computed in table 15 (+/- 2.71 for HA, 2.41 for MA, 2.41 for C).

		HFnorm								
Epoch	Marker	High-Anxious (N=9)			Moderate-Anxious (N=15)			Controls (N=9)		
		M	Change	Class	M	Change	Class	M	Change	Class
1	Begin 1st day 1	11.79	-0.15	N	8.59	-8.80	D			
2	Begin 1st day 2	9.57	-2.37	N	15.60	-1.78	N			
3	**Psychologist 1**	**11.94**	0.00	N	**17.39**	0.00	N			
4	Psychologist 2	13.84	1.90	N	18.22	0.84	N			
5	Captain	15.29	3.35	I	17.21	-0.18	N			
6	End 1st day 1	13.29	1.35	N	15.21	-2.17	D			
7	End 1st day 2	14.08	2.14	N	13.30	-4.09	D			
8	Begin 2nd day 1	15.83	3.88	I	16.56	-0.82	N			
9	Begin 2nd day 2	17.64	5.70	I	13.93	-3.45	D			
10	Simulator boarding	11.01	-0.93	N	8.92	-8.47	D			
11	Seating	13.60	1.66	N	10.93	-6.45	D			
12	Take-off	11.47	-0.48	N	16.90	-0.48	N			
13	Turbulence	13.63	1.69	N	14.07	-3.31	D			
14	Cruising	13.46	1.52	N	18.09	0.71	N			
15	Relaxing	21.54	9.60	I	14.11	-3.28	D			
16	Descent	12.37	0.43	N	11.13	-6.26	D			
17	Landing	7.80	-4.14	D	13.51	-3.88	D			
18	Restaurant 1	16.55	4.61	I	14.99	-2.40	D			
19	Restaurant 2	11.73	-0.21	N	13.33	-4.05	D			
20	End 2nd day	13.70	1.76	N	16.07	-1.31	N			
21	Begin 3rd day 1	9.78	-2.16	N	11.75	-5.64	D			
22	Begin 3rd day 2	13.80	1.85	N	10.21	-7.17	D			
23	Hangar	13.67	1.73	N	12.48	-4.91	D			
24	Airplane Visit	8.15	-3.79	D	7.24	-10.14	D			
25	Restaurant 1	13.28	1.34	N	12.77	-4.61	D			
26	Restaurant 2	14.78	2.84	I	13.63	-3.75	D			
27	Crew 1	13.98	2.04	N	18.26	0.88	N			
28	Crew 2	15.77	3.83	I	14.99	-2.40	D			
29	Briefing	16.94	5.00	I	19.76	2.37	I			
30	Lounge 1	12.22	0.28	N	9.95	-7.43	D			
31	Lounge 2	13.51	1.57	N	14.21	-3.18	D			
32	Boarding out	14.64	2.70	N	12.92	-4.46	D	8.35	-3.83	D
33	Seating out	13.99	2.04	N	16.90	-0.48	N	14.39	2.21	N
34	Engines on	16.15	4.21	I	12.78	-4.60	D	19.75	7.57	I
35	Take-off	11.92	-0.02	N	10.97	-6.42	D	19.15	6.97	I
36	Cruising 10 min	11.60	-0.34	N	14.10	-3.29	D	15.75	3.56	I
37	Cruising 20 min	11.53	-0.41	N	10.76	-6.62	D	16.37	4.18	I
38	**Cruising 30 min**	10.64	-1.30	N	11.23	-6.15	D	**12.19**	0.00	N
39	Descent	13.48	1.54	N	11.89	-5.50	D	15.61	3.42	I
40	10 min to landing	13.90	1.96	N	13.37	-4.01	D	16.08	3.89	I
41	5 min to landing	14.81	2.87	I	13.40	-3.99	D	14.70	2.51	I
42	Landing	14.33	2.39	N	13.03	-4.36	D	15.45	3.27	I
43	Duty Free 1	11.92	-0.03	N	12.28	-5.11	D	10.07	-2.12	N
44	Duty Free 2	9.05	-2.89	D	15.02	-2.37	D	7.74	-4.45	D
45	Boarding In	8.76	-3.19	D	9.57	-7.81	D	7.06	-5.12	D
46	Seating In	8.88	-3.07	D	10.69	-6.70	D	9.59	-2.60	D
47	Engines on	13.80	1.86	N	17.78	0.39	N	14.96	2.78	I
48	Take-off	8.11	-3.83	D	15.34	-2.05	N	17.96	5.78	I
49	Cruising 10 min	12.29	0.34	N	14.29	-3.09	D	12.82	0.63	N
50	Cruising 20 min	12.44	0.50	N	10.10	-7.28	D	16.08	3.89	I
51	Cruising 30 min	13.16	1.22	N	11.76	-5.62	D	13.42	1.24	N
52	Descent	12.32	0.38	N	13.55	-3.83	D	13.43	1.25	N
53	10 min to landing	12.66	0.72	N	13.16	-4.23	D	16.89	4.70	I
54	5 min to landing	10.80	-1.14	N	16.72	-0.66	N	19.30	7.12	I
55	Landing	13.13	1.19	N	12.81	-4.57	D	19.11	6.92	I

Note: Bold numbers indicate the reference value for calculation of change.

9.15 Table 24. Total Power

Table 24. Means and standard deviations of Total power (ms^2) during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls.

		Total Power (ms^2)					
Epoch	Marker	High-Anxious (N=9)		Moderate-Anxious (N=15)		Controls (N=9)	
		M	SD	M	SD	M	SD
1	Begin 1st day 1	2,275.11	2,137.94	920.81	1,071.11		
2	Begin 1st day 2	2,453.48	1,594.38	1,028.97	911.46		
3	Psychologist 1	2,199.47	1,556.15	1,172.38	958.50		
4	Psychologist 2	1,843.93	1,829.72	879.47	1,209.77		
5	Captain	2,124.27	2,962.26	948.00	1,464.95		
6	End 1st day 1	2,199.01	2,074.99	943.08	1,237.31		
7	End 1st day 2	2,308.88	2,487.84	930.48	1,110.81		
8	Begin 2nd day 1	3,562.57	4,925.59	1,602.52	2,216.23		
9	Begin 2nd day 2	2,742.37	2,620.80	1,060.83	1,198.72		
10	Simulator boarding	4,109.48	4,208.84	1,798.36	2,190.43		
11	Seating	5,868.71	3,167.28	2,247.64	1,928.52		
12	Take-off	4,337.08	2,754.49	1,967.31	1,187.54		
13	Turbulence	3,142.74	1,270.70	1,298.17	797.06		
14	Cruising	3,886.12	3,661.82	1,499.71	1,273.36		
15	Relaxing	2,413.52	3,612.50	1,130.53	2,052.44		
16	Descent	3,256.93	3,015.69	1,596.54	1,879.67		
17	Landing	4,109.14	5,246.26	1,862.78	2,845.60		
18	Restaurant 1	1,600.44	2,429.27	694.64	1,324.75		
19	Restaurant 2	3,565.32	4,490.62	1,392.82	2,050.92		
20	End 2nd day	2,567.44	3,653.21	1,138.44	1,889.41		
21	Begin 3rd day 1	2,246.39	1,339.54	900.43	532.72		
22	Begin 3rd day 2	1,941.79	1,840.29	919.89	1,091.06		
23	Hangar	1,448.79	1,763.84	568.30	779.57		
24	Airplane Visit	4,149.69	2,833.47	1,439.37	993.89		
25	Restaurant 1	1,749.16	909.13	692.03	412.20		
26	Restaurant 2	1,882.08	1,788.49	931.74	1,412.71		
27	Crew 1	1,687.69	1,965.77	648.09	791.80		
28	Crew 2	1,847.93	1,688.75	834.43	879.88		
29	Briefing	1,651.69	1,546.92	729.99	662.69		
30	Lounge 1	1,309.76	1,670.14	400.95	577.76	1,193.67	1,414.85
31	Lounge 2	1,316.33	1,644.51	532.65	642.26	615.09	1,243.60
32	Boarding out	948.95	950.76	258.74	291.07	1,724.88	1,675.97
33	Seating out	1,086.67	1,703.86	359.06	708.11	859.06	1,276.82
34	Engines on	1,185.36	1,450.02	563.26	611.42	653.74	1,046.17
35	Take-off	1,907.80	1,650.88	468.36	327.56	1,282.08	1,111.49
36	Cruising 10 min	1,242.44	1,962.22	624.02	654.00	625.99	1,353.27
37	Cruising 20 min	1,033.99	1,988.02	342.13	609.57	620.98	1,300.72
38	Cruising 30 min	1,726.17	935.11	624.44	380.83	1,562.91	1,443.37
39	Descent	1,273.00	1,628.34	339.79	495.42	1,248.08	1,583.16
40	10 min to landing	985.88	1,743.82	336.89	622.69	845.88	1,381.98
41	5 min to landing	530.33	1,648.64	385.82	703.60	845.75	1,385.42
42	Landing	1,676.88	965.31	593.60	354.26	1,480.27	1,354.85
43	Duty Free 1	930.09	1,505.26	451.54	570.72	534.03	1,056.73
44	Duty Free 2	979.39	727.12	399.53	339.65	1,132.32	1,223.35
45	Boarding In	3,168.86	2,182.87	1,647.74	858.29	1,585.34	1,736.82
46	Seating In	1,503.55	1,906.52	688.15	714.22	829.70	1,541.14
47	Engines on	1,802.96	1,878.69	727.59	700.50	929.65	1,201.17
48	Take-off	1,644.79	1,966.11	301.52	581.87	840.10	1,119.82
49	Cruising 10 min	691.10	1,274.13	234.45	464.06	1,840.26	1,908.97
50	Cruising 20 min	2,505.27	2,263.07	1,366.56	940.40	931.12	1,382.42
51	Cruising 30 min	2,341.02	2,026.29	1,050.97	758.83	386.29	969.84
52	Descent	2,207.86	2,032.90	1,231.71	920.12	1,301.23	2,013.89
53	10 min to landing	1,194.60	1,532.51	376.00	550.69	1,480.18	2,110.06
54	5 min to landing	742.50	1,241.02	302.29	478.74	2,035.62	1,946.50
55	Landing	1,348.22	942.36	517.38	401.35	2,181.67	2,931.72

9.16 Table 25. VLF

Table 25. Means and standard deviations of VLF (ms²) during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls.

		VLF (ms²)					
Epoch	Marker	High-Anxious (N=9)		Moderate-Anxious (N=15)		Controls (N=9)	
		M	SD	M	SD	M	SD
1	Begin 1st day 1	920.81	1,071.11	780.48	741.02		
2	Begin 1st day 2	1,028.97	911.46	441.64	294.65		
3	Psychologist 1	1,172.38	958.50	578.59	472.68		
4	Psychologist 2	879.47	1,209.77	498.78	274.03		
5	Captain	948.00	1,464.95	661.16	344.42		
6	End 1st day 1	943.08	1,237.31	665.53	323.04		
7	End 1st day 2	930.48	1,110.81	797.07	520.67		
8	Begin 2nd day 1	1,602.52	2,216.23	772.65	624.30		
9	Begin 2nd day 2	1,060.83	1,198.72	893.22	688.26		
10	Simulator boarding	1,798.36	2,190.43	1,120.70	851.43		
11	Seating	2,247.64	1,928.52	1,188.50	816.05		
12	Take-off	1,967.31	1,187.54	896.26	700.23		
13	Turbulence	1,298.17	797.06	750.02	375.19		
14	Cruising	1,499.71	1,273.36	660.31	520.28		
15	Relaxing	1,130.53	2,052.44	1,005.05	681.63		
16	Descent	1,596.54	1,879.67	989.38	715.16		
17	Landing	1,862.78	2,845.60	789.21	445.35		
18	Restaurant 1	694.64	1,324.75	411.31	214.47		
19	Restaurant 2	1,392.82	2,050.92	675.88	365.38		
20	End 2nd day	1,138.44	1,889.41	482.63	283.97		
21	Begin 3rd day 1	900.43	532.72	807.96	477.81		
22	Begin 3rd day 2	919.89	1,091.06	683.78	430.52		
23	Hangar	568.30	779.57	509.26	325.46		
24	Airplane Visit	1,439.37	993.89	1,191.79	743.35		
25	Restaurant 1	692.03	412.20	668.37	623.82		
26	Restaurant 2	931.74	1,412.71	600.07	542.36		
27	Crew 1	648.09	791.80	250.70	217.05		
28	Crew 2	834.43	879.88	453.33	427.08		
29	Briefing	729.99	662.69	325.37	337.35		
30	Lounge 1	400.95	577.76	536.63	538.40	416.13	474.35
31	Lounge 2	532.65	642.26	552.07	511.53	211.71	416.70
32	Boarding out	258.74	291.07	211.41	248.91	192.89	315.20
33	Seating out	359.06	708.11	407.64	480.99	319.38	521.40
34	Engines on	563.26	611.42	288.11	446.32	239.24	351.48
35	Take-off	468.36	327.56	497.30	368.62	420.06	422.77
36	Cruising 10 min	624.02	654.00	298.44	389.43	205.36	462.80
37	Cruising 20 min	342.13	609.57	326.32	419.21	233.43	478.00
38	Cruising 30 min	624.44	380.83	688.05	554.55	639.48	671.72
39	Descent	339.79	495.42	447.53	497.33	402.72	541.53
40	10 min to landing	336.89	622.69	343.07	487.59	193.65	431.74
41	5 min to landing	385.82	703.60	346.95	428.27	293.50	467.37
42	Landing	593.60	354.26	422.13	353.61	531.12	619.85
43	Duty Free 1	451.54	570.72	216.52	341.01	294.64	429.47
44	Duty Free 2	399.53	339.65	286.20	230.82	537.92	618.28
45	Boarding In	1,647.74	858.29	317.83	408.99	445.96	497.74
46	Seating In	688.15	714.22	494.68	507.43	425.49	634.71
47	Engines on	727.59	700.50	430.94	407.93	311.37	381.46
48	Take-off	301.52	581.87	189.52	316.39	301.49	410.02
49	Cruising 10 min	234.45	464.06	329.19	384.91	729.99	770.73
50	Cruising 20 min	1,366.56	940.40	277.58	409.41	463.62	551.12
51	Cruising 30 min	1,050.97	758.83	359.35	535.97	165.61	347.82
52	Descent	1,231.71	920.12	685.10	612.10	529.43	760.50
53	10 min to landing	376.00	550.69	395.23	561.15	868.49	998.12
54	5 min to landing	302.29	478.74	252.05	361.44	625.96	626.78
55	Landing	517.38	401.35	469.08	365.43	701.87	744.59

9.17 Table 26. LF

Table 26. Means and standard deviations of LF (ms²) during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls.

Epoch	Marker	LF (ms²) High-Anxious (N=9) M	SD	Moderate-Anxious (N=15) M	SD	Controls (N=9) M	SD
1	Begin 1st day 1	737.98	525.92	362.73	327.07		
2	Begin 1st day 2	704.38	569.49	259.27	149.40		
3	Psychologist 1	555.69	436.82	410.43	299.66		
4	Psychologist 2	496.59	305.60	337.17	195.94		
5	Captain	616.89	558.07	384.33	239.81		
6	End 1st day 1	878.22	671.11	528.59	289.54		
7	End 1st day 2	796.06	927.31	524.36	268.06		
8	Begin 2nd day 1	608.73	460.82	504.20	360.44		
9	Begin 2nd day 2	782.98	604.26	534.22	387.16		
10	Simulator boarding	695.51	667.90	426.92	384.32		
11	Seating	1,126.06	614.04	557.05	430.36		
12	Take-off	1,152.53	827.77	484.83	248.16		
13	Turbulence	1,073.01	496.82	615.53	616.79		
14	Cruising	1,005.66	844.88	536.89	292.52		
15	Relaxing	553.96	458.54	751.74	513.45		
16	Descent	895.77	745.17	645.24	353.26		
17	Landing	759.89	774.94	430.13	367.38		
18	Restaurant 1	520.18	624.56	330.73	252.47		
19	Restaurant 2	826.57	633.84	464.31	221.95		
20	End 2nd day	768.32	624.51	541.50	314.31		
21	Begin 3rd day 1	493.57	408.41	535.32	385.44		
22	Begin 3rd day 2	689.27	590.33	424.73	266.99		
23	Hangar	622.76	773.23	374.40	229.80		
24	Airplane Visit	715.79	524.48	437.20	313.07		
25	Restaurant 1	631.07	421.22	393.88	257.28		
26	Restaurant 2	571.97	292.11	407.85	285.75		
27	Crew 1	571.58	625.80	193.89	217.79		
28	Crew 2	419.07	521.27	205.37	165.35		
29	Briefing	553.98	554.12	250.23	304.29		
30	Lounge 1	616.44	620.64	353.01	322.40	682.45	554.16
31	Lounge 2	615.02	615.32	317.89	282.25	458.53	460.20
32	Boarding out	309.97	535.98	230.62	274.60	346.61	262.90
33	Seating out	583.41	510.10	279.01	195.67	423.24	343.80
34	Engines on	457.46	357.99	281.91	155.77	448.73	299.43
35	Take-off	327.17	240.64	262.79	191.58	574.20	503.66
36	Cruising 10 min	552.21	301.11	348.81	380.91	487.36	239.81
37	Cruising 20 min	714.90	432.88	271.55	259.03	502.48	269.45
38	Cruising 30 min	815.50	536.73	371.01	319.15	431.89	255.39
39	Descent	794.21	931.55	253.35	174.91	611.04	558.24
40	10 min to landing	746.31	623.31	312.49	203.62	565.94	446.98
41	5 min to landing	580.27	221.25	261.55	171.92	460.80	291.27
42	Landing	751.72	554.89	260.45	168.92	573.34	372.78
43	Duty Free 1	494.67	405.74	339.35	247.07	368.82	145.08
44	Duty Free 2	285.98	272.13	185.14	141.99	320.81	481.72
45	Boarding In	577.09	696.06	272.23	321.31	391.64	428.62
46	Seating In	583.62	675.47	233.91	273.61	569.73	284.76
47	Engines on	738.37	786.19	239.19	222.99	558.08	485.19
48	Take-off	301.59	136.96	267.73	195.79	447.37	371.20
49	Cruising 10 min	576.70	382.03	279.68	195.68	434.24	340.94
50	Cruising 20 min	864.49	617.94	283.07	296.04	473.79	335.82
51	Cruising 30 min	789.61	817.01	318.29	315.99	429.68	207.25
52	Descent	527.68	490.52	381.54	362.31	488.04	326.50
53	10 min to landing	654.21	553.98	339.14	261.21	512.23	306.41
54	5 min to landing	520.64	476.69	343.47	455.02	875.63	1,162.05
55	Landing	498.10	472.96	281.61	295.07	878.27	1,184.73

9.18 Table 27. HF

Table 27. Means and standard deviations of HF (ms²) during specific epochs of seminar for subjects with fear of flying (High-Anxious and Moderate-Anxious) and Controls.

		HF (ms²)					
Epoch	Marker	High-Anxious (N=9)		Moderate-Anxious (N=15)		Controls (N=9)	
		M	SD	M	SD	M	SD
1	Begin 1st day 1	133.23	118.33	105.41	138.68		
2	Begin 1st day 2	130.84	90.24	81.62	44.38		
3	Psychologist 1	137.08	148.75	124.63	68.22		
4	Psychologist 2	147.53	164.38	111.38	81.10		
5	Captain	150.51	135.89	128.11	74.69		
6	End 1st day 1	173.12	153.36	140.06	85.04		
7	End 1st day 2	160.02	131.07	124.05	75.48		
8	Begin 2nd day 1	248.29	230.21	136.18	93.33		
9	Begin 2nd day 2	246.21	212.84	136.62	118.14		
10	Simulator boarding	192.42	178.03	117.35	130.69		
11	Seating	350.99	236.08	168.15	101.89		
12	Take-off	276.58	234.91	153.67	81.96		
13	Turbulence	250.97	131.08	161.30	124.32		
14	Cruising	263.21	205.91	154.41	73.46		
15	Relaxing	221.77	211.14	200.33	165.12		
16	Descent	195.33	156.74	135.52	86.16		
17	Landing	173.12	202.58	142.93	133.15		
18	Restaurant 1	148.01	174.47	91.05	58.97		
19	Restaurant 2	192.67	200.16	120.49	58.09		
20	End 2nd day	170.67	184.92	124.47	77.07		
21	Begin 3rd day 1	104.29	61.66	117.71	75.08		
22	Begin 3rd day 2	132.52	111.66	101.45	92.38		
23	Hangar	89.74	69.02	89.57	109.81		
24	Airplane Visit	163.84	100.76	115.33	115.08		
25	Restaurant 1	131.03	71.77	111.61	124.73		
26	Restaurant 2	130.37	75.09	107.99	105.34		
27	Crew 1	135.99	134.19	81.40	122.69		
28	Crew 2	140.72	135.01	69.89	76.22		
29	Briefing	161.21	150.22	79.18	78.48		
30	Lounge 1	185.14	146.53	55.79	71.81	81.67	90.25
31	Lounge 2	129.22	133.50	57.22	73.89	49.20	83.50
32	Boarding out	92.04	75.59	73.63	52.93	46.97	52.60
33	Seating out	70.62	121.61	71.70	94.24	95.93	106.00
34	Engines on	108.34	131.80	42.93	66.74	97.80	126.03
35	Take-off	111.61	108.69	76.52	53.99	166.23	141.66
36	Cruising 10 min	64.85	119.81	44.07	69.25	68.86	131.08
37	Cruising 20 min	105.60	147.56	34.65	51.69	84.73	134.33
38	Cruising 30 min	115.22	61.45	90.41	55.13	125.34	140.03
39	Descent	156.79	151.34	37.88	61.99	197.49	176.01
40	10 min to landing	93.79	148.30	59.33	80.63	117.49	153.38
41	5 min to landing	51.56	140.64	43.53	68.33	86.87	121.56
42	Landing	153.47	105.89	70.96	61.54	143.56	119.29
43	Duty Free 1	64.41	98.33	52.65	69.97	35.47	61.34
44	Duty Free 2	38.46	18.41	53.65	66.48	44.40	59.12
45	Boarding In	98.57	80.07	52.32	57.61	44.25	49.60
46	Seating In	102.40	105.31	54.90	61.21	41.30	82.56
47	Engines on	103.24	140.79	50.13	72.42	77.74	112.68
48	Take-off	40.96	73.26	40.06	68.66	100.05	123.73
49	Cruising 10 min	69.16	101.47	56.92	73.38	104.61	124.42
50	Cruising 20 min	115.20	155.09	66.44	67.73	109.73	143.01
51	Cruising 30 min	156.12	153.32	100.74	81.07	36.23	81.12
52	Descent	68.40	92.14	75.63	97.33	142.57	136.72
53	10 min to landing	89.55	115.99	133.53	102.01	140.27	191.54
54	5 min to landing	62.76	84.56	129.39	95.79	460.75	285.03
55	Landing	95.87	57.95	90.91	134.21	291.88	423.84

9.19 Anxiety and mood

BEFINDLICHKEIT	Zeit: trifft nicht zu	NUMMER: 1 2 3 4 5 6 7	trifft zu
Ich fühle mich **kälter** als sonst.	0%		100%
Mein Herz **schlägt viel schneller.**	0%		100%
Ich glaube, ich brauche **mehr Luft.**	0%		100%
Ich spüre ein verstärktes **Kontrollbedürfnis.**	0%		100%
Ich **schwitze** stärker.	0%		100%
Ich bin **freudig** / froh.	0%		100%
Ich bin **traurig** / deprimiert.	0%		100%
Ich bin wütend **/ überreizt.**	0%		100%
Ich bin angespannt / **nervös.**	0%		100%
Ich bin ruhig / **entspannt.**	0%		100%
Ich fühle mich **selbstsicher.**	0%		100%
	überhaupt keine		extrem stark
Generelle **Flugangst** im Moment.	0%		100%

Curriculum Vitae

Name:	Margit Burger, nee König
Date of Birth:	January 13, 1964
Place of Birth:	Vienna
Nationality:	Austria
Address:	A-2440 Moosbrunn, Neubachgasse 44
Family status:	married, two children (1991, 1993)

Education

June 2007	Participation in the 3rd world conference on Fear of Flying in Montreal
Since May 2004	Clinical and Health Psychologist
1995 – 2001	University of Vienna, studying Psychology
1978 – 1983	Vienna Business School, A-1010 Vienna, Akademiestr 12
1974 – 1978	Secondary School: A-1040 Vienna, Wiedner Gürtel 68
1970 – 1974	Elementary School: A-1100 Vienna

Career:

From 2007	***PSZ – inter.work Arbeitsassistenz***, A-2500 Baden Commercial and project management
2003 – 2007	***inter.work Arbeitsassistenz***, A-2500 Baden Executive management
2001 – 2003	***inter.work Arbeitsassistenz***, A- 2500 Baden (Psychosocial help and employment coaching of people with psychiatric illness)
1999 – 2001	***BBRZ*** , A-1110 Vienna: Honorary training for psychological diagnostic
1993	Maternity leave, son Clemens
1991	Maternity leave, daughter Sarah
1986 – 1991	**Austrian Chamber of Commerce**, Damascus Syria Secretary of the Austrian Commercial Attaché in Syria
1984 – 1986	***American Embassy,*** A-1090 Vienna, Human Resource
1983 – 1984	***Coloniale Commerce***, A-1100 Vienna (Import – Export)

Moosbrunn, April 2011