



Psychophysiological reactivity of currently dental phobic-, remitted dental phobic- and never-dental phobic individuals during exposure to dental-related and other affect-inducing materials



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ABSTRACT

Psychophysiological responses indicating the preparation of defensive behaviour, such as heart rate (HR)-increase and startle-response (SR) potentiation, have often been reported amongst individuals suffering from phobic disorders when exposed to phobia-related information. Although exposure is widely considered the 'gold standard' for treatment of Specific Phobia, it is unclear to what extent psychophysiological defensive response patterns change following treatment, and whether any changes are maintained. We assessed the acoustic SR- and HR-response to neutral, positive, negative and phobia-related pictures and sounds in 41 individuals currently suffering from dental phobia, 22 formerly dental phobic individuals who had remitted following an exposure-based treatment eight months prior to assessment, and 29 control individuals with no history of dental phobia. We observed SR-potentiation to dental-related stimuli in controls combined with HR-deceleration. In contrast, amongst phobic individuals SR-potentiation was accompanied by HR-acceleration to dental pictures. Successfully treated individuals showed inhibited startle reactivity in combination with HR-deceleration to dental related materials of both modalities. Our findings suggest inappropriate fight-flight preparation amongst individuals with dental phobia, reflecting overactivation of the defensive system. However, successful treatment results in inhibited physiological defence preparation, with remitted individuals displaying a response pattern that differed from that of phobic individuals and controls.

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As defined by DSM-5 (American Psychiatric Association, 2013), a Specific Phobia (SP) is characterized by marked psychological and bodily fear symptoms when the phobic individual is exposed to the feared stimulus, sometimes culminating in overt flight responses. These fear symptoms are thought to be a product of hyper-responsiveness of the defensive system, observable on a neurophysiological level. While the fear symptoms of specific phobias are no longer evident after successful treatment, it is not clear whether the same is true of the putatively underlying psychophysiological responses. The current paper investigates this question via the example of dental phobia.

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On a neurophysiological level, hyper-responsiveness of the defensive system is thought to be the key psychopathological process underlying SPs. This defence system shows characteristic patterns of responding, varying according to the perceived threat and the strength of the accompanying arousal of the defensive system (see Lang, Bradley, & Cuthbert, 1997; Lang, Davis & Öhmann, 2000). Functionally, these patterns of responding can be divided into two classes: defensive immobility and defensive action. Triggered by mildly arousing aversive stimulation, the individuals' orienting and stimulus processing is facilitated, physiologically accompanied by a decrease in heart rate (HR) (e.g. Graham & Clifton, 1966; Turpin, 1985) and an inhibition of defensive reflexes such as the startle response (SR) (e.g. Graham, Putnam, & Leavitt, 1975). As arousal increases, defensive reflexes become facilitated and the individual becomes defensively primed. When triggered by a large increase in sympathetic activation, evoked by

highly arousing aversive stimuli, HR switches from deceleration to acceleration. This marks a change from defensive immobility to action, in the form of flight-fight preparation and behavioural mobilization (for a more detailed description see Lang et al., 1997).

In line with this account, and the hypothesised role of the defensive system in specific phobias, SR-potential on exposure to feared stimuli has been consistently observed across a wide range of phobic disorders, i.e. animal SPs including snake and spider phobia (De Jong, Merckelbach, & Arntz, 1991; Globisch, Hamm, Esteves, & Öhman, 1999; Hamm & Weike, 2005; Hamm, Cuthbert, Globisch, & Vaitl, 1997), injection phobia (Hamm et al., 1997), and Social Phobia (Larsen, Norton, Walker, & Stein, 2002; McTeague et al., 2009). Furthermore, many studies have demonstrated that phobic individuals display heart rate (HR)-acceleration (Globisch et al., 1999; Hamm et al., 1997; Sartory, Eves, & Foa, 1987) during phobia-relevant picture viewing, indicating inappropriate defensive mobilization evoked by exposure to phobia-related cues.

If overexcitement of the defensive system is a component of the pathology in SP, it should no longer be evident after successful treatment. However, the limited research that addresses this issue presents a mixed picture. Brief exposure-based cognitive behavioural treatment (CBT) is the 'gold standard' in the treatment of SPs (Wolitzky-Taylor, Horowitz, Powers, & Telch, 2008). In relation to HR-change after CBT, a recent review and meta-analysis (Gonçalves et al., 2015), which focussed on Anxiety Disorders including SPs, identified 18 studies assessing HR-change during symptom provocation in SPs after treatment. In 13 of these studies, a synchronic decrease of subjective fear and HR-response was reported. However, five studies reported desynchronized subjective and physiological fear responses or no treatment effects at all. Although there was a strong tendency towards CBT reducing HR, the meta-analysis did not yield a statistically significant result. In relation to SR-change due to treatment, findings are even sparser and long-term effects are completely unknown. Two studies (De Jong, Arntz, & Merckelbach, 1993; Kashdan, Adams, Read, & Hawk, 2012) reported that a one-session in vivo exposure treatment resulted in SR-decrease either during a behavioural approach task or picture viewing in spider phobic individuals immediately post-treatment. In summary, it is not yet clear whether physiological defence-responses change in line with the decreases of subjective fear seen following successful exposure-based CBT-treatments (Wolitzky-Taylor et al., 2008) and if so, whether changes remain stable in the long run. The phenomenology of change-patterns due to successful therapeutic treatment has not previously been investigated.

We aimed to test possible changes in physiological reactivity following CBT treatment in the context of dental phobia. When viewing dental-related pictures, individuals with dental phobia have been shown to display a phobia-typical pattern of fight-flight preparation, indicated by HR-acceleration and, compared to a neutral condition, a potentiated SR (Sartory, Heinen, Wannemüller, Lohrmann, & Jöhren, 2009; Wannemüller, Sartory, Elsesser, Lohrmann, & Jöhren, 2015). They have also been shown to exhibit enhanced SRs in anticipation of cues signalling the threat of painful shocks (Bradley, Silakowski, & Lang, 2008). However, Sartory et al. (2009) and Wannemüller, Sartory, Elsesser et al. (2015) found that startle potentiation appeared modality-dependent, evident during exposure to dental-related pictures but not to sounds. Viewed from an evolutionary perspective, this is a surprising result and it prompted the authors to consider whether sound exposure might put phobic individuals into a state of 'tonic immobility' (see Kozłowska, Walker, McLean, & Carrive, 2015), or whether SR-attenuation might comprise part of a functional 'holding-still' response during dental surgery. This unexpected result suggests that studies investigating responses to dental-related stimuli

amongst individuals with dental phobia should use stimuli of both modalities, in case this pattern of modality-specific responding is in fact a stable feature of dental phobia.

The CBT treatment in the current study was a coping- and exposure-based brief CBT introduced by Wannemüller et al. (2011, Wannemüller, Sartory, Jöhren, & Margraf, 2015). As with other SPs, for dental phobia brief exposure-based cognitive behavioural treatment (CBT) is the treatment of choice (Gordon, Heimberg, Tellez, & Ismail, 2013). The treatment by Wannemüller et al. (2011) and Wannemüller, Sartory, Jöhren et al. (2015) appears to be very effective in reducing subjective and behavioural dental fear symptoms (Wannemüller et al., 2016) and to be more effective compared to other treatment formats (Wannemüller et al., 2011). Thus it provides a suitable mode of treatment for investigating the psychophysiological responding of individuals successfully treated with CBT in dental phobia.

We investigated subjective and physiological responses to visual and acoustic dental-related, neutral, negative and positive control materials in a group of dental phobic individuals (PHOB), remitted phobic individuals (R-PHOB) eight months after completion of exposure-based CBT, and never dental phobic controls (CON).

We expected currently phobic individuals to perceive dental-related materials as highly threatening, indicated by ratings of high arousal and unpleasantness. On a physiological level, we expected them to display a pattern of immediate fight-flight preparation responses reflecting a state of *circa-strike*, with HR-increase and, compared to neutral materials, a potentiated SR during exposure to dental-related materials. Since dental surgery is generally considered to be unpleasant and unwelcome, we expected non-phobic controls to rate dental materials equally arousing and (un)pleasant as negative materials. However, we expected controls to display a pattern of oriented attention with a potentiated SR to both negative and dental related stimuli, compared to neutral materials, accompanied by HR-decrease, as seen for orienting responses (e.g., Graham & Clifton, 1966; Turpin, 1985). We used positive and negative control materials of both modalities and expected all groups equally to show unimpaired activation of the appetitive and defensive system, indicated by HR-orienting to those stimuli. We also expected all groups to show startle inhibition to positive and potentiating to negative materials, as these are the normal response patterns evoked by such stimuli (Lang et al., 1997). However, our main aim was to investigate whether the physiological response pattern to dental-related stimuli of phobic individuals in complete remission would still reflect a high activation of the defensive system as expected for the PHOB-group, or if the response-pattern of R-PHOBs would resemble that of individuals never affected by dental phobia.

1. Method

The study was approved by the local ethics committee of the Ruhr-University Bochum.

1.1. Participants

Participants (N = 92; 60.9% female) included three groups. The first group comprised individuals diagnosed with current dental phobia (PHOB, n = 41). The second group included never dental phobic controls (CON, n = 29). The third group consisted of 22 individuals who had previously been diagnosed with dental phobia, but had successfully been treated with a CBT program and were remitted (R-PHOB), thus no longer fulfilling the criteria for dental phobia at the time of the psychophysiological assessment. The PHOB-condition consisted of phobic individuals who were either untreated (n = 34) or had completed the same CBT program

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