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Responses of ultra-weak chemiluminescence and secretory IgA in saliva to the induction of angry and depressive moods

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Abstract

Oxidative damage to tissues and cells contributes to disease processes. We used ultra-weak chemiluminescence (uwCL) as an indicator of oxidative activity to examine the effects of psychological challenges on oxidative responses. We also examined the association of underlying psychological characteristics with oxidative and immune responses. Eighteen healthy men and women with a mean age of 24.1 were recruited. Anger and depressive symptoms were evaluated using the State-Trait Anger Expression Inventory and the Center for Epidemiological Studies Depression Scale, respectively. Following a baseline period, participants were required to complete two separate speech tasks where they were asked to recall life events that made them feel angry (AT) or depressed (DT). The tasks were separated by a 30-min recovery period and the order was randomized between participants using a counterbalanced design. Saliva was sampled and assayed for uwCL and secretory immunoglobulin A (sIgA). The level of uwCL was significantly increased in response to both tasks ($p < .05$), whereas sIgA concentrations decreased significantly in response to DT ($p < .05$). At 30 min after each task, uwCL values were positively related to anger-in ($p < .005$), anger expression ($p < .05$) and trait anger ($p < .05$) post-AT, and sIgA concentrations were positively related to anger-out ($p < .05$) post-AT and -DT, after controlling for covariates. The present study suggests that induction of angry and depressive moods can increase oxidative activity and transiently weaken immunity indicated by salivary sIgA concentrations. In addition, anger personality traits may modify these responses.

Keywords: Chemiluminescence; Oxidative stress; IgA; Mood induction; Anger; Depression

1. Introduction

Ultra-weak chemiluminescence (uwCL) is considered to result from oxidative chemistry occurring within cells (Chen et al., 2003). It is based mainly on an electronic transfer in the oxidation–reduction reaction (Hosker et al., 1989; Takagi et al., 2005). Changes in uwCL levels in response to oxidative activity have been observed in many systems, including bacteria (Maccarrone et al., 1998), plants (Chen et al., 2003; Flor-Henry et al., 2004; Yoshinaga et al., 2006) and animals (Doi et al., 2002; Zimiani et al., 2005). Human saliva contains peroxidase and the electron donor SCN−, and it emits ultra-weak photons that can be detected as uwCL. uwCL can be regarded as one branch of lipid peroxidation (LPO) occurring later than malondialdehyde formation (Wang et al., 2001), which is an effective monitor of lipid peroxide generation. For this reason, measurement of salivary uwCL may be a

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useful non-invasive technique to monitor rapid perturbations to oxidative activity.

Previous studies on animals have indicated the effects of psychological challenge on development of oxidation (Moller et al., 1996). These include an increase in LPO and a decrease in endogenous antioxidant defenses in plasma by immobilization stress on rats (Liu et al., 1994), a rise in LPO in the heart of rats exposed to immobilization stress (Davydov and Shvets, 2001), LPO elevation in mice brain after exposure to psychological challenge employing a communication box paradigm (Matsumoto et al., 1999), and higher levels of 8-hydroxydeoxyguanosine (8-OHdG) in stressed rat′s liver (Adachi et al., 1993). In humans, the effects of various psychosocial factors on oxidative processes are evident from indirect biological and physiological indicators, although the role of psychological challenge on specific measures of oxidation in human has rarely been studied. Some research suggests a relationship between psychological conditions and oxidative stress (Gidron et al., 2006). For example, remaining awake all night caused a dramatic increase of thiobarbituric acid-reactive materials, an indicator of lipid peroxidation, in the urine of healthy subjects (Kosugi et al., 1994). Associations between depressive symptoms and urinary 8-OHdG have also been reported (Irie et al., 2005). Given that psychological challenge appears to cause oxidative damage in tissues or cells, we would hypothesize an increase in uwCL values under such conditions. These processes may have implications for health outcomes because excessive oxidative activity has been related to allergic responses (Park and Lee, 2006; Okayama, 2005), cardiovascular diseases (Muller et al., 2007; Lahera et al., 2007), and pathogenesis of cancer (Hwang and Bowen, 2007; Karihtala and Soini, 2007), although the importance of transient or acute changes remains unclear. In addition, salivary secretory immunoglobulin A (sIgA) has been shown to respond to psychological challenges, although both increases and decreases in concentration have been observed depending on the type and duration of stress (Segerstrom and Miller, 2004). Given that sIgA might directly regulate the activation of reactive oxygen on the mucosal surfaces (Wolf et al., 1994), these two measures may therefore be interrelated.

An important aspect of psychosocial influence on acute responsivity is the nature of the acute psychological demands, and this may partly explain some of the inconsistencies in literature. A match between acute demands and the nature of the underlying (trait) mood state of participants may stimulate heightened responsivity. It is possible that in chronically angry/depressed individuals, conditions that acutely induce angry/depressed mood will produce higher levels of physiological response. However, research to date that has examined the effects of angry/depressive symptoms on psychobiological responses has typically employed non-specific stressors that have not been designed to induce specific mood states.

Therefore, we examined the effects of anger/depressive symptoms on salivary uwCL responses to two separate speech tasks that were designed to induce acute angry and depressed moods, both of which are known to impact on the acute biological stress responses. Given that salivary uwCL and sIgA levels were found to be temporarily increased when participants were under performance anxiety (Takagi et al., 2005), we hypothesized that uwCL would display the same change pattern as sIgA. Data from this study has been previously published elsewhere showing that these tasks induce robust activation of the cardiovascular system and increase sympathetic activity, as was evidenced by increases in 4-hydroxy-3-methoxyphenylglycol, a metabolite of noradrenaline (Hamer et al., 2007).

2. Participants and methods

2.1. Participants

Eighteen healthy men ($n = 7$) and women ($n = 11$) with a mean age of 24.1 (SE 0.69), and mean body mass index (BMI) of 22.7 (SE 0.73), who were free from any medication, were recruited from a student population. The participants consisted of 12 whites, 3 Chinese and 3 South Asians. All participants gave full informed consent to participate in the study and ethical approval was obtained from the UCL (University College London) Graduate School Committee on the Ethics of Human Research.

2.2. Psychophysiological testing

Testing was performed in a quiet, air-conditioned room either in the morning, beginning at 9 am, or in the afternoon beginning at 1:30 pm. Participants were requested to refrain from vigorous exercise, smoking, and food, caffeine, and alcohol intake for 2 h prior to testing. At the beginning of the session, weight and height were recorded for the calculation of BMI and participants completed a series of questionnaires relating to demographic details and medical history. Participants then rested for a further 20 min to acclimatize to the situation. Following the baseline period, participants were required to complete two separate psychologically demanding speech tasks that each lasted for 5 min, using a counterbalanced design. During the two speech tasks, participants were instructed to speak into a video camera about two separate life events that had caused them to feel angry or depressed (anger task, AT; depression task, DT). Some examples of such life events (e.g., death or major illness of a close family member, problems with a relationship, being a victim of crime, etc.) were presented to the participants whilst they were given task instructions and then a 2-min preparation period followed before the 3-min speech. The tasks were separated by a 30-min recovery period during which participants were supplied with reading material of low emotional content. At the end of each task, the participant rated feelings of stress, anger, depression, irritation, sadness and happiness on a seven-point scale from 1 = low to 7 = high. These ratings were also obtained at baseline. Saliva samples for the assessment of uwCL and sIgA were taken at baseline, immediately after the tasks, and then at 30 min post-task, using cotton dental rolls (Salivettes, Sarstedt, Leicester, UK). The cotton rolls were held in the mouth for exactly 2 min for each sample, to ensure that conditions were standardized for flow-dependent measures. Saliva samples were frozen at −80 °C until assayed.

2.3. Questionnaires

Anger experience was measured using the State-Trait Anger Expression Inventory (STAXI), a 44-item self-administrated questionnaire, with separate measures of trait-anger, anger-in, anger-out, anger-control, and anger-expression (Spielberger, 1988). Depression was assessed utilizing