STARTLE AND ORIENTING REFLEX COMPONENTS MODULATION BY ATTENTION TO TASK AND PERFORMANCE OF MENTAL TEST WITH NOISE FOREGROUND : IMPLICATION FOR STERSS AND AFFECT RESEARCH

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백색소음하에서 단어암기 및 재인검사 수행시의 경악 및 정향반사 특성 : 스트레스/정서연구에의 시사점

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Abstract

In current study on 8 college students there was examined modulation of eyeblink (as measured by integrated EMG of m.orbicularis oculi) and skin conductance response (SCR) to an acoustic startle probe (85 dB[A] white noise) by attending to task presented in auditory modality (to memorize words for further recognition) and entire performance of the word recognition test. Both eyeblink magnitude and SCR amplitude and rise time to startle probes were modified (larger magnitude of EMG peak, lower amplitude and shorter rise time of SCR) during attending to task as compared to performance on test. Results are interpreted in terms of modification of electrodermal and eyeblink components of startle and orienting reflexes by task characteristics (passive versus active efforts), attentional demands and aversiveness of experimental situation. However, eyeblink startle response manifested potentiation during attending to task, while SCR demonstrated attenuation. There are discussed implications of startle modulation as a potentially sensitive probe of situational demands in stress research and also are considered prospects for further studies.

Introduction

It has been demonstrated that the startle reflex response to unexpected noise is able to increase reliably during exposure to aversive stimuli (i.e., stressor) or fearful situation, a phenomenon known as the fear-potentiated startle reflex [4,9,11,12,14]. Recently, in a series of experiments Lang and his colleagues [6,7,13] employed the startle reflex as a model to analyze emotional and attentional processes in human subjects, and these studies proved that startle reflex potentiation is sensitive to manipulations of affective state and also to individual differences in emotionality and affective styles [13,14] . Augmented startle reactions have been observed during unpleasant states evoked by viewing affective pictures [4,6], by imagery of fearful situations [17], and even by anticipation of a noxious event [14] suggesting that startle potentiation occurs independently of the mode of fear evocation , i.e., may appear in different situations featured by negative affect and aversive conditions.

According to Lang (1995) startle potentiation provides a direct index of defensive activation that might be unique informative where peripheral responses patterns are mixed and complicate clear differentiation or startle, orienting and defense reflexes. Patrick and Berthot (1995) explicitly manipulated the response demands of an experimental task to examine potentiation as a function of differing action tasks. Startle probes were recorded during interval when subjects were passively awaited a stimulus or when prepared to action. Similar paradigm have been used to study attentional effects on the startle response [1,6,11,12] and processes associated with motor preparation [8]. Aversive situation often involve overt motor acts or preparation for action, and there is evidence that the availability of an active coping response can attenuate anxiety associated with noxious event [16]. Mobilization for active coping attenuates anxiety, lowers stress level, and startle potentiation effects should be smaller in the active task as compared to passive task.

Emotional influences on startle are intensively explored [4, 6, 7, 9, 13]. In addition to the effects of emotion, it is important to consider the influence of attention on startle reactivity. Specifically, there is evidence that the startle reflex tends to be enhanced as attention is focused towards the modality of a probe stimulus and inhibited or attenuated as attention is directed away [1,11,12]. It is admitted that both attentional and affective processes could influence startle response[b]. Cross-modality effects are manifested when the startle reflex, besides being augmented by aversive stimuli, is enhanced when startling stimulus occurs in the same sensory modality that is engaging attention (e.g., task is presented in auditory modality as well as startle probe) [1,17]. It is possible that attention and emotion can modulate startle response concurrently and independently, and such dual process interpretation assumes that attentional effects on startle can operate independently of emotional effects.

Active coping attenuates anxiety [14, 16] and this is important to assess the impact of active coping on potentiated startle during anticipation of a stressor. There is some evidence that preparation associated with mobilization to action and active coping affected startle potentiation [8]. Thus active coping situation prompted a negative, defensive state in subjects, alternatively it could be argued that motor preparation affected the blink response in the active tasks even through anxiety was blocked [8,14].

The eyblink component of the startle reflex is reliably potentiated in aversive states [6,7] initiated by different experimental designs [13,15]. Although other components of startle response have been described, particularly short term acceleration of heart rate [1,11], they have not been investigated in relation to manipulations that modify the eyblink components of the startle reflex, except some studies [17]. Electrodermal system, like the eyeblink, responds to startling stimuli, and there are several reasons to propose that aversive processing and negative affect may modify it in similar way. SCR like the eyeblink reflex, is sensitive to stimulus intensity [2,5,10,15]. Changes in the SCR and eyeblink are correlated in attentional paradigm [10], also SCR increases with increasing arousal [13]. High arousal, along with negative valence, appears to be crucial ingredient in emotional modulation of the eyeblink reflex [3,4]. Thus, it appears reasonable to examine the hypothesis that the SCR to startling stimuli is modulated by negative emotional states, attention and coping efforts in a manner similar to that of the eyeblink.

The purpose of current experiment was to examine whether eyeblink amplitude and SCR to invariant startle-eliciting stimulus can be modified by change in on-going processing tasks (attending word in noise or performing word recognition test) and to explore the relationships between SCR and eyeblink responses to startle stimuli in situations different in context of availability of active coping strategies.

Methods

Eight college students (19-23 years old) participated in the study. Physiological signals (skin conductance, facial integrated EMG) were recorded by BIOPAC, Grass Neurodata System and Acqknowledge III software. The following variables were measured for each condition: skin conductance level (SCL), the first skin conductance response (SCR) amplitude and rise time (1.0-4.0 s latency from onset of audio probe) was analyzed to estimate orienting significance of stimuli following recommendations of [2].

Integrated EMG (IEMG) was recorded from left m.orbicularis oculi and was processed to calculate amplitude and latency of EMG peak in 50-500 ms window from onset of acoustic startling probe. Amplitude was converted in an index of amplitude rise versus on-going IEMG level and expressed in conventional units (c.u.) convertable in μV. Procedure of IEMG waveform analysis during eyeblink was performed according to methodological consideration reported in [4, 6,7].

The experimental procedure consisted of (1) an adaptation period (5 min), (2) initial resting baseline recording (1 min, BAS), (3) white noise (85 dB[A], 40 s, WN), (4) the first word recognition task presentation with white noise background (40 s, TASK I - 10 English word for further recognition), (5) the recognition test I of given task also with noise background (20s, TEST I), (6) the second word recognition task with white noise background (40 s, TASK II - 10 Korean words), (7) word recognition test II with the same noise background (20 s, TEST II) , (8) post-test resting baseline (1 min, POST), (9) music (3 min) for de-briefing and (10) post-music baseline (1 min).

The instructions were given to subjects before task presentation. The instructions outlined the possibility of discontinuation of noise if the test was performed correctly in pre-set time limits. This was to encourage and challenge subjects to apply active mental efforts to avoid aversive noise background. Subjective stress-level rating questionnaires and check lists were used for psychological assessment. Filling the check-lists did not alter the physiological response patterns. Statistical analysis was performed by SPSS using T-test for paired samples.

Results

Eyeblink startle reflex. IEMG amplitude was potentiated during TASK conditions (mean values for TASK I 0.74 c.u. and TASK II 0.99 c.u. , i.e. , higher than 0.64 c.u. in WN only) and attenuated during TEST (TEST I 0.21 c.u. and TEST II 0.28 c.u.). Averaged data with standard errors for WN, TASK and TEST conditions are presented in Figure 1.

However, differences between conditions yielded statistical significance only in TASK - TEST pairs, while potentiation of startle in TASK-WN pairs was manifested only as tendency without reaching significance level. This fact might be partially due to relatively small number of subjects in this study and high variability of IEMG amplitudes.

Skin conductance responses. SCR amplitude demonstrated response pattern opposite to eyeblink response, namely, SCR magnitude was significantly higher in

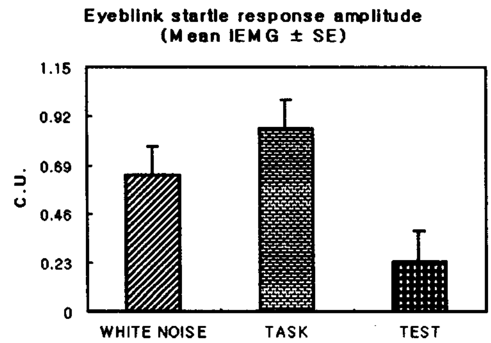

Figure 1. Eyeblink amplitude (IEMG) response modification during task attending (TASK is mean for TASK I and TASKII) and word recognition test (TEST is mean for TEST I and TESTII). Standard errors (SE) are shown on the bars (N=8).

TEST condition as compared to TASK and WN conditions. For example, paired difference of SCR amplitude for TEST I - TASK I pair was 2.77 μs (p=0.045), and TEST II - TASK I was 2.66 μs (p=0.05). Difference between WN and TASK I and TASK II did not reach significance level (-0.70 and -1.12 μs respectively, ps>0.05). Mean values for each condition are shown in Figure 2.

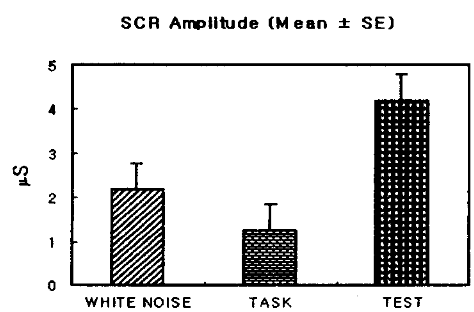

Figure 2. The first SCR amplitude during white noise (WN), TASK and TEST conditions (N=8). Mean values are shown with standard errors.

SCR rise time was practically identical in WN and TEST conditions and tend to be longer as compared to TASK. However differences of WN-TASK and WN-TEST pairs for SCR rise time were not significant. Skin conductance level drift (SCL drift) during each condition calculated as difference between initial and final value of SCL demonstrated trend similar to SCR amplitude, e.g., highest values for TEST and lowest for TASK. However, here as well as in SCR amplitude tendencies, only TEST-TASK differences were significant statistically. For example, paired difference for TEST I-TASK I was 3.00 μs (p=0.048). SCR rise time and SCL drifts data are presented in Figures 3 and 4.

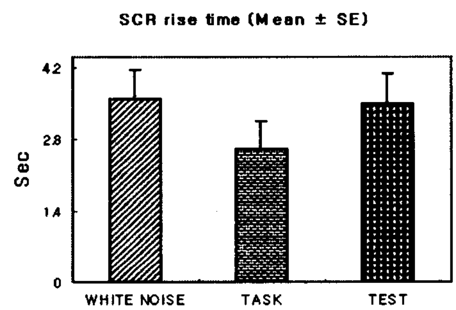

Figure 3. The first SCR rise time in WN, TASK and TEST conditions (N=8). Mean values with standard errors.

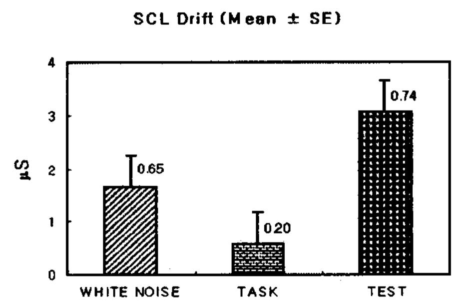

Figure 4. Skin conductance level drift during WN, TASK and TEST conditions (N=8). Means with standard errors.

Discussion

Data replicated the results of other studies in finding larger amplitude of IEMG response to startle probe during TASK than TEST [9,17] . Amplitude and rise time of SCR to startle probes did not produced the same pattern of modulation as did eyeblink as it was reported by [17].

Nevertheless, there was confirmed that the SCR can be modulated by ongoing psychophysiological processes that are unrelated to the eliciting stimulus, as it was outlined in the same study [17].

Startle eyeblink is specifically sensitive to negative valence in ongoing processes [10,13,17], SCR, however, responds more to stimulus or situation of greater emotional arousal [7,9,13], as well as orienting and defensive reflexes [5]. We do not exclude possibility that potentiation was affected as well by modality effects, since both acoustic probe (WN) and task were delivered in the same auditory modality.

In our study SCR eliciting WN was held constant in every respect across condition, and response magnitude should be modulated , like startle, by ongoing task attending and test performance processes. Thus, SCR in this study was not manifested as a component of startle and did not responded to modulatory manipulations in way like eyeblink, but in general was affected by situational characteristics (without changed parameters of acoustic probe) and this finding replicated in part data of other authors [17] . It was shown that SCR habituation to neutral tones was retarded and SCRs were larger and more frequent when tones occurred under arousing conditions than when the tones occurred under relaxed conditions [3]. Increased SCL drift during performance, as well as augmented SCR magnitude during test performance test as compared to attending to task, may lead to suggestion that this condition (TEST) was featured by heightened arousal and increased sympathetic activation [3,4,15]. Interpretation of this fact may be proceeded in terms of more sustained arousal requirements during preparation and execution of active coping efforts during test performance [8,9,10]. However, potentiation of startle reflex exhibited in task, and not test condition, states for more emotional negativity of situations where active coping is not available as strategy of behavior. Attentional demands were either capable to impact observed responses [1,6,8].

Taking into account that SCRs are associated with both orienting and defense responses, it seems rationale to analyze both phasic and tonic components of electrodermal arousal and add other autonomic variables, such as ,for instance, heart rate and pulse volume responses to differentiate autonomic effects specific for these reflexes of interest (startle, orienting and defense) [5,11].

Eyeblink startle and skin conductance response, however, have some differences that might be important to be outlined, namely, in startle modification experiments, the eliciting stimulus is held constant, and response modification is caused by emotional or attentional properties of concurrent tasks. In most research designs directed to SCR modification, as it was mentioned by Vrana (1995), discrete stimulus intensity, novelty, significance or emotional contents of eliciting stimulus were directly manipulated and it is the change in eliciting stimulus itself that modifies the SCR [2,5,10, 15,17]. Thus usually designs for SCR and startle are different and parallels are difficult to be done. Another distinction exists in time course of responses, since eyeblink appears within milliseconds, while SCR onset latency is approximately 1-4 s and rise time of SCR is approximately 2 s long [2, 5].

Finally, modification of the startle reflex eyeblink bas been possible with manipulation of situational demands, as well as such additional components of startle and orienting as SCR. However, SCR did not behave in a way similar to eyeblink reflex. It must be mentioned, that due to limited number of subjects and untraditional startle probe duration, obtained results still have preliminary character. It seems that more research is needed to determine whether other responses are either component of startle and orienting reflexes to examine their relationships. Nevertheless, this direction of research seems rather fruitful, since it might result in new sensitive physiological variables to be used for identification of the role of negative emotional states in modulation of startle and orienting responses. Such indicators and indices are especially important in stress research.

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