Eyeblinks, EP Augmenting / Reducing and Personality

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ABSTRACT

Objectives : Eyeblinking varied depending on individual cognitive abilities or personality traits thought to related to brain mechanisms of sensory modulation. This study explored whether personality traits are related to the rate of eye blinks and how eyeblink and evoked potential augumenting-reducing(EPAR) interact.

Methods : Forty four students were studied with EPAR topography to explore how eyeblinks, personality and EPAR interact. The Zuckerman Sensation Seeking Scale(SSS) and Eysenck Personality Questionnaire(EPQ) were used as personality measured by a stimulus response program during EP study.

Results : Rate of blink increased as intensity of light increased. The General(GEN), Thrill and Adventure Seeking(TAS), Experience Seeking(ES) and Disinhibition(DS) subscales in SSS and Extraversion-Introversion(E) subscale in EPQ showed significant negative correlations with number of eyeblinks in the hightest intensity of light, whereas Neuroticism(N) subscales in EPQ showed a positive correlation. Correlation between number of eyeblinks with the brightest light and EPAR slope varied topographically. The strongest positive correlation was noted in right posterior temporal area.

Conclusion : High sensation seekers blinked significantly fewer times than lower sensation seeker did. Higher personality correlations with eyeblink than with EP may imply that the eyeblink works as a primary filter since it is more directly related to central mechanisms of sensory modulation than EP. The right posterior temporal area may play an important role in modulation of visual stimuli.

KEY WORDS : Eyeblinks · EP · Personality traits.

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Introduction

Blinking is thought to be related to certain cognitive processes. Telford and Thompson(1) showed that the rate of blinking was low during concentration and intense mental activity. Wood and Hassett (2) found eye blinks increase during solving difficult problems. Stern et al(3) reported the immediate effect of externally directed attention is a reduction in blink rate and blinks tend to occur during moments of decreased attention. However, stimuli potentially injurious to the organism elicit reflex blinks(3).

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High arousal stimuli containing auto accident scenes induced a higher eye blink rate than low arousal stimuli(4). Unfocused or rapidly changing internal states such as disorientation, emotional excitement, frustration and anxiety seem to be associated with a high rate of blinking(5, 6). Stern et al(3) also reported higher levels of activation are associated with elevated blink rates.

In general blinking rate decreases during attending, interesting stimuli or concentrated mental activity and blinking rate increases during anxiety and anxiety inducing stimuli. Individual differences in eyeblink rate may be related to individual differences in cognitive abilities or to personality traits thought to depend on brain mechanisms of sensory modulation. Sensation-seeking(7) and introversion extraversion(8) are two such traits. Although the evoked potential augmenting-reducing(EPAR) has been used in measuring sensory modulation, interaction of eyeblink and EPAR has not been studied. This study explored whether these personality measures are related to the rate of eye blinks and how eyeblink and EPAR interact.

Method

Subjects

Two hundred seventy one male freshmen at the University of California, Irvine were originally screened on vertex EPs. Each volunteered after a request for research subjects was mailed to all freshmen. Forty four students who showed augmenting or reducing in the upper or lower 25% of the distribution(9), were selected to participate in a separate topographic EP and eyeblink study. All subjects were 18 years old. At the original EP screening all subjects completed the Zuckerman Sensation Seeking Scale(SSS) (10) and Eysenck Personality Questionnaire(EPQ) (11).

The Forty four selected subjects include twenty one who had EPAR slopes$\geq$3.40 and twenty three who had slopes≤ -2.50. These cutoffs represented the upper and lower 25% of the EPAR slope distribution. These subjects returned for further EP testing, as described below, including a new determination of EPAR slope.

Measures

Blinking : Subjects sat in a darkened room and viewed light flashes on a traslucent screen(25×27 Cm) located 1m in front of them. Four intensities of light were displayed : 6, 37, 84 and 214 ft-c.(measured at the screen, footcandles were equivalent to footlamberts). Each light flash had a duration 40 msec : a total of 480 flashes were presented at one per two seconds, with 120 trials at each intensity. The system for displaying the light stimuli used a computer controlled Kodak carousel slide projector fitted with an Ilex No. 4 Synchro-electronic shutter. Subjects were wired with 32 gold disc electrodes for evoked potential measurement. Note this apparatus was different from the one used in the original EP screening. Eye blinking was monitored with lead Fp1 and any trial which had the amplitude on Fp1 exceeding 127 microvolt was regarded as an eyeblink. The number of eyeblinks was automatically obtained by a stimulus response program(12). The number of eyeblinks at each intensity of light was recorded.

Evoked potentials : Amplified and filtered 32 leads of EP data were recorded by a stimulus response program. Trials where eyeblinks or other movement artifacts occured were automatically excluded from the EP average. Eps were first detrended using linear regression and then digitally filtered to remove frequencies below 3.5 Hz and above 35 Hz as described elsewhere(13). Eps were measured by area integration for P100(72−108 ms), N120(104−136 ms) and P200(128−172 ms). The solpe of N120 amplitudes at the four intensities of light as a function of log luminance was calculated by the method of least squares and served as the EPAR measure : positive slopes indicate augmenting and negative slopes indicate reducing. Topographic map was created by interpolation from the 32 known values on an approximately equal area projection of the sagittal cortical surface(14).

Result

Subject blinked an average of 141.2 times(sd=104.7) among the 480 trials(29.42%). Rate of blink increases as intensity of light increased and the rate of blink in the hightest intensity of light was 44.42% (Table 1). The correlations between eyeblink rate and personality scores are shown in Table 2. Overall, as the intensity of light increased, there were more blinks and the magnitude of the correlations increased. The strongest correlations were with high sensation-seeking on Thrill and Adventure Seeking(TAS) and Experience Seeking(ES) subscores and fewer eyeblinks(TAS ; $r=-0.38$, ES ; $r=-0.42$, $p<0.01$). The neuroticism(N) scale showed a significant positive relationship with eyeblinks($r=0.31$, $p<0.05$).

Table 1. Eyeblink rates at different intensities of light

Intensities of light	Eyeblink x	Eyeblink sd	Eyeblink Rate of blink*
6 ftc	14.7	12.2	12.25%
37 ftc	31.8	28.1	26.50%
84 ftc	41.3	33.1	34.42%
214 ftc	53.3	37.6	44.42%
Combined	141.2	104.7	29.42%

*number of eyeblinks/number of flashes(120)

Table 3. Correlation between slope and number of blinks in the brightest light

Areas	Correlation
Frontal(Fz)	−0.056
Central(Cz)	−0.064
Occipital(Oz)	−0.300
Right temporal(TT_2)**	0.409*
Left temporal(TT_1)***	0.051

Two-tailed, df=37, *$p<0.01$
**Interpolated lead between T_4 and T_6.
***Interpolated lead between T_3 and T_5.

Corrlations between the number of eyeblinks in the brighest light(where the variances wre greatest) and slopes on the 32 leads were tested, then a correlation map was created(Fig. 1). Summary of correlations are presented in Table 3. The strongest correlation was noted in right posterior temporal area, whereas other areas did not show any significant correlations(Fig. 1, Table 3).

Discussion

As the intensity of light increase the rate of eyeb-

Table 2. Correlations between number of eyeblinks at each light intensity and personality scores

Scales	x	sd	r with eyeblink 6ftc	37ftc	84ftc	214ftc	Combine
GEN	45.2	9.3	−0.05	−0.05	−0.14	−0.31*	−0.18
TAS	49.8	11.1	−0.11	−0.30*	−0.35*	−0.45**	−0.38**
ES	44.5	7.4	−0.22	−0.32*	−0.43**	−0.44**	−0.42**
DS	47.1	8.7	0.08	−0.22	−0.29*	−0.37*	−0.28
BS	45.9	7.8	0.03	−0.00	−0.14	−0.19	−0.11
E	15.2	4.7	0.01	−0.02	−0.26	−0.33*	−0.26
N	8.7	4.5	0.18	0.27	0.34*	0.28	0.31*
P	4.6	2.5	0.12	−0.03	−0.14	−0.19	−0.11

Two-tailed, df=42, *$p<0.05$, **$p<0.01$
GEN(General), TAS(Thrill and Adventure Seeking), ES(Experience Seeking)
DS(Disinhibition), BS(Boredom Susceptibility), E(Extraversion-Introversion)
N(Neuroticism), P(Psychoticism)

link increased across all subjects. This is consistent with the idea that eyeblinks work as a protective response to intense stimuli(3). Blinking response also varied according to individual capacity of sensory modulation as measured by sensation seeking. High sensation seekers may better tolerate high intensity stimuli(15).

Significant correlations between EP slope and Zuckerman SSS have been found in some subscales(7, 15, 16). In this study, the numbers of eyeblinks at the highest intensity of light(214 ftc) were significantly correlated with all subscales except Boredome Susceptibility(BS) in SSS and Neuroticism(N), Psychoticism(P) subscale in EPQ. The higher personality correlations with eyeblink than with evoked potentials may imply that the eyeblink works as a primary filter since it is more directly related to central mechanisms of sensory modulation than evoked potentials.

The correlation pattern between number of eyeblinks and EP solpes on 32 leads revealed significant postitive correlation in the right temporal area. This positive correlation is least likely from any artifact effect of blinking because of the distance between

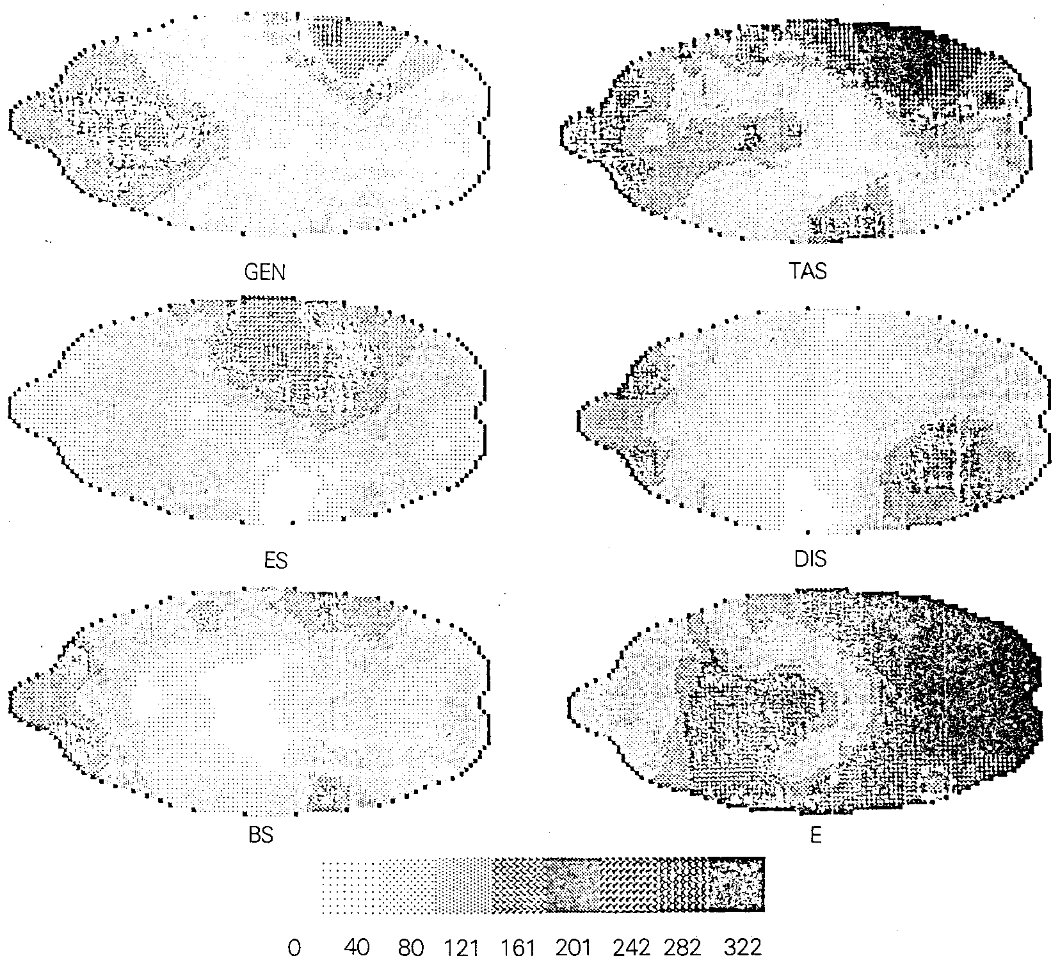

Fig. 1. Correlation map between number of blinks in the brightest light and slope on 32 leads. Black areas, higher than 0.322 in r-value, indicate statistical significance(two-tailed, p<0.05).
Abbreviations are as in Table 2.

posterior temporal and prefrontal area. Right posterior temporal and parietal areas have been related visuospatial function(17, 18). The significant correlation of this area in our study may have some psychophysiological implication.

Volkman(19, 20) reported that the suppression of primary visual cortex arises as a corrolary to the efferent discharge that close the eyelids. The evoked potentials in some other cortices may be augmented to compensate the visual suppression which occured during blinking, in case of excessive eyeblink from strong tendency of lower sensation seeking. As seen in Fig. 1 and Table 3, the occipital area had a negative correlation between number of blinks and slope although its significance was not less than 0.05($r=-0.300$, $p=0.06$ on Oz). This negative correlation indicates that visual cortex and eye lids work in the same directionas Volkman reported. But other areas especially the right posterior temporal area may complement the response occuring at visual cortex and eye lids as Fig. 1 suggests. The right posterior temporal area may play an important role in modulation of visuospatial stimuli.

Some studies(21, 22, 23) suggest that central dopaminergic activity may affect rate of eyeblink. They also found an inverse correlation between platelet monoamine oxidase(MAO) activity and eyeblink rate in schzophrenia. Negative correlations between platelet MAO levels and augmenting of EPs have been found in patient groups(24) and in students showing sign of affective disorder(25). Von Knorring and Perris(16) reported that EP augmenters are characterized by low levels of serum dopamine beta hydroxylase(DBH) and CSF 5HIAA(serotonine metabolite), HVA(dopamine metabolite) and endorphine. Johansson et al(26) found the negative relationship between sensation seeking and DBH, MAO and CSF endorphine levels. Although comprehensive summary of their interaction is difficult because of the wide variety of subjects, these findings suggest that eyeblinks, evoked potentials, monoamine activity and personality are inter-related.

REFERENCES

1) **Telford CW, Thompson N.** Some factors influencing voluntary and reflex eyelid responses. Journal of Experimental Psychology 1933 ; 16 : 524-539.
2) **Wood JG, Hassett J.** Eyeblinking during problem solving : The effect of problem difficulty and internally vs externally directed attention. Psychophysiology 1983 ; 20 : 18-20.
3) **Stern JA, Walrath LC, Goldstein R.** The endogenous eyeblink. Psychophysiology 1984 ; 21 : 22-33.
4) **Weiner EA, Concepcion P.** Effects of affective stimuli mode on eye blink rate and anxiety. Journal of Clinical Psychology 1975 ; 81 : 256-259.
5) **Kanfer FH.** Verbal rate, eye blink and content in structured psychiatric interviews. J Abn Soc Psychol 1960 ; 61 : 241-247.
6) **Ponder E, Kennedy WP.** On the act of blinking. Quart J Exper Physiol 1927 ; 18 : 89-110.
7) **Zuckerman M, Murtaugh TM, Siegel J.** Sensation seeking and cortical augmenting-reducing. Psychophysiol 1974 ; 88 : 187-214.
8) **Eysenck HJ.** The Biological Basis of Personality. Springfield, Charles C Thomas Publisher. 1967.
9) **Buchsbaum MS.** Neurophysiological Studies of Reduction and Augmentation. In : Individuality in Pain and Suffering, edited by Petrie A, Chicago, University of Chicago Press, 1978 ; 141-157.
10) **Eysenck HJ, Eysenck SBG.** Manual of the Eysenck personality Questionnaire. London, Hodder & Stoughton, 1975.
11) **Zuckerman M, Buchsbaum MS, Murphy DL.** Sensation seeking and its biological correlates. Psychological Bulletin 1980 ; 88 : 187-214.
12) **Coppola R.** A table driven system for stimulus response experiments. Proc. Digital Equipment Users Soc (Digital Equipment Corp., Maynard.), 1977 ; 1219-1222.
13) **Lavine RA, Buchsbaum MS, Schlechter G.** Human somatosensory evoked responses : effects of attention and distraction on early components. Physiol Psychol

1980 ; 8 : 105-108.

14) **Buchsbaum MS, Rigal F, Coppola R, Cappelletti J, King AC, Johnson J.** A new system for gray-level surface distribution maps of electrical activity. Electroenceph Clin Neurophysiol 1982 ; 53 : 237-242.

15) **Haier RJ, Robinson KL, Braden W, Williams D.** Evoked potential augmenting-reducing and personality differences. Person Individ Diff 1984 ; 5 : 3,293-301.

16) **von Knorring L, Perris C.** Biochemistry of the augmenting-reducing response in visual evoked potentials. Neuropsychobiology 1981 ; 7 : 1-8.

17) **Luria AR.** The Working Brain, An introduction to Neuropsychology. Translated by Haigh B, New York, Basic Book, 1973 ; 128-168.

18) **Walsh K.** Neuropsychology. Edinburgh, Churchill Livingstone, 1974 ; 197-294.

19) **Volkman FC, Riggs LA, Moore RK.** Eyeblinks and visual suppression. Science 1980 ; 207 : 900-902.

20) **Volkman FC, Riggs LA, Ellicot AG, Moore RK.** Measurements of visual suppression during opening, closing and blinking of the eyes. Vision Res 1982 ; 22 : 991-996.

21) **Freed WJ, Kleinman JE, Karson CN, Potkin SG, Murphy DL, Wyatt RL.** Eye-blink rates and platelet monoamine oxidase activity in chronic schizophrenic patients. Biol Psychiatry 1980 ; 15 : 329-332.

22) **Karson CN, Freed WJ, Kleinman JE, Bigelow LB, Wyatt RJ.** Neuroleptics decrease blinking in schizophrenic subjects. Biol Psychiatry 1981 ; 16 : 7,679-682.

23) **Karson CN, Kleinman JE, Berman KF, Phelps BH, Wise CD, Delisi LE, Jeste KV.** An Inverse correlation between spontaneous eye-blink rates and platelet monoamine oxidase activity. Brit J Psychiat 1983 ; 142 : 43-46.

24) **Buchsbaum MS, Landar S, Murphy DL.** Average evoked response in bipolar and unipolar affective disorders : Relationship to sex, age of onset and monoamine oxidase. Biol Psychiatry 1973 ; 7 : 199-212.

25) **Haier RJ, Buchsbaum MS, Murphy DL, Gottesman II, Coursey RD.** Psychiatric vulnerability, monoamine oxidase and the average evoked potential. Arch Gen Psychiatry 1980 ; 37 : 340-345.

26) **Johansson F, Almay BGL, von Knorring L, Terenius L, Astrom M.** Personality traits in chronic pain patients related to endorphin levels in cerebrospinal fluid. Psychiatry Research 1979 ; 1 : 231-239.

눈깜작임, 증감뇌유발전위와 성격의 상호관계

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=국문초록=

목 적 : 눈깜작임은 뇌에서 감각을 조절하는 기능과 관계된 개인의 인지능력과 성격에 따라 달라질 수 있다. 저자들은 이러한 성격이 눈깜작임과 증감뇌유발전위 등과 상호 어떠한 연관이 있는지를 연구하려고 하였다.

방 법 : 44명의 정상 대학생에게 증감뇌유발전위, 눈깜작임과 Zuckerman의 감각추구척도와 Eysenck 성격설문지 등을 조사하여 그 상호관계를 분석하였다.

결 과 : 증감뇌유발전위에서 빛의 강도가 증가할수록 눈깜작임이 증가하였다. 대부분의 성격척도에서 눈깜작임과 유의한 역상관관계를 보였으며 신경증척도만이 정상관관계를 보였다. 눈깜작임과 증감유발전위의 기울기와 가장 강한 정상관관계를 보인 뇌의 부위는 우측 후 측두엽이었다.

결 론 : 감각추구 경향이 강할수록 눈을 적게 깜작이었다. 유발전위보다 눈깜작임이 성격과 더 높은 상관관계를 보여 눈깜작임이 더 일차적인 필터 역할을 한다고 생각된다. 그리고 우측 후 측두엽은 여러 뇌 부위 중 시각을 조절하는데 가장 중요한 역할을 하는 것으로 유추된다.

중심 단어 : 눈깜작임 · 뇌유발전위 · 성격유형.