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EFFECTS OF PERSONALITY AND SEMANTIC CONTENT OF STIMULI ON AUGMENTING AND REDUCING IN THE EVENT-RELATED POTENTIAL *

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Two groups of subjects classified as high vs. low in the need for power (*n* power) were assessed for augmenting versus reducing in the event-related potential (ERP) elicited by neutral and power-related words. Words at four different intensity levels in each of these two classes were randomly presented and ERPs in response to each word class at each of the four intensity levels were computed from EEG recorded at Fz. The results indicated that the two groups responded differentially to the power-related vs. neutral words. High *n* power subjects showed reduction in response to both power-related and neutral words while low *n* power subjects showed augmentation in response to the power-related words.

1. Introduction

A variety of recent evidence has begun to explore electrophysiological and biochemical concomitants of various personality traits (e.g., Buchsbaum, 1976; Neblitsyn and Gray, 1972). Much of this work has been concerned specifically with individual differences in modulation of stimulus intensity, termed augmentation-reduction (Buchsbaum, 1976; Buchsbaum and Gershon, 1980). This dimension was originally explored by Petrie (1967) and was assessed with the Kinesthetic Aftereffects Test (KFA). A number of workers have reported that augmentation and reduction could be assessed by examining changes in the amplitude of the averaged evoked response as a function of variations in stimulus intensity (e.g., Soskis and Shagass, 1974; Spilker and Callaway, 1969; Zuckerman, Murtaugh and Siegel, 1974). Moreover, high correlations have been reported between the KFA and evoked potential

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measures of this individual difference (e.g., Spilker and Callaway, 1969). The research and theorizing on this personality difference has assumed it to be a general trait which affects all types of stimulus input relatively equally.

Based upon a variety of data suggesting that individuals with different personality styles may be differentially 'prepared' to perceive and process stimuli in different semantic categories (e.g., Erdelyi, 1974), the present experiment was designed to explore differences in augmentation vs. reduction of the event-related potential (ERP) elicited by words in different semantic classes in subjects differing in personality style. Specifically, we evaluated whether subjects differing in the need for power (*n* power; see McClelland, 1975) show different patterns of ERP augmentation/reduction to power-related versus neutral words.

McClelland (1975) has recently collected a large body of data on individual differences in *n* power. Differences among individuals in this motive disposition are assessed by objective coding of imaginative stories written in response to ambiguous pictures (Winter, 1973). McClelland (1979) has found that individuals who score high in *n* power and also inhibit its expression are more prone toward hypertension and show higher levels of epinephrine output if stressed compared to subjects scoring low in this variable.

In related research, *n* power following power arousal was found to be significantly inversely correlated ($r = 0.57$, $p < 0.01$) with sensation seeking (as measured by Zuckerman's sensation-seeking scale; see Zuckerman, 1974), indicating that increases in *n* power were associated with less sensation seeking (Steele, 1973). Recent electrophysiological data indicate that subjects low in sensation seeking tend to be reducers (i.e., show smaller increases in ERP amplitude with increasing stimulus intensity compared to a group of augmenters; see Zuckerman et al., 1974). Based upon these finding, we hypothesized that subjects high in *n* power would show ERP reducing compared with subjects low in *n* power, particularly in response to power-related words.

2. Methods

2.1. Subjects

Twenty male sophmore undergraduates were selected as subjects from a much larger pool who had been given a version of the TAT a year previously. Ten subjects were considered to be high and 10 subjects low in *n* power. The TATs were scored for *n* power according to established criteria (Winter, 1973) by coders whose agreement with expert scoring was at least 85%. Content so scored includes references to having 'impact on others' by aggression, persuasion, acting so as to elicit an emotional response in others, accumulating signs of prestige, and so on. All scores were converted to standard scores corrected by regression for story length ($m = 50$, s.d. = 10). The median score for the high *n* power subjects was 60; for the low *n* power subjects it was 45. The experimenter was blind to the subject grouping.

2.2. Procedure

All subjects were brought to the physiological laboratory on the day prior to the actual experiment for some preliminary testing and to acquaint them with the procedures to be followed the next day. This was designed to minimize their anxiety about having EEG recordings taken.

Subjects were exposed to a series of 256 randomly presented stimuli with an inter-stimulus-interval of 2 sec. The stimuli were pre-recorded on tape and consisted of the presentation at four intensity levels of the following three types of stimuli: power-related words ('help', 'power' and 'strike'), neutral words ('green', 'water' and 'stone') and 1000 Hz 800 msec tones. Only data in response to the words will be presented. Each word was presented eight times at each of the four different intensity levels. The highest intensity, level 4, was approximately 94 dB SPL. Each of the remaining three intensity levels was 10 dB down from the preceding higher level. Word, word type and intensity were randomized and the total of 256 stimuli were presented in four 64 stimuli blocks, counterbalanced in a word–word–tone sequence. An electronic marker pulse preceded each stimulus by 200 msec and was placed on one channel of an FM tape recorder. This pulse was employed to trigger the computer for each averaging epoch.

Stimuli were presented on a loudspeaker mounted directly in front of the subject. Subjects were instructed to attend to the words and tones and to push one button each time a tone was heard and a second button each time a word was heard. This instruction was included to maximize attention to the tape. Both buttons were mounted on the right arm of the chair and all button presses were performed with the right hand.

2.3. Apparatus and recording procedure

EEG was recorded from FZ and OZ referenced to linked ears on a Grass Model 7 polygraph through wide band a.c. preamplifiers. EOG was recorded from the external canthus and supraorbit of the left eye. All electrode resistances were below 5000 Ω. In addition to the raw EEG and EOG, an event marker corresponding to each stimulus epoch was recorded on chart paper and all epochs confounded by eye movement artifact were eliminated from the analysis.

A Digital Equipment Corporation PDP-9T computer was employed to digitize the EEG and derive ERPs for each of the two word classes (power and neutral) at each of the four intensity levels, for each site, yielding a total of 16 ERPs per subject. The analysis was performed on the N1-P2 amplitude which was evoked most reliably. In addition to the reliability of N1-P2, other considerations were important in our choice of this component as the main dependent measure. A large body of data on augmentation/reduction in the ERP points to the N1-P2 component as the most significant component in revealing individual differences in the stimulus-intensity response (Buchsbaum, 1976). Moreover, this component has been shown to be responsive to selective attention instructions, similar to those employed in the present study (e.g., Hillyard, Hink, Schwent and Picton, 1973). The latency of N1 varied between 75 and 149 msec while P2 latency varied between 125 and 275 msec.

A 50 μv 60 Hz calibration signal was applied to the input terminals of each polygraph channel preamplifier before each block of stimuli was presented. During computer analysis the average positive and negative peak amplitude of this signal during an 800 msec epoch was computed. These values were employed to create a scale factor to calibrate the amplitude of averaged EEG epochs. The d.c. offset was compensated for by similarly analyzing an epoch recorded with the inputs to all polygraph channels shorted.

3. Results

The data from Oz did not reveal any significant group or group $\times$ level effects for either the neutral or power-related words. Therefore, only data from the FZ lead will be presented in this report.

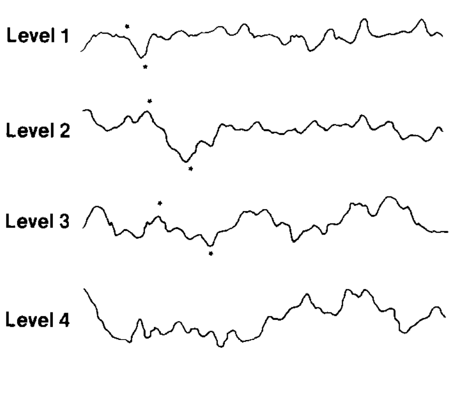

Fig. 1.

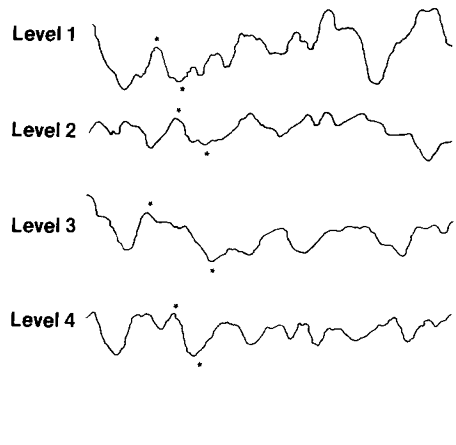

Fig. 2.

Fig. 1. ERPs derived from FZ and elicited in response to power-related words at each of four intensity levels in a representative subject high in the need for Power. Level 4 was approximately 94 dB SPL. Each of the remaining three intensity levels was 10 dB down from the preceding higher level. The ERPs are based on a mean of 20 stimuli per average. Stimulus onset coincides with the beginning of the waveform. The asterisks correspond to the N1 and P2 peaks. This peak-to-peak amplitude was the dependent measure employed.

Fig. 2. ERPs derived from FZ and elicited in response to power-related words at each of the four intensity levels in a representative subject low in the need for Power. Other features of these waveforms correspond to the description provided for fig. 1.

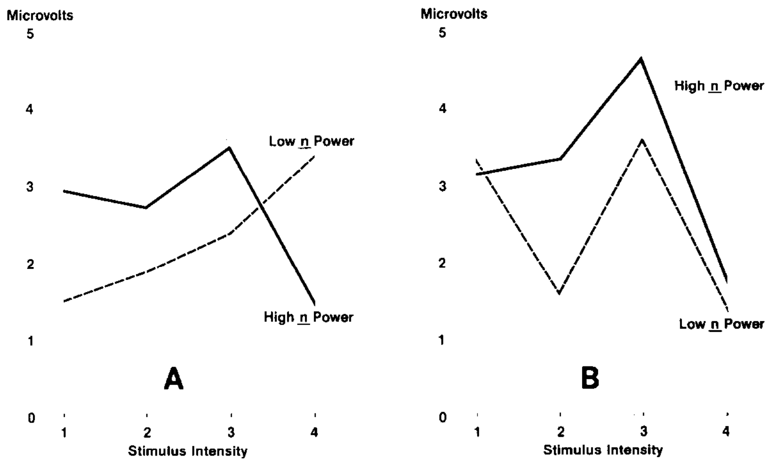

Fig. 3. (a) Mean N1-P2 amplitude derived from FZ and elicited in response to power-related words at each of the four intensity levels, separately for subjects high vs. low in *n* power (N = 10 for each group); (b) Mean N1-P2 amplitude derived from FZ and elicited in response to neutral words at each of the four intensity levels, separately for each group.

The number of trials per average varied between 15 and 24. Peak identification was performed visually by an experimenter blind to the subject's group. Figures 1 and 2 present the ERPs at each intensity level of one representative subject from each of the two groups. The asterisks correspond to the N1 and P2 peaks. Our dependent variable was N1-P2 amplitude. The raw data were transformed to log scores in order to normalize the distribution. Since occasionally the N1-P2 amplitude was zero, one was added to all N1-P2 values prior to log transformation. [1]

An analysis of variance across word type (i.e. power vs. neutral) with group and level (intensity level) as factors revealed a significant group × level interaction [$F(3,54) = 2.90$, $p < 0.05$]. Importantly, neither the main effect for group nor for level was significant. When the data were examined separately for ERPs in response to power vs. neutral words, it was found that the group × level interaction was significant only for the power words, as we had predicted [$F(3,54) = 3.30, p < 0.03$]; in response to neutral words: [$F(3.54) = 1.49, p = 0.23$].

Fig. 3 presents the data for power and neutral words separately. It can be seen that in response to power-related words, the high *n* power subjects show the lowest amplitude response to the highest stimulus intensity, while for the low *n* power, this relation is precisely reversed. It can be seen from fig. 3b that the pattern of ERPs in response to neutral words is different than in response to power-related

[1] A square root transformation was also performed which did not necessitate adding 1 to each data point. The results from this analysis were virtually identical to that obtained from the log transform reported above.

words. Here both groups show the lowest N1-P2 amplitude in response to the strongest stimulus intensity with no significant differences between the groups in change from the least to strongest intensity.

4. Discussion

The data from this study indicate that power-related vs. neutral words differentially affect high vs. low *n* power subjects. The high *n* power subjects showed a reduction in N1-P2 amplitude at the highest stimulus intensity for both power-related and neutral words. The low *n* power subjects showed augmentation in response to the power words and no consistent amplitude-intensity function in response to the neutral words.

These findings are consistent with the data reviewed in the introduction indicating that increases in *n* power were associated with less sensation seeking (Steele, 1973) and subjects with low sensation seeking tend to be reducers (Zuckerman et al., 1974). The fact that subjects high in *n* power tend to be reducers suggests that environmental stimuli may generally have less impact on these subjects. It is possible that their disposition to exert power over others may develop as a coping style to accentuate the impact and significance of environmental stimuli. Clearly, this is a speculative suggestion which needs to be examined in future research.

Finally, it should be emphasized that subjects were classified on the basis of a projective measure which objectively codes samples of thought content. We believe the present data to be the first to establish reliable differences in brain responsiveness between two groups of subjects differentiated on the basis of the content of their thought samples as revealed in the TAT.

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References

Buchsbaum, M.S. (1976). Self-regulation of stimulus intensity: Augmenting/reducing and the average evoked response. In: G.E. Schwartz and D. Shapiro (Eds.). Consciousness and Self-Regulation: Advances in Research, Vol. 1. Plenum: New York.

Buchsbaum, M.S. and Gershon, E.S. (1980). Genetic factors in EEG, sleep and evoked potentials. In: J.M. Davidson and R.J. Davidson (Eds.). The Psychobiology of Consciousness. Plenum: New York.

Erdelyi, M.H. (1974). A new look at the New Look: perceptual defense and vigilance. Psychological Review, 81, 1–25.

Hillyard, S.A., Hink, R.F., Schwent, V.L. and Picton, T.W. (1973). Electrical signs of selective attention in the human brain. Science, 182, 177–180.

McClelland, D.C. (1975). Power: The Inner Experience. Irvinton-Halsted-Wiley: New York.

McClelland, D.C. (1979). Inhibited power motivation and high blood pressure in men. Journal of Abnormal Psychology, 88, 182–190.

Nebylitsyn, V.C. and Gray, J.A. (Eds) (1972). Biological Bases of Individual Behavior. Academic Press: New York.

Petrie, A. (1967). Individuality in Pain and Suffering. University of Chicago Press: Chicago.

Soskis, D.A. and Shagass, C. (1974). Evoked potential tests of augmenting-reducing. Psychophysiology, 11, 175–190.

Spilker, B. and Callaway, E (1969). 'Augmenting' and 'reducing' in averaged visual responses to sine wave light. Psychophysiology, 6, 49–57.

Steele, R.S. (1973). The physiological concomitants of psychogenic motive arousal in college males. Unpublished doctoral dissertation, Harvard University.

Winter, D.G. (1973). The Power Motive. Free Press: New York.

Zuckerman, M. (1974). The sensation seeking motive. In: Maher, B.A. (Ed.). Progress in Experimental Personality Research, Vol. 7. Academic Press: New York.

Zuckerman, M., Murtaugh, T. and Siegel, J. (1974). Sensation seeking and cortical augmenting-reducing. Psychophysiology, 11, 535–542.