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Asymmetry of electrodermal activity in man

MICHAEL S. MYSLOBODSKY and JACK RATTOK
Department of Psychology, Tel-Aviv University, Ramat-Aviv, Israel

Skin conductance responses were examined bilaterally in a group of 12 normal subjects. Ten of them were right-handed and two were left-handed. All right-handed subjects exhibited asymmetry in skin conductance response during verbal-numerical and visual-imagery tasks. With the visual activity, larger responses were found in the left hand; while during the verbal task, larger responses were recorded from the right hand. The results were interpreted as evidence of hemispheric asymmetry of the electrodermal activity orienting response control mechanisms.

Electrodermal activity (EDA) has long been used as a nonspecific measure of arousal, orienting reactions, or emotional responses. Nevertheless, a certain degree of specificity can be demonstrated when inspecting EDA changes during visual and verbal tasks (Edelberg, 1972). Differences in the amount of EDA in verbal and visual activities suggest some fundamental peculiarities in the structure of the EDA control system.

Indeed, it is recognized that a number of brain functions (language, perception, emotions, etc.) are asymmetrically represented in the two cerebral hemispheres (Dimond & Beaumont, 1974). Hence, EDA may well be represented differently in the right and left sides of the body in a way similar to the asymmetry of spontaneous and evoked activity of the brain (Galin & Ellis, 1975; Wood, Golf, & Day, 1971).

Lateral EDA asymmetry was discovered in schizophrenics and depressive patients (Gruzelier, 1973; Gruzelier & Venables, 1974) although the data on asymmetry in normal subjects are contradictory. In control groups, some EDA measures have been reported as practically symmetrical, while there are other data indicating that the skin resistance response from two homologous sites of the right and the left hands may be significantly different in normal subjects (Fisher, 1958; Obrist, 1963). It remains to be proven that EDA control is specifically associated with hemispheric functions in normal individuals. Distinct EDA asymmetry would be expected in normal subjects if the type of stimuli presented or the response required of the subject manipulated the state of one hemisphere in a predictable way.

Specifically, our prediction was that there would be more EDA in the right hand during verbal or numerical analytical tasks which primarily activate the left hemisphere. In visual imagery tasks which activate the right hemisphere, more EDA was expected in the left hand.

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METHOD

Subjects

Twelve male volunteer graduate students were studied. Ten were right-handed and two were left-handed. Ages ranged from 25 to 36.

Procedure

Subjects were situated in a sound-isolated semi-darkened air-conditioned chamber (23° C, 50% humidity). EDA was studied under two experimental conditions: a visual-imagery task and a verbal-numerical task. Tasks lasted for 5 min and were separated by a 1-min interval.

In the visual task, subjects were exposed to a series of slides (art work, pictures with sexual content, landscapes). After each slide, a dim gray spot of light was projected onto the same screen; and the subject was instructed to hold an image there mentally of the preceding picture.

In the verbal-numerical task, series of words were presented through earphones in several successive sessions. Subjects were required to select words denoting numbers and to perform certain calculations.

Apparatus

Slides and background gray spots were projected for 10 sec each by a Kodak Carousel 35-mm projector through a one-way window onto a .5 x .7 m screen located 2 m in front of the subject. The instructions were recorded on a tape (Sony TC-126) recorder and presented to subjects before the task.

EDA was recorded from bipolar silver-silver chloride electrodes placed on the distal phalanges of the index and ring fingers of both hands. Skin was screened with isolating tape, leaving a 1-cm^2 window for the electrode; and a small quantity of electrode jelly was spread over this area. With a constant current of 20 microA, resistance changes across the skin were detected and amplified by a two-channel instrument designed to study EDA by one of us (J.R.). It consisted of highly stabilized field effect transistor input integrated circuit operational amplifiers with a circuit to neutralize baseline changes. Thus only reactive EDA was monitored.

The output of each amplifier was fed into separate voltage-control frequency circuits (VCF) and then processed by electronic counters which estimated EDA amplitude and duration. An input conductivity increment of the order of 1 kohm/sec resulted in a .7-V increment in amplifier output and 20 counts of the counter.

During each task, continuous recordings of EDA were made from each hand and were stored for further processing. An instant estimation of EDA asymmetry was obtained by feeding

the amplified signals into a highly stabilized analog integrator-comparator unit. The amplified signals from each hand and the integrator output were recorded on a Beckman Dynograph R polygraph.

RESULTS

In all subjects, verbal and visual activity resulted in clear EDA lateral asymmetry. In the right-handed subjects, higher EDA values were found in the right hand during the verbal task, while the visual task resulted in higher left-hand skin conductivity.

Total magnitude of EDA during the verbal task was 1,834 in the left hand and 2,203 in the right hand (arbitrary units of the counter output for 5 min of the task). During the visual task, the EDA magnitude was 2,594 in the left hand and 2,107 in the right. Generally, greater asymmetry and larger values of EDA from both sides were recorded during visual rather than verbal tasks, irrespective of the verbal material content or the complexity of the numerical data processing. Changes in EDA in the left hand during verbal vs. visual tasks were highly significant ($p < .001$). Changes in EDA in the right hand in the same situation were minimal and nonsignificant.

In one left-handed subject, EDA asymmetry changes were similar to those described above; in the other, the direction of asymmetry was reversed. For 10 right-handed subjects, an EDA asymmetry coefficient ($EDA_r - EDA_l/EDA_{max}$) was estimated; and an analysis of variance for repeated measures was conducted. The asymmetry coefficient for the verbal task was .17, while for the visual task it was −.19. Both were highly significant.

DISCUSSION

Thus, EDA may be affected unilaterally in a predictable way by selectively activating an orienting reaction from the right or left hemisphere. Contradictory results on normal subjects cited in the beginning of this paper may be ascribed to the stimuli (loud sounds) used to evoke EDA. This procedure could only reveal EDA asymmetry when one of the hemispheres is distinctly more reactive (or unreactive) due to its abnormality or peculiarities of personality.

The clear EDA asymmetry revealed in the present study in right-handed subjects is mainly related to the specific tasks performed. On the other hand, it may be ascribed to the fact that our subjects were all male. It has been demonstrated that the polarization capacity of female skin is less than in males (Rein, 1924). There is also some evidence that the brain of females is less lateralized than males. Visuospatial skills were reported to be more clearly located in the subdominant hemisphere in males (Kimura, 1969) and some aspects of verbal processing are also better lateralized in their dominant hemisphere (Krashen, 1975).

Opposite changes of EDA asymmetry during verbal and visual activities has implications for the understanding of the structure of the orienting reaction which has been shown to be a multidimensional measure of thinking, attention, and emotion (Edelberg, 1972; Maltzman, 1971). It was mentioned that EDA evoked through the right hemisphere was larger, suggesting a stronger orienting response. It is believed that the right hemisphere has a negative affective charge (Hécaén & Angelergues, 1963; Gainotti, 1972). Some authors speculate that the right hemisphere is in a way the emotional part of the human brain (Flor-Henry, 1969; Gainotti, 1972).

It was proposed that the greater emotionality of the right hemisphere is due to its more "primitive" global synthetic approach to data processing (Hécaén & Angelergues, 1963). This idea received support in recent studies (Nebes, 1974) showing right-hemispheric superiority for the analysis of "part-whole relationships." This contrasts with the left hemispheric approach of focusing on details and abstrating peculiarities from a background. It seems worth considering that the right-hemisphere-mediated orienting response is likely to function as a general diffuse estimator of the situation, for the general "tuning" of the brain; i.e., for "fight or flight." On the other hand, the left-hemisphere-mediated orienting response is expected to be more selective, tuning the brain to manipulate, perceive, and differentiate. The distinction between two skin-galvanic orienting responses, one being an indicator of problem solving and the other reflecting stimulus-bound novelty-induced activities, was initially made by Maltzman (1971). Our hypothesis proposes an anatomical and perhaps neurochemical basis for these two types of orienting responses.

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