THE PSYCHO-GALVANIC REFLEX

A COMPARISON OF A.C. SKIN RESISTANCE AND SKIN POTENTIAL CHANGES

BY

J. D. MONTAGU

From Runwell Hospital, Wickford, Essex

Two closely-related electro-dermal phenomena constitute the so-called "psycho-galvanic reflex". These are (a) a decrease in the electrical resistance of the skin, and (b) a change in the skin electromotive force in response to a wide variety of stimuli.

Féré (1888) connected two electrodes on the forearm of a subject in series with a weak source of electricity and a galvanometer. He observed that various sensory and emotional stimuli were associated with an increased deflection of the meter. Tarchanoff (1890) obtained similar deflections of a galvanometer without the aid of an external electromotive force.

Gildemeister (1923) found that the phenomena of Féré and of Tarchanoff possessed similar latent periods. Jeffress (1928) confirmed this, and he also obtained a high positive correlation between the magnitude of the two responses. These workers, like Tarchanoff, used an instrument of low resistance, which would not fully differentiate potential changes from resistive effects.

Forbes (1936) oscillographically recorded the pure potential and impedance changes of a single reacting area of skin. He reported the existence of two distinct components in the potential "waveform", and he referred to the "slower resistance or impedance response".

Goadby and Goadby (1949) found that the resistance response was abolished by complete exsanguination of a limb, while the potential response remained intact. They concluded that the resistance change was due to vasoconstriction and that the potential variations were probably expressions of activity at sympathetic nerve endings in blood vessels and sweat glands.

The object of this paper is to present the results of experiments in which the apparent A.C. resistance and the skin potential of a single reacting area were continuously recorded under a variety of conditions. The mutual independence of the two phenomena was repeatedly confirmed.

Methods

Material.—The subjects were 17 male and seven female patients who were suffering from various functional mental disorders. Their ages ranged from 16 to 58 years. Several of them were investigated on a number of occasions. Forty-six experiments were performed, during each of which the apparent A.C. skin resistance and the skin electromotive force were recorded for periods ranging from half an hour to more than one and a half hours.

Experimental Conditions.—The subject lay on a bed in a thermostatically heated room, the temperature of which was kept at 72 to 74° F. The equipment was in the adjacent room, from which the subject could be observed through a one-way screen of Venetian glass. During the first half hour the subject was encouraged to relax and was left undisturbed. Thereafter, various stimuli were applied. In six experiments the subjects slept spontaneously during the initial resting period; in three more cases sleep was induced with the help of a small dose of "seconal" by mouth. In the last 10 experiments the effects of certain drugs were studied after local application by iontophoresis.

A.C. Skin Resistance.—The subject was connected in series with 10 megohms to a stabilized 60-cycle source of 2 volts peak. The current of 0.2 μ A. was therefore virtually constant over the whole range of recorded resistance values. A frequency of 60 c.p.s. was chosen in order to eliminate the beats which resulted from a small amount of 50-cycle interference when the oscillator was set at this frequency. The voltage developed across the electrodes was amplified, rectified, and compared with a constant reference voltage. At the beginning of the experiment the signal was balanced against the reference by adjusting the gain of the amplifier until the null point was obtained on a centre-zero meter. A decade box was substituted in place of the subject, and the instrument was adjusted to balance at the nearest convenient figure. This was the "reference level" for the experiment, and any departure from it was indicated in terms of percentage change. Two ranges of sensitivity provided full-scale deflection for changes of $\pm 50\%$ and $\pm 25\%$ of the reference value, and these ranges were linear to within $\pm 1\%$ of full scale. In practice, the less sensitive range was nearly always used. The instrument was arranged to cut out if full-scale deflection was

exceeded in order to protect the recording device in the event of an electrode being displaced.

Skin Potential.—A two-stage balanced D.C. amplifier was used. Since one electrode was at earth potential, the instrument was operated asymmetrically and the second input grid was grounded. The input resistance was 10 megohms and the grid current was negligible. Two ranges of sensitivity gave full-scale deflection for 50 mV. and 100 mV., and these ranges were linear to within $\pm 1\%$.

Mutual Independence of the Measures.—Both measures were recorded simultaneously through the same pair of electrodes, the active electrode being condenser-coupled both to the A.C. source and the A.C. amplifier. To determine whether the applied A.C. had any undesirable effect on the potential measurements, a 100,000 ohm resistor was connected in place of the subject. It was found to be necessary to multiply the A.C. current 10 times in order to produce a deflection corresponding to 0.5 mV.

Electrodes.—These consisted of fine silver discs, 1 cm. in diameter, which were recessed in shallow polythene cups. The discs were chlorided electrolytically, and the cups were filled with a jelly which consisted of starch, glycerine, and sodium chloride (*vide infra*). Two electrodes with less than 1 mV. difference in potential were selected, and this difference in potential was checked at the beginning and end of every experiment.

Location of Electrodes.—The active electrode was attached by adhesive tape to the palmar surface of the tip of the right middle finger. The skin at this site was not prepared in any way in order to minimize the disturbance of the normal conditions. The earthed electrode was attached, also by adhesive tape, over the forearm extensors of the same side. To make this area as unreactive as possible the skin was rubbed briskly with ether and was pierced with a hypodermic needle. A drop of blood was squeezed to the surface and electrode jelly was rubbed well in. To show that this area was truly inactive, three subjects were treated as follows: At the end of an experiment the active electrode was transferred from the tip of the finger to the mucous membrane of the lower lip. In each case the resistance fell from above 10,000 ohms to less than 1,600 ohms, and measurable responses could not be elicited. (The current was increased tenfold in order to make the measurements.) The electromotive force also decreased, and reactions to stimuli were unobtainable.

Recording Instruments.—Two similar "record" 0 to 1 mA. pen recorders were used, one of them being modified for centre zero operation. The chart rulings were aligned at the start of each experiment and were used as time marks. A chart speed of $\frac{1}{2}$ inch per minute was usual, but in some cases further detail was obtained by increasing this to 1 inch or 3 inches per minute. Provision was made for inserting synchronous signal marks on each trace, but since these marks tended to obscure the traces at slow paper speeds, they were only used for demonstrating alignment of the rulings. Stimuli were usually applied as the pens crossed a line.

FIG. 1.—The relative response times of the instruments to simultaneous abrupt changes of input. Upper trace shows resistance (reference level = 30,000 ohms); lower trace shows potential difference. Time scale: rules at 20-second intervals. The scales shown on the left are applicable to all the illustrations. RL = Reference level.

Response Time.—The two recorders were damped unequally by their associated circuits. The responsiveness of the instruments was therefore studied by simultaneously changing the electromotive force and the resistance of a simple skin analogue. The results are reproduced in Fig. 1, which shows a greater lag in the resistance trace.

Stimuli.—Four types of stimuli were used: (a) A rapid, make-and-break shock from a high tension battery through two electrodes on the calf of one leg. The intensity of the shock was preliminarily adjusted until the subject stated that it was slightly unpleasant; (b) a variety of auditory stimuli from a loudspeaker under the bed; (c) a cough or deep breath; (d) a hypodermic "injection".

Drugs.—The local effects of the following drugs were studied by means of iontophoresis:—(a) Atropine sulphate, 3% solution, (four subjects); (b) eserine salicylate, approximately 1% solution (three subjects); (c) mecholyl

chloride, 0.5% and 1% solutions (three subjects). In each case the drug was introduced from the positive pole with a current of 3 mA. for a period of 10 minutes. Three control tests were made with water under otherwise similar conditions.

In these experiments a second active electrode was attached to the palmar surface of the left mid finger, which was used as a control. The recording instruments were switched from side to side at approximately three-minute intervals. After a preliminary period of half an hour, in which it was ascertained that both sides were reacting similarly to stimuli, the active electrodes were removed. The right mid finger was placed in the solution of the drug, and the fingers of the opposite hand were immersed in a bowl of water, which formed the dispersive electrode. After the treatment both hands were dipped into warm water for a few seconds and they were dried by dabbing with a towel. The electrodes were reapplied and a warm pad was wrapped round each mid finger.

Results

Slow Changes.—During the initial period of quiet rest the skin resistance nearly always showed a steady tendency to fall. In the case of the potential the active electrode was always found to be negative with reference to the inactive electrode, and the potential difference showed less tendency to drift. In all but three of the experiments the initial value of the resistance was also the highest value recorded during the test, and in the exceptional cases the resistance remained near the initial level. In no case did it show an upward trend. The drop was occasionally marked, the resistance falling to less than half of the initial value within 15 minutes. It tended to rise again in association with anticipation and alertness when the subject was disturbed. The potential difference, on the other hand, fluctuated about a steady level in half of the cases; in the other half it sometimes rose and sometimes fell.

The consistent tendency displayed by the resistance to decrease during a period of rest was contrary to previous experience with the same instrument under similar conditions. In a series of more than 200 recordings the skin resistance had usually shown a progressive upward trend, which was sometimes marked. In those cases, however, the active electrode had consisted of a flat disc with an intervening square of paper moistened with normal saline. It seemed probable that the decreasing resistance in the present studies was associated with the use of an electrode jelly. On enquiry, this was found to contain as much as 25% of sodium chloride. The supposition was confirmed by including three subjects in both series, when the appropriate opposite trends were observed in every case. Nevertheless, in view of some interesting findings which were associated with the progressive decline in the

resistance level, the hypertonic jelly was retained throughout the present tests.

Rapid Changes.—Many of the more rapid fluctuations in the measures were provoked by deliberate or incidental stimuli. Other similar changes frequently appeared in the absence of any identified cause, and there seemed to be no qualitative differences between the spontaneous and the induced activity. However, a stimulus if effective was always followed by a change in both resistance and potential, a relationship which was not always evident in the case of spontaneous fluctuations. This will be referred to again later.

Although an induced response in one measure was invariably accompanied by a change in the other, the sizes and forms of the two phenomena were seen to vary independently. With the exception mentioned below the resistance responses were consistent in form. Each response comprised a sharp fall in resistance, which was followed by a slower return toward the base line, as seen in Fig. 2. On the other hand, the rapid changes in potential appeared less consistent and four distinct forms were noted: (a) A simple increase in the potential difference; (b) a small decrease followed by a larger increase; (c) a small increase followed by a larger decrease; and (d) a simple drop in potential difference. Various complex polyphasic forms were also noted, but after comparison with the corresponding resistance changes it seemed probable that these contained several component responses. Falls in potential difference were seen to be more rapid than rises, and each was usually followed by a proportionately slower return in the appropriate direction toward the base line. At the usual paper speed of $\frac{1}{2}$ inch per minute, increases in potential difference appeared characteristically humped (Fig. 2); decreases were often more angular (Fig. 4). When several falls occurred consecutively, the similarity of the potential and resistance traces was sometimes striking.

Owing to the use of a hypertonic electrode medium the resistance showed a slow tendency to decrease, as already described, when the subject was left undisturbed, and to rise again when he was alerted. Consequently, it was possible to observe the effects of stimulation at various levels of the base line. It was noted that after a period of rest in which the base line decreased the additional drop in resistance in response to a stimulus was often disproportionately small but that the resistance subsequently regressed to a higher level. Succeeding stimuli evoked larger responses, which tended to bring the resistance down to, but not below, the level of response to the first stimulus. This trend may be

FIG. 2

seen in Fig. 2. In such cases even strong and repetitive stimuli failed to bring the resistance down below the apparent minimal value, but the subsequent "overshoot" was greater.

The question of whether the base line would ever reach the minimal level was answered when a subject fell asleep spontaneously soon after the start of an experiment. This was accompanied by a steady exponential decrease in resistance to 39% of the initial value during the ensuing half hour. When the subject was aroused at the end of this period, there was no further drop in resistance but only a large and rapid rise, which began after a longer latent period than the corresponding potential response. This reaction is illustrated in Fig. 3. Several more attempts to confirm this observation were partially successful. Eight other subjects were encouraged to go to sleep either spontaneously or with the help of a small dose of "seconal" by mouth. On three of these occasions this was accompanied by a slow decrease in resistance to values of less than 18,000 ohms, and in each case abrupt awakening of the subject caused only a slight or imperceptible additional drop in resistance (mean drop of 500 ohms), which was followed by a large rise. In the remaining cases there occurred a smaller

FIG. 2.—Responses to repetitive incidental stimuli after a period of rest.

The stimuli were identified as sniffs (Sn), deep breaths (DB), and a noise (N).

Upper trace shows resistance (reference level = 16,000 ohms); lower trace shows potential difference (active electrode negative). Time scale: rules at 2-minute intervals.

FIG. 3.—Responses obtained on arousal of a sleeping subject. Note the absence of a further drop in resistance.

Upper trace shows resistance (reference level = 16,000 ohms); lower trace shows potential difference (active electrode negative). Time scale: rules at 2-minute intervals.

Arrows denote approximate point of entry into subject's room.

FIG. 3

decline in resistance during sleep to values above 19,000 ohms. Arousal of these subjects evoked a mean additional drop of 5,500 ohms and the subsequent overshoot was less evident or did not exist. This variation in the size and character of the resistance changes was not associated with any similar pattern in the corresponding potential responses.

The different forms of potential response assumed greater significance when they were studied in relation to their base lines. It was then found that if the potential difference was low it tended to increase, and that decreases occurred when the potential difference was already high. This was well illustrated in a few tests in which the potential difference showed a slow decline, punctuated by spontaneous fluctuations, as the subject relaxed. In such cases a complete transition in the form of the fluctuations was sometimes observed. Initial falls were succeeded by biphasic changes and ultimately by pure rises. Falls reappeared whenever the potential difference approached a certain value, which remained approximately constant in any particular test. In consequence, the potential difference was prevented from exceeding an apparent limit regardless of the size of the disturbances. The operating range varied considerably from case to case, the highest and lowest values differing by as little as 11 mV. in one test and by more than 40 mV. in five others. In the last few experiments the responses in the two hands were compared by switching from one to the other, and an initial inequality was sometimes observed in the potential levels on the two sides. There was also some evidence that this could be associated with different forms of response, the potential difference falling in the finger with the highest potential and *vice versa*. As the subject adapted to the environment the discrepancy in the levels diminished progressively and the responses became similar in form and magnitude.

Traces which illustrate some of these points are reproduced in Figs. 4 to 6. In Fig. 4 the first stimulus, a shock, evoked a large increase in the potential difference. The flat plateau which may be

FIG. 4

FIG. 4.—Traces illustrating various forms of potential response. Note the plateau at the peak of response to the first stimulus. Upper trace shows resistance (reference level = 30,000 ohms); lower trace shows potential difference (active electrode negative). Time scale: rules at 2-minute intervals. Arrows denote electric shocks.

FIG. 5.—Traces illustrating dissimilarities in spontaneous activity in the two measures. The potential response to the second stimulus is inverted. Upper trace shows resistance (reference level = 20,000 ohms); lower trace shows potential difference (active electrode negative). Time scale: rules at 2-minute intervals. Arrows denote auditory stimuli.

FIG. 5

FIG. 6.—Series of responses showing transition from rise to fall in potential difference. Upper trace shows resistance (reference level = 30,000 ohms); lower trace shows potential difference (active electrode negative). Time scale: rules at 20-second intervals. Arrows denote auditory stimuli. Signal marks before the arrows indicate alignment of the charts.

seen at the peak of this response is of interest since the level of 72 mV. was the highest value to be recorded during the experiment. Furthermore, the potential difference reached this point on seven occasions during the course of half an hour. The two succeeding shocks were given while the potential difference was still raised to this level, and each evoked a fall. A similar inversion of response to a second stimulus may be seen in Fig. 5, and in this case the drop terminates in a plateau. This was the lowest point to be attained in this recording. The last stimulus in Fig. 4 was applied when the potential difference was submaximal and it induced a small biphasic response. The consecutive series of responses which is shown in Fig. 6 illustrates in greater detail a transition from increase to decrease in potential difference through an intermediate biphasic stage with successive stimulation.

It was evident from these observations that the size of the resistance drop and the form of the potential response were related to their respective base lines. Since there was no consistent association between the slow changes in resistance and potential, there was also no apparent relationship between the two responses apart from their concurrence. In Fig. 3 a large potential change was accompanied by a rise in resistance without any preliminary drop. Elsewhere, the various forms of potential response were each associated with a decrease in resistance. It is also interesting to note that a biphasic potential change was accompanied by a single drop in resistance, as seen after the third stimulus in Fig. 6. In their time relations the two phenomena generally exhibited similar latent periods. When any discrepancy was observed, the resistance change invariably appeared to lead, but slow paper speeds made the traces unconvincing. A more detailed example is shown in Fig. 7, in which similarity of latency is indicated by a barely perceptible initial change in potential; in other respects temporal differences are evident. Nevertheless, every effective applied stimulus was followed by a change in both resistance and potential. In the case of spontaneous fluctuations, on the other hand, even this relationship was not always apparent. A considerable amount of activity can be seen in the resistance trace of Fig. 5, but much of this is unaccompanied by any perceptible change in the potential. Yet the applied

FIG. 7.—Responses to a deep breath showing dissimilar temporal relations. Upper trace shows resistance (reference level = 20,000 ohms); lower trace shows potential difference (active electrode negative). Time scale: rules at 20-second intervals. Signal marks on extreme left confirm correct alignment of charts.

stimuli evoked deflections in both traces of approximately equal magnitude.

The evidence that has been advanced so far indicated that the two phenomena were dependent, in part at any rate, upon different peripheral mechanisms since they varied independently in accordance with local conditions. However, their concurrence in response to stimuli suggested that, with the possible exception of some spontaneous changes in resistance, the phenomena might be mediated through the same nervous pathway. It was therefore decided to study the effect of atropine on the responses in order to determine the part played by the cholinergic fibres of the sympathetic supply to the skin. Atropine was applied locally to the right mid finger by iontophoresis, while the corresponding finger of the left hand was used as a control. The latter was included in the dispersive area at the negative pole during iontophoresis. It

FIG. 8.—Comparison of resistance and potential responses on the right and left sides 15 minutes after local atropinization of the right mid-finger.
Upper trace shows resistances reference level = 30,000 ohms; lower trace shows potential differences (active electrodes negative).
Time scale: rules at 1-minute intervals.
Arrows denote alternate deep breaths and coughs.

soon became apparent that some of the effects were due to the electric current *per se*, and a control procedure with water at both poles was therefore used on three occasions. The effects of the galvanic current were then found to be as follows:—

(a) The negative potential in the right finger (positive pole) was always found to be reduced, and that on the left side increased, when recording was resumed after galvanization. The drop on the right side ranged from 10 to 70 mV.; in one case the finger was still 10 mV. positive with respect to the inactive electrode. On the left the potential was invariably raised above 90 mV., the increase ranging from 15 to 50 mV. The potentials on the two sides gradually returned towards the common initial level but there was always a considerable residual discrepancy at the end of the experiment.

(b) The potential responses were greatly reduced on both sides, and in one case no perceptible changes

could be elicited for 10 minutes. The responses gradually increased on both sides equally, but even after 30 to 40 minutes they had seldom attained their initial magnitude. It was also noted that the responses sometimes, although not invariably, assumed different forms on the two sides in association with the dissimilar potential levels. When this occurred, increases in potential difference were recorded from the right side and decreases from the left.

(c) The galvanic current caused no consistent change in the level of the skin resistance. This was either the same as, or lower than, the pre-treatment value, and any decrease that occurred was approximately equal on both sides. It seems probable that this variable reduction may have been due to the precautions which were taken to ensure adequate and equal local temperatures.

(d) The bilateral equality of the resistance responses was unaffected by the current.

When atropine was introduced from the positive pole several additional effects were obtained. In two of the four subjects atropinization was followed by a moderate increase in the level of the skin resistance on the treated side only; in the remaining cases there was little change. The other effects were quite consistent. After a period which varied from five to 15 minutes a progressive diminution was noticed in the resistance responses on the treated side. In three of the subjects no responses at all could be elicited after periods of 10, 15, and 30 minutes respectively; in the fourth case the responses were scarcely perceptible after 25 minutes when the experiment was terminated. The results in this last case can be seen in Fig. 8, which shows a marked difference in the responses on the two sides 15 minutes after iontophoresis. The effect on the potential responses was similar, although more rapid. In every case responses were abolished on the treated side within five to 15 minutes; in the opposite finger, on the other hand, the responses gradually increased in size, as in the control tests.

Since atropine was found to abolish the responses it was considered that it would be of interest to find out whether they would also be potentiated by eserine. This was found not to be the case. In only one subject was there any apparent difference between the two sides in the half hour following iontophoresis. On this occasion the resistance changes in the control finger were nearly three times as large as on the treated side for 15 minutes, after which they rapidly diminished to equality.

Finally, the effect of acetyl β -methylcholine (mecholyl) was studied in order to see if the responses could be reduced or abolished by inducing an excessive local acetylcholinomimetic action. This also was unaccompanied by any significant change in the resistance level, and neither the resistance nor the potential responses showed any consistent differences between the two sides.

Discussion

Under normal conditions an applied stimulus, if effective, was always followed by a change in both resistance and potential. However, the forms of the two responses altered independently, and their concurrence was not invariable in the case of spontaneous activity. It seems that they are dependent, in part at any rate, upon different mechanisms. The resistance change has been shown by other workers to be either considerably reduced (Carmichael, Honeyman, Kolb, and Stewart, 1941) or completely abolished (Goadby and Goadby, 1949) by exsanguination of the part. This procedure did not alter the potential response (Goadby and Goadby, 1949). The segregation of the two phenomena has now been

carried a step further by finding that the potential response was reduced or absent after passing a galvanic current through the skin, and that this did not affect the resistance change. By means of an appropriate alteration of the local conditions either response may be reduced or abolished independently of the other. Their dependence upon separate mechanisms is an inevitable conclusion.

Forbes (1936) claimed to have demonstrated a predictable potential "waveform" from a single reacting area of skin. This comprised a negative "a" potential followed by a positive "b" potential, the latter being apparently dependent on an intense stimulus or on apprehension. Forbes studied these changes without reference to the base line. Although his finding has been confirmed, it now appears that the form which he described constitutes a special case which only occurs at an intermediate level of activation. A decrease in potential difference (Forbes' "positive" component) has sometimes been seen to precede an increase, and both increases and decreases occur independently in association with lower and higher initial potential differences respectively. There was nothing in the present recordings to suggest that the two components of a biphasic response were each associated with a separate release of mediator, as Forbes (1936) believed. Such responses were accompanied by a single change in resistance. Moreover, there was some evidence to suggest that different forms of potential response may occur simultaneously in the two hands when the local conditions are different. The exact form assumed by any response appeared to be determined by the magnitude of the disturbance and by the existing local conditions.

The resistance response is believed to be largely or entirely due to vasoconstriction (Carmichael *et al.*, 1941; Goadby and Goadby, 1949). That there is no evidence of dilator fibres in the digits has been re-emphasized by Ackner and Pampiglione (1957), who also state that "the degree of the reduction of volume following a stimulus is partly related to the pre-existing dilatation and no reflex vasoconstriction can be expected if the vessels are not adequately dilated at the time". This observation is closely paralleled in the present study by the virtual disappearance of the resistance response as the base line approached an apparent minimal value. The slow, pronounced decline in resistance which brought this point to light occurred when the subjects relaxed or fell asleep. That the skin resistance should fall during sleep is contrary to general experience (see Woodworth and Schlosberg, 1955) as well as to previous observations with the same instrument. It was found to be associated with the use of a strongly hypertonic electrode jelly, and it would be of in-

terest to know whether this was also accompanied by vasoconstriction. The mechanism whereby the resistance returned to a higher level after stimulation despite the persisting presence of the jelly is likewise unclear.

Earlier reports concerning the effects of atropinization have been well reviewed by Landis and DeWick (1929), and they are seen to be utterly conflicting. More recently, Carmichael *et al.* (1941) have reported that the resistance response was consistently found to persist after localized atropinization by iontophoresis. The same technique was used in the present study but with opposite results. The resistance and the potential changes were both consistently abolished, the latter being the first to disappear. In the control finger, on the other hand, the resistance responses remained undiminished and the potential changes gradually increased. These conflicting findings are hard to explain. The positive results that were obtained in the present instance with atropine suggested that the responses might also be affected by eserine and by acetyl β -methylcholine, but this was found not to be the case. The negative outcome of these trials is of little significance since there was no certainty that an adequate local concentration of the drugs had been achieved.

The dependence of both the resistance and the potential response upon an intact sympathetic innervation has been amply demonstrated in the past (Schilf and Schuberth, 1922; Richter, 1927; Wang and Richter, 1928; Carmichael *et al.*, 1941; Goadby and Goadby, 1949). The present results with atropine suggest that both phenomena are also cholinergically mediated.

Summary

The apparent A.C. skin resistance and the skin potential of a single reacting area were continuously and simultaneously recorded under a variety of conditions.

The use of a strongly hypertonic electrode jelly was associated with a progressive decrease in the skin resistance, which was further enhanced during rest and sleep. Stimulation under these conditions evoked a negligible additional drop in resistance but caused it to return to a higher level. Subsequent stimuli evoked larger falls.

The active electrode was always found to be

negative with respect to the inactive area. The form of the potential response was seen to be related to the initial potential difference. When this was low, stimulation caused it to increase; decreases occurred when the potential difference was high. At intermediate levels biphasic responses occurred. Decreases reappeared whenever the potential difference approached an apparent maximal value, which remained approximately constant in any particular test.

The resistance and potential responses varied independently in form and magnitude in association with their respective base lines.

"Spontaneous" fluctuations in resistance, which resembled responses to stimuli, occurred in the absence of any perceptible changes in skin potential.

The potential response was reduced or absent after a galvanic current had been passed through the skin. This procedure did not affect the resistance response.

The local application of atropine by iontophoresis resulted in the disappearance of both resistance and potential responses, which could still be elicited in a control finger.

It is concluded that the two phenomena are dependent upon different mechanisms. The effects of atropine suggest that both are cholinergically mediated.

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