# A COMPARISON OF THE EFFECT OF ATROPINE AND PLACEBO ON THE GALVANIC SKIN RESISTANCE*

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Since Fere's description in 1888 (1) of the electrical response of the skin, many studies of this effect have been reported. This phenomenon, called the galvanic skin response (GSR), follows a variety of stimuli and is most often measured as a change in resistance to a direct current flow of electricity. Three major theories have been proposed to account for the observed changes. One theory has assigned the response to muscular activity, another to circulatory changes within the skin, and a third to activity of the sweat glands. At the present time, the consensus is that the GSR is dependent on sweat gland activity, more specifically on some presecretory change in the sweat glands (2).

Previous studies have indicated that both sweat gland activity and skin resistance level are affected by various drugs. Thus, sweat-inhibiting drugs (e.g., atropine) have been reported to increase the level of skin resistance (3, 4, 5) and sweat-stimulating drugs (e.g., pilocarpine) have been reported to decrease the level of skin resistance (3, 4, 5). These early investigations do not include a quantitative consideration of the relative effects of the different drugs or drug dosage and do not provide data of the range of individual differences which may be expected to occur. The control procedures and the methods used in reporting the data are also open to question, and for this reason do not permit a high degree of confidence in the duplication of the results.

The present study was initiated to investigate the relative effects of atropine and a placebo on skin resistance level. If atropine as compared to the placebo consistently increases the level of skin resistance, the authors intend to determine the requirements for the quantification of the drug effect.

## EXPERIMENTAL

Ten white male subjects ranging in age from 22 to 37 were studied. They were all patients in a Veteran's hospital dermatologic service whose dermatitis had disappeared and were ready for discharge from the hospital. No subject received either oral or parenteral drugs for 48 hours prior to the experiment. Each individual was tested in two experimental periods separated by an interval of from two to ten days. In the experiment, the subject was placed in the circuit and a 15-minute adaptation followed; then, either a 1 cc. of physiological saline (placebo) or $\frac{1}{150}$ grain of atropine sulphate dissolved in 1 cc. of physiological saline was injected intramuscularly. The record of resistance level was then continued for 40 minutes.

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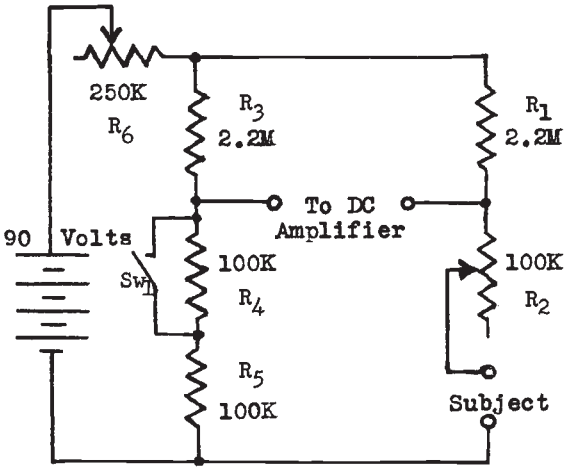


FIG. 1. Wheatstone Bridge circuit used in the measurement of subject resistance level.

Instrumentation for the study consisted of a modified Wheatstone bridge illustrated in Figure 1 with associated subject electrodes and a DC amplifier and oscillograph for recording. The bridge circuit modification shown in Figure 1 insures reasonably constant subject current and permits adjustment for balance without disturbing the bridge constants.

The ouput of the bridge was coupled to a stable DC amplifier and this, in turn, was fed into a direct writing oscillographic recorder (Esterline-Angus 1 ma. recorder Model AW). The oscillograph chart record was calibrated to read resistance levels plus and minus 50,000 ohms on either side of the chart center which was then set at bridge balance by the adjustment of resistance $R_2$ and $R_4$ (Figure 1). In each case where the resistance level exceeded the limits of the chart record resistance $R_2$ was adjusted to bring the reading back to the chart center.

The subject electrodes consisted of plastic cups enclosing a flat disk of zinc and filled with a combination of bentonite and 5% saturated $ZNSO_4$ in proportions to form a soft paste. The cups were held in position over the hypothenar eminence of each palm by means of a 1¼ inch wide soft rubber strap containing perforations which permitted adjustments for the width of the subject's hand. This arrangement results in a layer of electrolyte between the skin and zinc in such a manner as to minimize polarization and the variations in resistance due to changes in contact area and pressure without excessive restriction on the movement of the subject's hands. This type of electrode is similar in design to that used by Wenger (6). Figure 2 shows the equipment with the electrodes attached to a subject.

Table 1 shows the results obtained in the ten subjects tested. The resistance levels for each record were obtained by averaging the highest and lowest resistance values in a one-minute section of record. This was done to balance the effect of momentary deflections which occur around the central resistance level. For each control and atropine record for each subject, resistance levels were determined beginning at 1½ minutes prior to and at 15, 30 and 40 minutes following the injection. These values were then converted into the square root of conductance in order to permit grouping of the results.* This unit tends to

* It has been shown that a non-linear transformation of resistance is required prior to grouping the results for statistical purposes. The transformation to the square root of con-

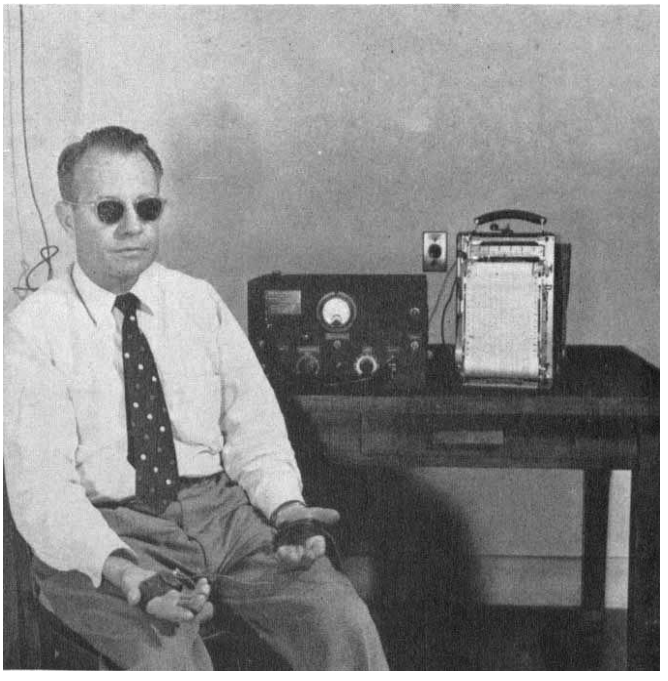

FIG. 2. Equipment with electrodes attached to a subject

correct for the non-linearity of the response and to eliminate differences between the records which depend on different preinjection resistance levels.

## RESULTS

Table 1 shows wide individual fluctuations in the relative effects of the drug and placebo. Eight of the ten subjects had a greater decrease in the square root of conductance (nine subjects a greater increase in resistance) 40 minutes after atropine than after the placebo control. The group as a whole also indicates the same trend; namely, the average change 40 minutes after the placebo is $-0.14$ and 40 minutes after the atropine is $-1.06$. Table 1 also shows that the difference between placebo and atropine records is distinguishable at the 15-minute period and that it increases progressively in the 30 and 40-minute periods following the injection.

The results of this study indicate a significant increase in resistance level due to the atropine as compared to the placebo and suggests the possibility of evaluating the magnitude of drug effect. The results must, however, be interpreted with some caution because the difference between atropine and the placebo may depend in part on the experimental order (placebo followed by atropine). The reverse order was not included because it introduced the possibility that the side effects of atropine would influence the subsequent placebo

ductance gives an acceptable approximation to the requirements for statistical processing, and has the additional advantage over certain other proposed transformations in that it is more easily understood (7).

TABLE 1

*Results for ten subjects using atropine and control*

Statistical significance* t (9 df); P < 0.001

| SUBJECT NUMBER | DRUG ORDER | $\sqrt{\text{CONDUCTANCE}} \times 10^3$ | CHANGE IN $\sqrt{\text{CONDUCTANCE}} \times 10^3$ | | |
|---|---|---|---|---|---|
| | | Prior to injection | 15 min. after injection | 30 min. after injection | 40 min. after injection |
| 1 | Placebo | 3.0 | −0.2 | −0.3 | −0.2 |
| | Atropine | 3.9 | −0.1 | −0.3 | −0.5 |
| 2 | Placebo | 3.7 | −0.1 | 0.0 | −0.1 |
| | Atropine | 2.8 | −0.2 | −0.1 | −0.1 |
| 3 | Placebo | 4.0 | −0.1 | 0.1 | 0.0 |
| | Atropine | 4.5 | 0.1 | −1.3 | −1.3 |
| 4 | Placebo | 3.1 | −0.4 | −0.9 | −0.8 |
| | Atropine | 2.1 | −0.1 | −0.2 | −0.3 |
| 5 | Placebo | 4.8 | −0.6 | −0.1 | −0.5 |
| | Atropine | 5.3 | −0.6 | −2.4 | −2.5 |
| 6 | Placebo | 4.4 | −0.2 | −0.1 | −0.6 |
| | Atropine | 4.1 | −0.7 | −1.3 | −1.7 |
| 7 | Placebo | 2.2 | −0.1 | −0.1 | 0.3 |
| | Atropine | 3.3 | 0.1 | 0.3 | −0.9 |
| 8 | Placebo | 4.6 | 0.9 | 0.8 | 0.2 |
| | Atropine | 5.9 | −0.4 | −0.5 | −1.3 |
| 9 | Placebo | 4.5 | 1.0 | −0.2 | 0.6 |
| | Atropine | 5.9 | −0.5 | −0.5 | −1.3 |
| 10 | Placebo | 3.9 | −0.6 | −0.5 | −0.3 |
| | Atropine | 3.2 | 0.2 | −0.1 | −0.7 |
| Mean | Placebo | 3.82 | −0.04 | −0.13 | −0.14 |
| | Atropine | 4.10 | −0.22 | −0.64 | −1.06 |

* Significance was computed from the standard error of the difference between scores in the last column for placebo and atropine.

run by making the subject apprehensive. The effect of order will be evaluated in later studies.

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