Committee Report

Publication Recommendations for Electrodermal Measurements

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ABSTRACT

The paper recommends an acceptable methodology for recording electrodermal activity which reflects a consensus of experts in the field. These recommendations are presented with a minimum of technical discussion in order to maximize their usefulness to investigators who are not specialists in this area.

For most purposes, skin conductance (SC) is to be preferred over skin potential (SP). It is recommended that SC be recorded from palmar sites with silver-silver chloride electrodes and an electrode paste consisting of a sodium chloride electrolyte in a neutral ointment cream medium. The area of contact with the skin should be controlled and time allowed for stabilization of the skin-electrode paste interface. Electrode bias potentials and polarization should be monitored during use. Signal conditioning is achieved by the application of a constant 0.5 volt across the electrodes and measurement of the resultant current flow by amplifying the voltage developed across a small resistor in series with the skin. The measurement of the amplitude—or even the detection—of small responses requires some form of tonic level control, permitting an adjustment of the tonic level. A circuit is provided for signal conditioning and tonic level control.

SP can be recorded with the same electrodes and electrode paste, unless the results are to be related to the British work on SP level, in which case the original potassium chloride electrolyte in an agar medium should be used. SP recordings require that one of the electrodes be placed over an inactive reference site, preferably over the ulnar bone near the elbow. No external voltage is applied, but some form of tonic level control may be needed. Electrodes need to be checked for bias potentials but not polarization.

DESCRIPTORS: Skin conductance measurement, Skin potential measurement, Electrodermal measurement.

The investigator who wishes to record electrodermal activity is faced with a bewildering number of choices as to the methodology to be employed. In some cases the alternatives are equally acceptable, whereas in other cases a poor choice can produce invalid results. At the request of the Editor, David Shapiro, a committee was formed for the purpose of setting forth an acceptable methodology for recording electrodermal activity which reflects a consensus of experts in the field.[1] It is hoped that doing so will accomplish two purposes: 1) to provide guidance for those investigators who are not experts in electrodermal methodology, and 2) to foster some degree of standardization. This second purpose should not, however, be overemphasized, as it is not our intention to dictate a specific method to seasoned investigators who have good reasons for using other techniques. Nevertheless, some degree of standardization is desirable if special circumstances do not dictate otherwise.

In keeping with the purpose of providing guid-

[1]A future paper will deal with the quantification and analysis of electrodermal recordings.

ance for relatively inexperienced investigators, the recommended procedures are discussed only in such detail as is necessary to understand what is recommended. The various considerations which dictated the recommendations are not fully discussed. The interested reader will find this information in the numerous technical references on electrodermal methodology (Edelberg, 1967; Grings, 1974; Lykken & Venables, 1971; Venables & Christie, 1973, 1980; Venables & Martin, 1967).

Choice of Skin Conductance versus Skin Potential

Unless an investigator is specifically interested in comparing his work with the literature on skin potential, it is likely that skin conductance measurements are to be preferred.[2] The biphasic nature of skin potential responses makes amplitude measures difficult to interpret, and the sensitivity of skin potential levels to hydration effects is probably greater than that of skin conductance. The simple counting of responses without regard to amplitude is a possible exception to this recommendation, since skin potential may be more sensitive than conductance for this purpose (Edelberg, Note 1) and the equipment demands are less for skin potential (which can be recorded without the construction of equipment for applying a voltage across the skin).

Electrodes

Two major concerns which determine the choice of electrodes are the need to select electrodes which show a minimal bias potential (between pairs of electrodes) and which do not polarize upon the passage of a current. Bias potential refers to the generation of different half-cell potentials at different electrode-electrolyte interfaces and is measured in the absence of an applied voltage. Polarization refers to the development of a counter electromotive force (emf) at the interface between the electrode and electrolyte. This counter emf, which arises as a result of the passage of current, acts as a battery which opposes the applied voltage. Both problems can be solved through the use of what are called reversible or nonpolarizing electrodes, which consist of a metal in contact with a solution of its own ions. In such electrodes, the chemical reaction produced by the passage of current does not appreciably change the chemical composition of the electrodes. In order to minimize bias potentials it is important to employ identical procedures in the construction and care of such electrodes. Helpful discussions of the problems of bias potentials and polarization can be

found in Edelberg (1967, pp. 5–9) and Margerison, Binnie, and Venables (1967, pp. 28–30).

Silver-silver chloride electrodes have been found to be most satisfactory for the recording of skin conductance.[3] They are widely used and are commercially available. They also can be constructed in the laboratory (e.g., Edelberg, 1967, p. 8; Miller, 1968; Venables & Martin, 1967, pp. 96–97; Venables & Sayer, 1963; Geddes, Baker, & Moore, 1969), though this requires considerable care. In order to be reversible silver-silver chloride electrodes must be used with an electrolyte containing an anion which forms a silver salt with a low solubility product. Either sodium or potassium chloride is suitable for this purpose, the choice between the two depending on other considerations.

It is essential to monitor electrodes for changes in bias potential and for polarization. Bias potentials should be checked every two or three days by placing the electrodes in a beaker of salt solution comparable to that used in the electrolyte (or by covering the pair with a connecting layer of electrode paste to make electrical contact) and measuring the potential difference between them. This requires a DC amplifier with sensitivity to allow for the evaluation of potential differences in the 0.1–10 mV range. For recording skin potential, electrodes should be selected initially with a bias potential of less than one millivolt, and they should be discarded or reconditioned if this potential increases to over three millivolts with use. For recording skin conductance, an initial potential of three millivolts and a max-

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[2]Skin conductance is recommended over skin resistance (Lykken & Venables, 1971).

[3]Zinc-zinc sulphate electrodes are also nonpolarizing. They are not readily available commercially, but they are simple to construct in the laboratory (Lykken, 1959). These electrodes must be scraped or sanded every couple of days in routine use in order to remove an oxide (or sulfide) coating which develops over time and acts as an insulator. This can be accomplished by scraping them with crocus cloth (made of carborundum) or sanding with fine sandpaper. Earlier criticisms of these electrodes were based on the use of zinc sulphate as the electrolyte, because sulphate ions in contact with the skin potentiate electrodermal responses. This problem can be avoided, however, by the use of an electrolyte solution consisting of 0.05 molar zinc sulphate plus 0.05 molar sodium chloride. At this concentration the zinc sulphate does not potentiate electrodermal responses, yet it does fulfill the conditions for a reversible electrode-electrolyte interface. There is some disagreement among the authors as to how acceptable this procedure is, and it is somewhat more complicated than using silver-silver chloride electrodes. Consequently, the use of zinc-zinc sulphate electrodes is not recommended as reflecting a consensus of experts in the field. On the other hand, these electrodes are much less expensive than silver-silver chloride electrodes and are mentioned here as a possible alternative methodology. Additional information as to their construction and use may be obtained from Robert Edelberg.

imum of five millivolts in use are acceptable. Note that they should not be tested immediately after having current passed through them, as in recording skin conductance. Similarly, bias potentials tend to drift when first placed in solution—or even if the solution is disturbed by moving the container or the electrodes. Consequently, stable measurements can only be obtained after the electrodes have been in contact with the electrolyte for a considerable period of time. For these reasons, electrodes should be stored in solution overnight and tested before use the next day. When not in use, the electrodes should be cleaned thoroughly (but without disturbing the silver chloride coating) and stored dry (Venables & Christie, 1973, p. 79).

Polarization can be checked *in vitro* or *in vivo* with the aid of a polarity reversal switch which reverses the way the electrodes are plugged in—i.e., as if the electrodes were exchanged with each other (see Figure 1, in **Signal Conditioning** section). If the electrodes are polarized, reversing them will reverse the direction of current flow, temporarily causing the emf which has built up to add to, rather than subtract from, the applied voltage. For example, if an applied voltage of 1.0 volt had resulted in a counter emf force of 0.1 volt, the effective voltage in the circuit would be 0.9 volt. If the electrodes were suddenly reversed, the two voltages would add, producing an effective voltage of 1.1 volt, which would appear on the polygraph record as an increased conductance because of the greater current flow. With the passage of current, the now reversed counter emf will dissipate and then build up in the opposite direction, thereby again opposing the flow of current. However, it will be obvious on the record that reversing the electrodes produced a transient increase in recorded skin conductance, indicating that the electrodes are no longer nonpolarizing.

Polarization can be checked *in vitro* by placing a pair of electrodes in salt solution and connecting them to one arm of a Wheatstone bridge, or other tonic level control circuitry (as discussed below), as usual, with the exception that a resistor of known value is inserted between one of the electrodes and the input to the bridge. For example, a 50K (1%) resistor is the equivalent of a subject with a conductance of 20 μmhos (in the absence of polarization the contribution of the electrode pair is negligible). The first check on the electrodes is to use the tonic level control to measure the conductance in this circuit. Next, the polarity should be reversed. If the first reading obtained corresponds to the expected 20 μmhos the electrodes have passed their first test. Although perhaps redundant, the same reading should be obtained immediately after reversing polarity. They can then be left in place with the current

passing through them for a period of time equivalent to that of the typical experiment—e.g., 45 min—at the end of which they should still be reading approximately 20 μmhos. As before, polarity reversal should not change the reading. The electrodes can then be considered to be nonpolarizing. It should be noted that this is an extremely conservative test. Since problems of polarization increase with increasing current and 20 μmhos represents an extreme upper limit of the (average) conductance to be obtained throughout an experiment, the electrodes are unlikely to be subjected to quite such extreme conditions in the typical experiment. Thus, if the degree of polarization encountered under these conditions is acceptable in terms of experimental error, it should be safe to assume that the electrodes will perform well in use.

Tests of polarization of electrodes *in vivo* simply require a reversal of the electrodes' polarity accompanied by an examination of the record to determine whether the recorded conductance quickly returns to the same level or requires some time to do so. Some transients are to be expected as a result of polarization of membranes in the skin. However, a little practice with good electrodes will reveal the extent of polarization to be expected from the skin, making it easy to discriminate between these and the effects of electrodes which are no longer nonpolarizing. This procedure does not allow a check against a known conductance, but it does allow a convenient monitoring of polarization in everyday usage. In addition, the systematic alternation of the direction of current flow within an experiment (e.g., every 10 or 15 min) has another advantage. The passage of current in one direction has the effect of chloriding one electrode while dechloriding the other. It is normally assumed that the direction of current flow through a given pair of electrodes will be random from subject to subject, allowing this effect to average out across subjects. Systematic alternations of polarity within an experimental session would ensure that such averaging takes place, leaving nothing to chance. It also reduces the risk of polarization inasmuch as a shorter time is involved for the passage of current in one direction. Consequently, if such a procedure is adopted, the *in vitro* test of polarization could be limited to a shorter time period, or polarity reversals could be interspersed during the longer time period.

Electrolyte and Electrolyte Medium

As indicated above, either potassium or sodium chloride can be used with silver-silver chloride electrodes. Sodium chloride is preferred because it is the major salt found in sweat and is, therefore, least likely to alter the electrodermal system being mea-

sured. Another consideration is that the half-cell potential at a silver-silver chloride electrode is a function of the chloride concentration, which therefore must remain the same at both electrodes throughout recording (Edelberg, 1967, p. 9). The use of sodium chloride at concentrations in the range of 0.050–0.075 molar approximate those found in sweat, making it unlikely that any sweat which diffuses into the electrolyte will significantly change the chloride concentration.

Although a variety of electrolyte media have been employed, at present it appears that a neutral ointment cream provides a convenient and satisfactory medium. Parke-Davis markets such a cream in the U.S. under the trade name Unibase, which should be available in one-pound jars through local pharmacies.

An excellent electrode paste for skin conductance recordings can be made with a minimum of equipment and knowledge of chemistry by mixing one part physiological saline—a standard solution of 0.15 molar NaCl (0.9%) which should be available through the university's chemistry stores (also called isotonic saline or irrigation saline)—and two parts Unibase: empty a one-pound jar of Unibase into a large bowl and add 230 ml of physiological saline, stirring until they are thoroughly blended.[4] A standard electric mixer will speed up this process. If mixing is done with only a spatula, the mixture should be allowed to sit for 24 hours in order for the lumps to disappear. The resultant mixture will have a concentration of approximately 0.050 molar NaCl and will have a virtually unlimited shelf-life due to an antimold ingredient in the Unibase.

The same electrode paste can be used for skin potential recordings if only a count of the number of skin potential *responses* is desired. If, on the other hand, an investigator is specifically interested in skin potential *levels* as investigated by Venables, Christie, and their colleagues, it will be advisable to use potassium chloride in an agar jelly medium as described by Venables and Sayers (1963). Electrolytes using agar jelly as a medium must be made fresh every 10 days.

Commercial electrode paste should *not* be used for electrodermal recordings unless the investigator is quite certain of their composition. Many have high salt concentrations which alter endogenous potentials and which will produce a change in skin conductance level and response amplitude over time (Edelberg, 1967, p. 10). Given the difficulty

of determining the composition of commercial electrode pastes, investigators are strongly urged to make their own mixture of Unibase and physiological saline as described above.

Finally, application of an electrode paste may have an effect on the electrodermal system being measured, in spite of all efforts taken to avoid this. As a result, time since application of the electrode paste should be viewed as a potential factor influencing measurements, and this variable should be controlled when comparing responses or levels across experimental conditions or subject groups. Although such changes may occur throughout the experiment, their magnitude can be somewhat reduced by allowing a stabilization time of at least 10 min. If the experimental design is such that this time dependency is critical, 15 or 20 min of stabilization time would be better.

Area of Contact

It has generally been assumed that the area of skin in contact with the electrode paste has a major impact on the measured conductance levels and amplitudes. Consequently, this variable should be carefully controlled to avoid changes over time and/or between subjects and the actual contact area reported in the methods section. One satisfactory method for achieving this is to use double-sided adhesive disks to attach the electrode to the skin. If care is taken to avoid seepage of the electrode paste beneath the adhesive tape, then the contact area equals the size of the hole cut in the tape. Other methods are discussed by Edelberg (1967, p. 12) and Venables and Christie (1973, pp. 83–84).

As the contact area decreases, the potential error due to seepage of the electrode paste increases, and the conductance levels and response amplitudes decrease. In view of this, small contact areas are to be avoided. An area of 1.0 cm^2 is recommended when the recording site permits. If an area this large cannot be achieved, then the maximal area permitted by the recording site is recommended.[5]

Skin potential measurements are not affected by variations in contact area, as long as areas of the skin with different potentials are not connected together. With contact areas of 1.0 cm^2 or less there

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[4] If physiological saline is not available, it can be made by adding 8.7 grams of NaCl (reagent grade or better) to one liter of distilled water.

[5] The assumption that contact area has a major effect on skin conductance levels and amplitudes has been challenged recently by Mitchell and Venables (1980), who report a minimal effect of this variable. If their findings prove to be generally true, then contact area may not be as important a parameter as has been supposed. Nevertheless, until this issue is resolved, investigators should take the precautions recommended.

should be no problem.[6] Larger contact areas are acceptable as long as the investigator can be certain that the potential is reasonably homogeneous within the area covered by the electrode.

Placement of Electrodes

Skin conductance measurements should be recorded with bipolar placements—i.e., with both electrodes on active sites. Skin potential, in contrast, must be recorded with one active site and the other electrode on an inactive reference site. A suitable reference, which can be used without abrading the skin, is a site over the ulnar bone two inches from the elbow. Although without abrasion this site may show an appreciable standing potential, there is minimal phasic activity (Edelberg, 1967, Table 1.2).

Several suitable active sites are found on the palms: the thenar and hypothenar eminences and the medial and distal phalanges of the fingers (see Venables & Christie, 1973, p. 108, for a diagram of these placements). Any one site will serve for the active electrode in skin potential recordings. Bipolar placements should be kept on the same hand to avoid ECG artifact (Venables & Christie, 1973, p. 81). In the ideal case, the activity would be identical under the two active electrodes, but such an ideal cannot be achieved with any certainty. Venables and Martin (1967, p. 69) found that the four finger tips did not always exhibit equal skin conductance activity, and Edelberg (1967, Table 1.1) reported systematic differences between recordings from the fingers, as opposed to those from the thenar and hypothenar eminences. Similarly, Christie and Venables (1972) report differences between finger and hand sites for resting and basal skin potential level. Nevertheless, some matching of sites seems appropriate, although there is some variation of opinion as to how best to achieve this. For example, bipolar placements could be recorded from the distal or medial phalanges of two fingers, or from one distal and one medial phalanx. Any two sites on the thenar and hypothenar eminences are appropriate, including adjacent sites on one eminence if the electrodes are small enough to permit this and if care is taken to prevent direct electrical contact between them via electrode paste on the skin surface. Venables and Christie (1980, pp. 28–30) recommend placing both electrodes on sites within the same dermatome (an area innervated by a single spinal nerve) and provide a diagram of the dermatomal distribution.

The palmar sites just discussed should be used

whenever possible in order to compare the results with the large literature using these placements. If that is not possible for some reason—e.g., both hands will be used to perform some active task—then recordings may be taken from the plantar surface of the feet. The most suitable site is on the medial side of the foot over the abductor hallucis muscle adjacent to the plantar surface and midway between the first phalanx and a point directly beneath the ankle (Edelberg, 1967, p. 17 and Table 1.1).

Signal Conditioning

Applied Voltage

The measurement of skin potential does not require the application of an external voltage. Skin conductance measurements, on the other hand, are obtained by measuring the current flow through the skin in response to a constant applied voltage. For bipolar recordings, 0.5 volt is recommended. Assuming equal resistance at the two sites, this will produce a potential difference of 0.25 volt across the skin at each site.

It is essential that this applied voltage be constant. This can be accomplished in a number of ways, but a simple, inexpensive, and safe procedure is to combine 3.0 V (from two standard 1.50 volt alkaline cell batteries in series) with a precision low voltage reference diode which drops the voltage to a constant 1.22 volt (see Figure 1).[7] Even though the batteries may show decreases in voltage with use,

[7]This circuit has been kept as simple as possible in order to make it understandable to most readers. However, it is somewhat primitive by current standards and could be improved by consultation with an instrumentation engineer as long as its essential functions are preserved. For example, a constant current FET rated at 5 to 10 mA could be used in place of the 100 Ω resistor in the reference diode circuit.
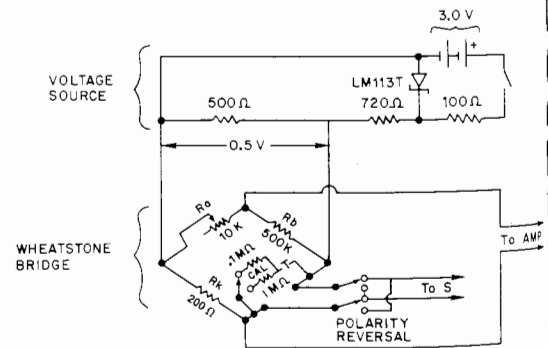

Figure 1. Signal conditioning circuit for the measurement of skin conductance (adapted from Edelberg, 1967). See text for discussion.

[6]Very small areas may result in reduction of measured potential due to the increasing resistance of the biogenerator relative to the amplifier input resistance.

the voltage will remain above 1.22 volts (until their useful life is over), allowing the diode circuit to maintain a constant voltage. The resulting 1.22 volts can then be divided between a 500 Ω and a 720 Ω series resistor, taking the 0.5 volt to be applied to the subject from across the 500 Ω resistor. An alternative approach is recommended by Lykken and Venables (1971), in which the applied potential is adjusted to 0.5 volt with each use, and Lowry (1977) provides an active circuit for producing a constant voltage. It must be stressed that, whatever system is employed, the applied voltage must be accurate and constant. Otherwise, the records will not be calibrated and incorrect readings will be obtained.

Some commercially available instruments use alternating current (AC) energizing currents. The advantage of AC is the reduction in electrode polarization that results from alternating the direction of current flow. The disadvantage is that the shunt provided by the capacitative property of the skin results in skin admittance (the AC equivalent of conductance) being higher than skin conductance. Therefore, the absolute measurements of levels obtained with an AC system will be greater than those which would have been obtained with conventional direct current (DC) methods. However, for measuring frequencies of SCRs or for assessing changes in SCR amplitude in, for example, habituation or conditioning studies, AC energizing voltages not higher in frequency than about 500 Hz are acceptable.

The Series Resistor

When a constant voltage is applied to the subject, the current flow through the skin is directly proportional to the conductance of the skin. This current flow can be measured by placing a resistor of no more than a few hundred ohms in series with the subject and then measuring the voltage across the resistor. Because this resistor is negligible compared to the subject's resistance, it does not affect the current flow. The voltage across this series resistor is, of course, directly proportional to the current flow and, therefore, to the subject's conductance. When amplified by the polygraph, it provides an accurate measurement of skin conductance.

The calibration of this voltage can be determined as follows. Assuming 0.5 volt as the applied voltage, the current flow through the skin will be 0.5 μampere for each μmho of conductance.[8] If, for example, a 200 ohm series resistor is used, the voltage generated across it will equal 200 ohms times 0.5

μamp/μmho $= 100$ μV/μmho of conductance. A 400 ohm series resistor would generate 200 μV/ μmho, etc. If the amplifier to be used is not sensitive enough to amplify signals this small, then it may be necessary to use a larger series resistor. At the extreme, with a 1K series resistor the potential across the resistor will equal 0.5 mV/μmho of conductance.[9]

Tonic Level Control

Most investigators are interested in the detection and measurement of skin conductance responses. A problem arises, however, because these responses, which may have an amplitude of a fraction of a micromho, are superimposed on a much larger tonic level: SCRs can be expected to range from .01 to 5 μmhos/cm^2, whereas SCLs range from 2 to 100 μmhos/cm^2 (Venables & Christie, 1973, p. 8). Thus, if a sensitivity setting is used which permits recording of the full range of levels, the resolution of responses is unacceptably poor. For example, assuming that for a given experiment it is determined that levels may range as high as 50 μmhos and that the series resistor produces a voltage of 100 μV/μmho, one must allow for a full scale pen deflection of 5,000 μV, or 5 mV. With a 5 cm pen excursion, the sensitivity can be no more than 1 mV/cm, or 1 mm/ μmho. With this sensitivity, then, a relatively large SCR of 0.5 μmho would produce a pen deflection of only 0.5 mm. Under these conditions, accurate measurement of amplitude is impossible, as is even the detection of small amplitude SCRs.

If, on the other hand, a large portion of the tonic SCL can be balanced or adjusted out, the situation improves dramatically. If a given subject produced a tonic level of around 23 μmhos, this could be recorded by balancing out 20 μmhos and then recording at a sensitivity of 2 μmhos/cm pen deflection (i.e., 200 μV/cm sensitivity if the series resistor produces 100 μV/μmho), a fivefold increase in precision. Under these conditions, an SCR of only 0.1 μmho produces a pen deflection of 0.5 mm. Proportionately greater accuracy is possible if recording conditions permit a sensitivity of 1 μmho/cm, which is usually the case where increased accuracy is most important—i.e., where small SCRs are expected. Thus, the solution to accurate measurements of SCRs is the introduction of some method of tonic level control, which permits an adjustment of the tonic level. In this approach, the extent of balancing of the signal can be varied both between and within

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[8]The terms mho and μmho are used here to refer to conductance. It should be noted, however, that the terms sieman and μsieman have replaced the terms mho and μmho as the internationally agreed units for conductance.

[9]As the value of the series resistor increases above 1K, the voltage loss across the resistor becomes appreciable, thereby violating the assumption of constant voltage across the subject.

subjects in order to allow maximum sensitivity. At each change in tonic level control, the chart paper is marked and the extent of balancing noted on the record. Accurate measurements of SCLs can then be reconstructed with this information.

There are numerous ways to accomplish tonic level control. Circuits for achieving this have been published by Lykken and Venables (1971) and by Lowry (1977). One relatively simple approach employs the variation on a Wheatstone bridge shown in Figure 1, which is an adaptation of the bridge presented by Edelberg (1967, Figure 1.4) for constant voltage measurements. In this bridge, the voltage is supplied as described above with a National LM113T precision low voltage reference diode. R_k is the 200 ohm resistor in series with the subject discussed above. R_a is an adjustable resistor used to balance the bridge (i.e., to cancel out the tonic level). Using a 10K, 10-turn potentiometer and the values given, each complete turn $(1,000\ \Omega)$ will cancel out 10 μmhos. The imbalance voltage will be 100 $\mu V/\mu$mho of skin conductance, as discussed above. The calibration of the balance and imbalance voltage assumes that the amplifier in the polygraph has an input impedance equal to or greater than 1 megohm. Two calibration resistors are provided to give standard conductances of 1 and 10 micromhos. The subject is connected to the bridge via a double pole, double throw switch (with gold contacts), allowing reversal of polarity in order to check for polarization of the electrodes.

For those investigators who do not wish to measure tonic levels, it is possible to record SCRs with a capacitance (or R-C) coupled input to the polygraph, as long as a constant voltage technique is used in the signal conditioner.[10] Accurate SCR amplitudes are obtained with time constants of 6 sec or longer (Edelberg, 1967, p. 36).[11] In this case, the tonic level control is no longer needed. The voltage from the series resistor can be fed directly into the capacitance-coupled input.

Summary

The following summary of recommended techniques will also serve to indicate the type of information to be included in the methods section of manuscripts. The recommendations for skin con-

ductance and skin potential will be summarized separately.

Skin conductance recordings should be obtained with silver-silver chloride electrodes and an electrode paste consisting of one part physiological saline and two parts Parke-Davis Unibase (or an equivalent neutral ointment cream), the final mixture having a concentration of approximately 0.050 M NaCl. The same paste must be used in both electrodes. A constant 0.5 V potential (regulated in some manner) should be applied across the two recording sites and a small (e.g., $\leq 500\ \Omega$) series resistor, with the subject's conductance estimated from the voltage generated across the small series resistor. Some form of tonic level control should be employed in order to increase the sensitivity of detection of small responses to at least 2.0 μmhos/cm of pen deflection. Depending on the number and size of responses, this sensitivity can be increased to 0.5 μmho/cm or more. Each adjustment of the tonic level control should be noted on the chart paper in order to preserve the measurement of skin conductance level. Electrodes should be tested every two or three days for bias potential and polarization. The tonic level control circuitry should incorporate calibration resistors to check its accuracy prior to each subject.

The placement of the two electrodes will normally be on the palmar surface of the hand, the most popular sites being the medial and distal phalanges of the fingers and the thenar and hypothenar eminences. The area of contact with the skin should be controlled with extremely small contact areas avoided (1 cm² is recommended if possible). Similarly, the time since application of the electrolyte should be controlled when comparing experimental groups or different conditions.

It is anticipated that skin potential will be recorded either to measure skin potential level or to count the number of skin potential responses. Silver-silver chloride electrodes are recommended in either case. However, if the skin potential level results are to be related to the British work with this measure, a KCl electrolyte in an agar medium should be used. For a count of the number of SPRs, either this electrolyte or the one recommended for skin conductance recordings will suffice. In either case, the same paste must be used in both electrodes. Electrodes need to be checked for bias potentials but not polarization. No external voltage is applied, but some form of tonic level control may be needed for increased sensitivity (as much as 1 mV/ cm pen deflection). If responses are only to be counted, R-C coupling will eliminate the standing potential.

One electrode is placed on an active site on the palm of the hand (the sites recommended for con-

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[10]If a constant current technique is used, skin resistance rather than conductance is recorded. Since there is a strong "law of initial value" effect with resistance, tonic levels must be recorded for the constant current technique, precluding the use of capacitance coupling.

[11]The accurate measurement of recovery limbs (i.e., the portion of the response following maximum amplitudes) requires DC recording.

ductance are also suitable for potential) with the reference electrode at an inactive site on the forearm. If absolute measurements of skin potential level are not required, the reference electrode can be placed without abrasion of the skin over the ulnar bone two inches from the elbow. If absolute skin potential level is of interest—as in the British work—then abrasion of the skin at the reference site is necessary.

These recommendations are not viewed as exhausting the range of acceptable methodology. They are offered to provide guidance for investigators who are not experts in electrodermal methodology. It is also hoped that they will promote some degree of standardization except in those cases in which there are clear reasons for employing alternative methods.

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Announcement

International Neuropsychological Society

From February 3rd through 6th, 1982, the tenth annual meeting of the International Neuropsychological Society (INS) will be held at the Pittsburgh Hilton Hotel. Proposals for papers and/or symposia are welcome from both INS members and nonmembers. For information contact: Kenneth M. Adams, Ph.D., Division of Neuropsychology (K-11), Henry Ford Hospital, Detroit, Michigan 48202.