A Comparison of Field and Laboratory Polygraphs in the Detection of Deception

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ABSTRACT

This study compared the effectiveness of field and laboratory polygraphs in discriminating guilty and innocent subjects tested using the Control Question Technique (CQT). Subjects were 48 prisoners examined regarding a mock theft in a peer threat context; physiological responses were recorded simultaneously on a Lafayette field polygraph and a Sensor Medics laboratory polygraph. Overall hit rates were essentially the same whether classifications were based on quantitative measures from the laboratory polygraph or on numerical scores from the field polygraph (i.e., 73% and 79%, respectively), and in both cases the best discriminating measures were electrodermal activity and indices of respiration suppression. Further analyses revealed that errors of classification were mostly due to the failure of the available measures to differentiate between relevant and control questions for innocent subjects. These results indicate that the CQT is susceptible to false positive errors when subjects are tested under field-like circumstances, a problem that is not likely to be eliminated by refinements in instrumentation and scoring.

DESCRIPTORS: Detection of deception, Field and laboratory polygraphs, Control Question Technique.

In the control question test (CQT), the polygraph technique that is typically used in criminal cases, physiological responses to specific crime-relevant questions are compared with responses to control questions covering the subject's prior history of wrongdoing. The CQT assumes that guilty and innocent subjects will with few exceptions show discriminable patterns of response to these two types of items; however, this assumption has been challenged on theoretical grounds (Iacono & Patrick, 1988; Lykken, 1981). Of primary concern is the problem of false positive errors: Some proportion of innocent subjects are likely to be more disturbed by the relevant questions on the test because these items are more directly incriminating, causing them to appear deceptive.

Ideally, questions about the accuracy of the CQT with guilty and innocent subjects would be resolved using a representative sample of real-life examinations in which ground truth was known with certainty. Unfortunately, the advantage of field validity studies—that they are based on actual crimes—is also a serious drawback because ground truth verification is often lacking in real-life cases. Iacono and Patrick (1988) have suggested the analog field study as an alternative to field research for addressing issues of CQT validity. This refers to a paradigm in which polygraph test subjects are motivated by genuine fear of the consequences of failing the test rather than by reward, and in which a certain criterion of guilt/innocence is available for the entire sample.

In a recent paper (Patrick & Iacono, 1989), we reported findings from an analog field study of the CQT in which psychopathic and nonpsychopathic prisoners were tested in a “group contingency threat” situation. Specifically, subjects were led to believe that their performance as individuals could decide benefits or penalties for the sample as a whole. Based on blind numerical analyses of charts from a standard field polygraph instrument, hit rates for guilty and innocent subjects (excluding inconclusives) were 87.0% and 55.6%, respectively.

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and 73.2% overall, with no differences between psychopaths and nonpsychopaths. Even when classifications were made using optimal cutoffs established on a post-hoc basis, the overall hit rate was only 73.5%, and further analyses suggested that false positive outcomes were related to individual differences in the impact of the threat manipulation.

The present paper provides a detailed analysis of physiological recordings obtained in this same study from a more sophisticated laboratory polygraph, which was used in tandem with the field instrument. Analyses of these new data address two empirical questions concerning the validity of the CQT: a) Are laboratory polygraphs more accurate than field instruments for purposes of detecting deception?, and b) Can false positive errors, which seem to occur at a high rate when CQT subjects are genuinely concerned about their test outcomes (see Iacono & Patrick, 1988, for a review of relevant research), be eliminated through refinements in response measurement and scoring?

Method

Subjects

Subjects were 48 male prison inmates (mean age = 25.90 years) recruited from a Canadian provincial prison, comprising equal groups (n = 24) of psychopathic and nonpsychopathic individuals diagnosed using Hare's (1980) psychopathy checklist (see Patrick & Iacono, 1989, for further details). Informed consent was obtained prior to participation.

Examiners

Two “study examiners” each conducted half of the polygraph tests for the study, and in addition each blindly scored both the field and laboratory charts from tests conducted by the other. Both examiners possessed the following credentials: a) completion of training at an established American polygraph school; b) membership in the major North American professional associations for polygraph operators (including the American Polygraph Association); c) over 25 years of police investigative experience; and d) over 10 years’ experience performing field polygraph tests with criminal suspects. In addition, a third, “independent examiner” (an outside police examiner with considerable CQT experience but no prior exposure to the study data) also scored all the laboratory charts; this examiner was an experienced criminal investigator and a graduate of an accredited police polygraph training academy. Henceforth, “nonblind study examiner” refers to the examiner who performed the test, “blind study examiner” refers to his associate who acted as blind rescorer, and “independent examiner” refers to the outside examiner who had no role in performing the tests.

Apparatus

The polygraph examinations were conducted in a private room within the prison’s health care center. Physiological measures were recorded simultaneously on two polygraph instruments: a 5-channel Lafayette Model 761-99G field model and a 4-channel Sensor Medics (formerly Beckman) Type R612 Dynograph. The field polygraph recorded thoracic and abdominal respiration, skin resistance response, and cardiovascular activity from a pneumatic pressure cuff inflated around the left upper arm (see Patrick & Iacono, 1989, for further details). The laboratory polygraph recordings were made on chart paper at a speed of 2.5 mm/s. A single respiration tracing was obtained from a pneumatic tube positioned around the subject’s lower thorax (between the two tubes used for the field polygraph), connected to a Grass PT5A Volumetric Pressure Transducer and in turn to a Sensor Medics 9853A Voltage/Pulse/Pressure Coupler. Skin conductance was measured from 1-cm Ag/AgCl electrodes placed on the thenar and hypothenar eminences of the right hand and connected to a Sensor Medics 9844 Skin Conductance Coupler, which imposed .5 V across the electrodes. Heart rate was measured from the subject’s right wrist and left ankle (EKG Lead II) using a Sensor Medics 9857 Cardiotachometer Coupler. Finger pulse amplitude was measured using a photoelectric plethysmograph positioned on the fleshy surface of the right thumb and connected to a Sensor Medics 9874 Photocell Coupler set to record with a .1-s time constant.

Procedure

“Guilty” subjects (comprising half of each diagnostic group) were instructed to commit a mock theft of $20 from an office in the health center; “innocent” subjects remained in the testing room for an equivalent period of time. Subjects in both groups were led to believe that their test outcomes would decide benefits or penalties for their co-participants, as follows: If fewer than 10 of the 48 study volunteers “failed” the polygraph test all participants would receive a bonus of $20 at the end of the study, but if more than 10 failed, then no one would receive the bonus. Further, subjects were told that if the bonuses were lost, the names of those responsible would be made available to the other prisoners. However, to eliminate any real risk of harm, all subjects received a $20 bonus at the end of the study, and information about test outcomes was conveyed privately to each individual at that time. (See Patrick & Iacono, 1989, for further details.)

Subjects were tested regarding the mock theft by one of two study examiners, each blind to guilt status.

1In our earlier paper (Patrick & Iacono, 1989), we presented several indirect sources of evidence supporting the effectiveness of the threat manipulation, including the following: a) subject attrition prior to the lie detection phase of the study; b) unsolicited remarks from participants before and after the polygraph test regarding the stressfulness of the procedure; c) heightened state anxiety reports relative to inmate subjects in past research; and d) heightened heart rate levels during the polygraph test relative to resting levels observed in previous research with inmate subjects.
and diagnosis. The Control Question Technique was very similar to that used by Raskin and Hare (1978) and included 10 questions, of which 3 were relevant questions covering the mock theft issue and 3 were control questions dealing with related issues from the subject's past. The examiner reviewed the controls with the subject and adjusted their wording in response to admissions so that each could be answered no. After the pretest interview (including biographical interview, discussion of the main issue and the rationale for the test, and review of the questions) and attachment of recording devices for the two polygraphs, the examiner administered three question sets (or charts). A fourth chart was obtained if the outcome was not clear after three. Between charts, the subject was asked whether any of the questions (specifically, the controls) had bothered him, and these items were further modified or clarified to accommodate new admissions. The wording of the relevant questions was never changed.

Quantification of Physiological Measures

Lafayette field polygraph. Scores from +3 to −3 were assigned to each control/relevant question pair—positive scores reflecting greater response to the control question and negative scores reflecting greater response to the relevant question—and then summed over question pairs, channels, and Charts 1–3, to yield a total score. (A fourth chart was obtained in 12 cases, but no more than 3 charts were ever required by the original examiner to reach a conclusive score.) Classification criteria were as follows: +6 or higher, truthful; −6 or lower, deceptive; and between +5 and −5, inconclusive.

Sensor Medics laboratory polygraph. For each subject, the following phasic response measurements were made blindly by trained research assistants for all control and relevant questions on Charts 1–3:

Respiration amplitude. The amplitude in mm of the last complete inhalation before the start of the question was subtracted from the amplitude of the first full inhalation following the answer to the question (cf. Raskin & Hare, 1978), and the difference was expressed as percent of prequestion amplitude to adjust for between-subject differences in gain setting, providing an index of respiration slowing and negative scores reflecting greater heart rate responses.

Heart rate response. A measure of heart rate deceleration (in bpm) was obtained by subtracting the highest level reached within the first 8 s following question onset (or between question onset and a point 2 s after the subject's answer if this period exceeded 8 s) from the lowest level reached during the 8 s following the point of maximum acceleration. Larger negative scores reflected greater heart rate responses.

The laboratory polygraph charts were numerically scored by the blind study examiners and an independent examiner. Scoring criteria for the respiration and electrodermal channels were the same as for the corresponding field channels. For the cardiovascular channel, scores were based on relative finger pulse amplitude (FPA) responses (i.e., pulse amplitude constriction and heart rate changes to relevant and control questions. To minimize the possibility that the blind study examiners would be influenced by their prior rescoring of field chart data from the same tests, identifying information was concealed on each laboratory chart and scoring of the charts took place approximately one year after blind rescoring of the field polygraph charts.²

²However, one potential source of bias in the numerical analyses is that the time these analyses were performed, both the study examiners and the independent police examiner had knowledge of the hit rates derived from the field charts, which included a high percentage of false positive outcomes (see Patrick & Iacono, 1989). In spite of this, correlations between blind scores derived from the field polygraph charts and numerical scores based on the laboratory polygraph charts, whether generated by the blind study examiners or by the independent examiner, were very high (see final subsection of Results).
Results

In order to compare the findings from the field and laboratory polygraphs, it is necessary to briefly summarize pertinent results from a blind numerical analysis of the field polygraph charts reported by Patrick and Iacono (1989). Significant differences between guilty and innocent subjects were found for all scores (respiration, skin resistance response, cardiovascular, and total), but only guilty subjects showed clear differentiation between relevant and control questions: The mean total score for guilty subjects was $-14.33$; for innocent, it was $-1.42$. No main effects or interactions were found for the psychopathy variable. A stepwise discriminant function analysis using the three channel scores to classify guilty and innocent subjects was significant, with skin resistance response and respiration scores (but not cardiovascular) contributing to the equation. Discriminant function classifications were 72.9% accurate, a figure nearly identical to the 73.5% hit rate obtained when optimal cutoffs ($\pm 2$) were used to classify guilty and innocent subjects based on total blind numerical scores.

Laboratory Polygraph Measures

Each laboratory polygraph measure was subjected to a Criterion Group $\times$ Psychopathy Diagnosis $\times$ Question Type $\times$ Chart ANOVA. The Geisser-Greenhouse (1958) correction was used in testing effects involving repeated measures factors in cases where homogeneity or compound symmetry assumptions were violated (cf. Keppel, 1982).

Table 1 shows means for each cell of the Criterion Group $\times$ Question Type interaction (the effect of primary interest from the standpoint of Control Question Test theory) in each analysis, along with summary statistics; this interaction was significant for all measures except respiration cycle time, post-question, and respiration baseline. Simple main effects tests ($\alpha=.05$) indicated that the interactions involving respiration cycle time (during question), skin conductance response, finger pulse amplitude, and heart rate response were a function of differential responding for guilty subjects only. The respiration amplitude measure yielded significant discrimination between relevant and control questions for innocent subjects, but not for guilty.

In contrast, none of the other effects emerged with any consistency across analyses. In particular, except for two minor interactions involving respiration measures—the Psychopathy Diagnosis $\times$ Question Type interaction for respiration amplitude, $F(1/43)=4.35$, $p<.05$, and the Criterion Group $\times$ Psychopathy Diagnosis interaction for respiration baseline, $F(1/43)=5.91$, $p<.05$—psychopathy diagnosis had no impact on responding.

A stepwise discriminant function analysis using the laboratory polygraph measures to classify guilty and innocent subjects was significant, $F(4/44)=5.28$, $p<.01$, with skin conductance response, two respiration indices (cycle time during question and amplitude), and heart rate response contributing;

<table>
<thead>
<tr>
<th>Measures</th>
<th>Guilty</th>
<th>Innocent</th>
<th>$F$</th>
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<tbody>
<tr>
<td>RA</td>
<td>3.08</td>
<td>-1.43</td>
<td></td>
</tr>
<tr>
<td>RCTpost</td>
<td>-0.34</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>RCTduring</td>
<td>0.40</td>
<td>1.34</td>
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<tr>
<td>RBL</td>
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<td>0.39</td>
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</tr>
<tr>
<td>range-corr SCR</td>
<td>18.77</td>
<td>45.69</td>
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<tr>
<td>FPA</td>
<td>23.90</td>
<td>30.17</td>
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</tr>
<tr>
<td>HRR</td>
<td>-10.47</td>
<td>-12.61</td>
<td></td>
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</tbody>
</table>

Note.—Scores are based on charts 1–3 of the polygraph test. RA = respiration amplitude; RCTpost = respiration cycle time, post-question; RCTduring = respiration cycle time, during question; RBL = respiration baseline; range-corr SCR = range-corrected skin conductance response; FPA = finger pulse amplitude; HRR = heart rate response. $^*$ is for Criterion Group $\times$ Question Type interaction. Degrees of freedom for $F$ are as follows: All respiration measures, 1/43; SCR and FPA, 1/44; HRR, 1/40. The differences reflect missing values for the respiration and HRR measures.

Table 1
Laboratory polygraph: Mean responses to control and relevant questions for guilty and innocent subjects

<table>
<thead>
<tr>
<th>Measures</th>
<th>Control</th>
<th>Relevant</th>
<th>Guilty</th>
<th>Innocent</th>
<th>$F$</th>
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$^*$p<.05, **p<.01.
standardized discriminant function coefficients were .53, .55, .37, and .37, respectively. Classifications based on the discriminant function scores were 79.2% accurate. McNemar’s (1962) chi-square test of significance for correlated proportions was used to compare discriminant function classifications of guilty and innocent subjects for laboratory versus field polygraph measures; the test was not significant, \( \chi^2(1, N=48)=0.33 \).

Relationship Between Field and Laboratory Polygraph Measures

Field versus laboratory polygraph numerical scores. Table 2 shows correlations for total and channel scores arranged in columns based on the following score pairings: a) nonblind versus blind scoring of the field polygraph charts, b) independent examiner versus blind study examiner scoring of the laboratory polygraph charts, c) blind study examiner scores for the field polygraph versus blind study examiner scores for the laboratory polygraph, and d) laboratory polygraph scores for the independent examiner versus field polygraph scores for the blind study examiners.

The correlations between the nonblind and blind field polygraph scores were generally very high, suggesting that the original examiners relied principally on the chart data and not on extra-polygraphic information (cf. Iacono & Patrick, 1988) in their scoring. In addition, the pattern of correlations between the two sets of laboratory polygraph scores (blind study examiner and independent examiner) was essentially the same as that for the two sets of field polygraph scores (nonblind and blind study examiners). Finally, for the two pairings involving scores derived from different sets of polygraph charts (i.e., field vs. laboratory polygraph), only the cardiovascular channel correlations differed substantially and systematically from correlations based on scores derived from the same set of polygraph charts, a finding that is perhaps not surprising because different parameters were tapped by the field and laboratory polygraphs.

Field numerical scores versus quantitative measures. Correlational analyses were used to compare field polygraph channel scores (respiration, skin resistance, and cardiovascular) with mean difference scores (control minus relevant, Charts 1–3) for the various laboratory polygraph measures. For field skin resistance versus laboratory range-corrected skin conductance response scores, the product-moment correlation \( (N=48) \) was .89, \( p<.01 \). A multiple regression analysis using mean difference scores for the four laboratory respiration measures (amplitude, cycle time-post question, cycle time-during question, and baseline) to predict the field respiration score yielded a multiple \( R \) of .66, \( F(5/ 42)=6.31, p<.01 \). Only respiration cycle time-during question and respiration amplitude made significant independent contributions to the equation, showing product-moment correlations with the criterion of .53 \( (p<.01) \) and .37 \( (p<.01) \), respectively. A second multiple regression analysis using the two Sensor Medics cardiovascular measures (finger pulse amplitude and heart rate response) to predict the field polygraph cardiovascular score produced a multiple \( R \) of .58, \( F(2/43)=10.63, p<.01 \). Heart rate response was weighted nearly twice as heavily as finger pulse amplitude in the regression equation, with a standardized regression coefficient of .44 as compared to .24 for finger pulse amplitude. The product-moment correlations for heart rate re-

<table>
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<th>Table 2</th>
<th>Correlations between numerical scores for field and laboratory polygraph charts</th>
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<td>Same Charts*</td>
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<tr>
<td>Scores</td>
<td>Field Polygraph</td>
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<tr>
<td>Total</td>
<td>.85</td>
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<tr>
<td>Respiration</td>
<td>.55</td>
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<tr>
<td>Electrodermal</td>
<td>.90</td>
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<tr>
<td>Cardiovascular</td>
<td>.82</td>
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</tbody>
</table>

*Under this heading, “Field” refers to the correlation between the nonblind and blind study examiners’ scoring of the Lafayette charts, and “Laboratory” refers to the correlation between blind study and independent examiner scoring of the Sensor Medics charts.

*Under this heading, “Blind Study Examiner” refers to the correlation between the blind study examiners’ scoring of the Lafayette charts and their scoring of the Sensor Medics data, and “Blind Study vs. Indep. Examiner” refers to the relationship between the blind study examiners’ scoring of the Lafayette charts and the independent examiner’s scoring of the Sensor Medics charts.
Discussion

In an earlier paper (Patrick & Iacono, 1989), we reported hit rate data from a mock crime study in which prison inmates underwent Control Question Test polygraph examinations in a “group contingency threat” situation. The hit rates for guilty and innocent subjects based on blind scoring of field polygraph charts were 87.0% and 55.6%, respectively, and 73.2% overall. In the present paper, we examined the relationship between field and laboratory polygraph measures, and whether quantitative analysis of the more sophisticated laboratory data would lead to improved classification of subjects.

Blind numerical scores from the field polygraph and quantitative measures from the laboratory polygraph each produced consistent differentiation between relevant and control questions, but only for guilty subjects. The absence of significant effects for the psychopathy variable is consistent with the results of Raskin and Hare (1978), and was discussed in our earlier paper (Patrick & Iacono, 1989).

Numerical scores from the field polygraph contained information largely redundant with data obtained from the laboratory polygraph, except for the cardiovascular channel where some divergence was expected given that each instrument included a unique parameter of cardiovascular activity. The overall hit rate for classification of subjects based on an optimal combination of the laboratory polygraph measures was no better than that obtained using an optimal combination of the three separate channel scores from the field polygraph. These figures were in turn no better than the overall field polygraph hit rates reported by Patrick and Iacono (1989) for total score classifications based on optimal cutoffs. Finally, the best discriminating variables emerging from analyses of numerical scores and quantitative measures were electrodermal activity and respiration (in particular, indices of respiration suppression or blocking), and correlational analyses indicated that our field examiners relied mainly on these parameters in their scoring.

In an earlier evaluation of multiple quantitative measures in the Control Question Test (CQT) context, Kircher and Raskin (1988) identified these exact same response parameters—electrodermal response and respiration suppression—as the best discriminators for classifying guilty and innocent subjects. The main difference between Kircher and Raskin’s findings and our own is that their overall hit rate for classifications based on the quantitative data was 97%, as compared to our 79%. However, there was also a major procedural difference between the two studies: Whereas Kircher and Raskin’s subjects faced only a potential reward for success on the polygraph test, inmate subjects in the present study faced a strong threat (i.e., reprisal from their peers) for failure. Further, quantitative analyses of the laboratory polygraph data revealed that our lower hit rate was mostly due to the failure of the available measures to differentiate between relevant and control questions for innocent subjects, and evidence presented in Patrick and Iacono (1989) indicates that false positives were related to individual differences in the impact of the threat.

The present findings indicate that for purposes of CQT detection of deception based on autonomic responses, sophisticated laboratory polygraphs provide no advantage over less expensive field instruments. Our data also indicate that refinements in instrumentation and scoring are not likely to eliminate false positive errors, which tend to occur at a high rate when the CQT is performed under field-like circumstances (Patrick & Iacono, 1989, 1991). Further investigations of polygraph test accuracy under conditions of high and low threat are needed to resolve discrepancies between field and laboratory research findings.

REFERENCES


Announcements

Postdoctoral Research Positions in Event-Related Potentials, Cognitive Development, and Aging

The Cognitive Electrophysiology Laboratory of the Division of Developmental and Behavioral Studies at New York State Psychiatric Institute, New York City, New York, has two positions available at the postdoctoral level. The positions are supported by grants from NIA and NICHD dealing with memory, aging, and cognitive development using event-related potentials concurrently recorded during tasks presumed to tap implicit and explicit memory performance. The candidate should have experience in the recording and analysis of psychophysiological data with emphasis on event-related potentials. Knowledge of computerized data collection and analysis on mini-, micro-, and mainframe computers is essential. Competency with the DOS operating system is critical, and programming skills are desirable. The appointments can begin as early as May-June, 1992. Salary range is based on experience with excellent fringe benefits.

Please send (1) a letter of application describing research interests, explicit description of skills, and experience; (2) curriculum vitae and representative reprints; and (3) the names and telephone numbers of three professionals with whom you have worked, to: Dr. David Friedman, Cognitive Electrophysiology Laboratory, A308, Box 58, New York State Psychiatric Institute, 722 West 168th Street, New York City, New York 10032.

Behavioral Medicine Postdoctoral Research Fellowship

The University of Pittsburgh has fellowships currently available. Program includes didactic training in physiology/psychophysiology, cardiovascular disease/pathophysiology, principles of behavior and behavior change, and research methods and statistics. 1-3 year program; stipends at current NIH levels of support. Must be a U.S. citizen or non-citizen national in accordance with NIH regulations for a NRSA fellowship award. Majority of training is in the laboratory with training faculty, including Drs. Michael Allen, Leonard Epstein, Rolf Jacob, J. Richard Jennings, Thomas Kamarck, Stephen Manuck, Marsha Marcus, Karen Matthews, Robert McDonald, Matthew Muldoon, Kenneth Perkins, Saul Shiffman, Alvin Shapiro, and Rena Wing. Send statement of objectives, curriculum vitae, and three letters of recommendation to: Karen Matthews, Ph.D., Department of Psychiatry, University of Pittsburgh, 3811 O’Hara Street, Pittsburgh, PA 15213, or call (412) 624-2041. EEOC/MF

Two-Year Postdoctoral Position Available in Human Clinical Electrophysiology

The University of California-Davis School of Medicine has a two-year postdoctoral position available in human clinical electrophysiology. Includes intraoperative neural monitoring training and research opportunity in cognitive neuroscience/psychophysiology. Training in rapidly expanding area of applied electrophysiology working in university medical center. Ph.D. in Psychology required. Salary approximately $26,000/year. Inquire/apply to: Henry L. Bennett, Ph.D., or Michael J. Russell, Ph.D., Anesthesiology, UCDMC, 2315 Stockton Boulevard, Sacramento, CA 95817.
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