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A COMPARISON OF TECHNIQUES FOR THE VOLUNTARY SLOWING OF HEART RATE IN HUMANS

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ABSTRACT

The results of two experiments are reported which compared heart rate (HR) feedback to other techniques for eliciting voluntary HR slowing. The first experiment showed that HR feedback and EMG feedback both generated greater decreases in HR than a control task (tracking a computer-generated display). However, neither type of feedback proved superior to corresponding instructions alone without feedback; also, control subjects not receiving feedback performed just as well in an instructions-only period as subjects in the two feedback groups. This suggested that feedback was not a critical variable in slowing performance. The second experiment compared HR feedback to an analog of Transcendental Meditation. The latter approach proved superior to feedback, in both the standard paradigm of alternating work-rest cycles and a continuous fifteen-minute period. "Meditation" subjects also exhibited less perturbation in respiratory activity and greater decrements in frontalis EMG. The theoretical and clinical implications of these results were discussed.

INTRODUCTION

A common finding in studies of learned heart rate (HR) control has been that speeding HR is an easier response to acquire, and yields considerably larger effects, than slowing HR (e.g., Headrick, Feather, and Wells, 1971; Gatchel, 1974). In addition, HR slowing is unresponsive to parametric manipulations which affect speeding performance (e.g., Lang and Twentyman, 1974; Young and Blanchard, 1974).

A common explanation for the attenuated slowing results has been that resting HRs in the laboratory are already so slow as to preclude further slowing, while there is practically no upper bound on the magnitude of rate increases (Engel and Chism, 1967; Lang, 1974). This position, however, receives scant support from findings of modest correlations between baseline HR levels and the degree of slowing (Gatchel, 1974). In addition, Bell and Schwartz (1974) found that subjects' self-recorded HRs upon arising were eight to nine beats slower than those recorded during laboratory sessions in HR slowing, suggesting that further decreases in the experimental situation are metabolically feasible.

Accordingly, the goal of the two studies reported here was to find ways of maximizing learned heart rate decreases in normal, college-age subjects. The first study was suggested by a consideration of the cardiac-somatic hypothesis developed by Obrist and associates (Obrist, Webb, Sutterer, and Howard, 1970), in which heart rate and skeletal muscle activity are seen as closely linked centrally under almost all normal, everyday conditions. With respect to the HR training data, this theory prompts the inference the subjects in speeding sessions discover respiratory and other somatic maneuvers which increase HR; subjects instructed to slow, conversely, find further reductions from the somatically quiescent baseline periods difficult. In addition, it has also been suggested that feedback may actually hamper slowing performance due to its intrinsic activating effects (Lang, 1975).

Taken together, these considerations point to the possibility that HR may be reduced most efficiently by lowering arousal level by whatever means work best, rather than concentrating exclusively on the HR feedback paradigm. In accordance with Obrist's theory, the first study therefore tested the hypothesis that training in muscle tension reductions, as reflected in the electromyogram (EMG), might cause greater decreases in HR than feedback of the heart rate itself.

METHOD

Subjects. Subjects were 30 undergraduate males enrolled in introductory psychology courses.[2] All were screened before the experiment for a history of cardiovascular disease, medications, or drug use.

Apparatus. The subject was seated in a reclining armchair in a small, partially sound-shielded room. Appropriate electrodes were attached to measure skin conductance, heart rate, respiration, and frontalis EMG. These measures were amplified and displayed on a Beckman type RM polygraph. The administration of instructions, stimulus presentation, and data recording were all accomplished on-line by a PDP-12 computer which had a slave display oscilloscope for the subject to view.

The feedback display was identical in appearance for all groups, but generated by different sources depending on the condition. The HR display consisted of a stationary horizontal line extending from the extreme left edge of the PDP-12 oscilloscope and terminating at some point on the scope face, with its end marked by a short vertical slash. The length of the line was directly proportional to the length of the previous R-R interval; each R wave interrupted the computer and caused the line to jump instaneously to a new length. The line thus extended farther to the right as the HR slowed. Two identical R-R intervals were denoted by a brief disappearance of the short vertical slash. On the EMG display, the line length of the trace was proportional to the time between resets of the integrator, so that the line became longer with increased relaxation. Finally, in the tracking condition the computer presented a ramdomly ordered sequence bearing no relation to any physiological measures.

Design. The design involved ten subjects in each of three groups. Each subject was run for five ninety-minute sessions; the first session for each group involved nonfeedback tasks designed to habituate subjects to the experimental situation and to assess their physiological responsivity. Subjects in Group One were asked to slow their heart rates, both with and without feedback, for the remaining four sessions. Group Two subjects attempted to reduce activity in the frontalis muscle. Group Three was a control group, whose members continued the display task of session one for the remaining four sessions.

Procedure. At the beginning of each session, the subject was seated in a comfortable reclining chair, and electrodes were attached to measure skin conductance, heart rate, respiration, and frontalis EMG. The instructions were then presented on the subject's oscilloscope slaved to the PDP-12 computer. Two blood pressure determinations were taken just before the baseline period started, and again after the session was over.

Each session consisted of five trials; each trial contained four parts. The first was a three-minute feedback period during which subjects attempted, depending on the condition, to decrease HR or frontalis EMG, or track the computer-generated display. Each successful response, which occurred when the end of the horizontal feedback line fell to the right of a vertical target line in the center of the scope (Figure 1), was reinforced by a brief display of the word "GOOD" on the oscilloscope screen. This was followed by a one-minute rest period, after which subjects worked on their respective tasks without feedback for a three-minute period designated as "transfer"; during this time subjects in the control group were instructed to slow HR also. A "scoreboard" was then briefly presented which informed subjects of their average HR, and change from baseline, during the preceding transfer task. The fourth part of each trial was another one-minute rest period, after which the next trial ensued.

Preceding the first trial of each session was a three-minute resting baseline period with no instructions, and then a three-minute period in which subjects were given a chance to decrease HR or EMG before any feedback was presented. A three-minute resting baseline also followed the last trial of each session. Session one, as mentioned above, was composed of tasks designed to habituate subjects to the laboratory and to the physiological recording procedures; all subjects tracked the computer-generated display during feedback periods, and estimated 10-second units of time during transfer.

Data reduction and measurement. All primary data reduction and recording were accomplished on-line by the PDP-12 computer, which stored frequency histograms for the HR data and summary statistics (median and inter-quartile range) for EMG, skin conductance, and respiration measures. An editing program was used to eliminate artifacts due to movement, missed triggers, etc. from the HR scores. The median and inter-quartile range (IQR) were used in preference to the mean and standard deviation to avoid distortion from one or two extreme or artifactual points. Change scores were calculated in which each variable for each trial period was expressed as a deviation from the corresponding value for the initial three-minute base period at the beginning of the session. These scores were then used for between- and within-subjects analyses of variance on each measure.

RESULTS

Overall, the mean initial HR of the sample was relatively low, averaging 63.8, 63.9, 61.9, and 63.4 for the four experimental sessions. Analyses of variance revealed no significant differences between groups or sessions on these scores or any other variables. There were also no between-groups effects for the baseline or task periods for any measures in session one. It was concluded that the data analysis was not compromised by initial levels differences.

Deviation scores for all physiological measures were subjected to analyses of variance with four main factors; three groups and two target settings made up the between-subject factors, while four sessions and five trials comprised the within-subject factors. (Two target settings were used across subjects, reinforcing either 50% or 75% of the resting distribution of HR or EMG; however, this manipulation had no effect and is not considered further in the analyses.)

Broadly, the pattern of HR change during each session was one of reduced HR during the feedback and transfer periods, with consistent and significant increases in rate during each following rest interval. This pattern was mirrored by the activity and variability of EMG, respiration, and skin conductance. These data, and an inspection of the raw polygraph records, suggest that subjects used the rest periods to shift position in the chair, take one or two large breaths, and glance about the room more than during task periods. Because this activity varied randomly across groups and sessions, and the feedback and transfer periods were of primary interest, no further analyses of the rest periods were undertaken.

For feedback trials, Figure 2 shows that the decrease in median HR for the HR and EMG groups was markedly greater than for the tracking group. This anticipated difference was statistically significant ($F=4.07$, $p<.01$). A separate analysis showed that HR and EMG groups did not differ from each other. Collapsing over groups and sessions, there was also a marked tendency for HR to decrease progressively across trials during feedback ($F=13.22$, $p<.001$).

The results for transfer periods were somewhat different. With all three groups instructed to lower HR or EMG, the reduction in median HR was very similar in all of them; no significant difference emerged. The magnitude of the changes for the HR and EMG groups was very comparable for feedback and transfer, and in fact very slightly greater for transfer during the last two sessions. Supplementary within-group analyses confirmed that there was no difference in HR change between feedback and transfer for either the HR or EMG groups. Tracking subjects, however, achieved significantly greater decrements during transfer than feedback periods ($F=8.43$, $p<.025$). The reduction in HR across trials was also similar to that for feedback, with a significant reduction for all groups ($F=10.70$, $p<.001$), and no interactions between groups and trials.

The EMG data are almost identical in nature to the HR results. Small reductions in frontalis EMG were observed during feedback for the HR and EMG groups, while tracking subjects actually displayed increased tension for the last three sessions (Figure 3). The F ratio for this difference was 3.47 ($p<.05$).

Unexpectedly, the EMG group did not achieve consistently greater reductions in EMG than the HR group, and the two groups did not differ statistically. The HR and EMG groups did exhibit a very slight downward trend across feedback trials, but this result was significant only when the tracking group was excluded from the analysis ($F=3.38$, $p<.025$).

The EMG data for transfer periods again parallel HR results. All three groups evinced reductions of similar magnitude in frontalis tension levels (Figure 5), comparable to those achieved during feedback. In fact, within-group analyses revealed that EMG actually decreased more during transfer than feedback for both the HR group ($F=4.38$, $p<.10$) and the EMG group ($F=9.01$, $p<.025$). The reductions by the tracking subjects led to a substantial difference compared to the increases seen during feedback ($F=5.25$, $p<.05$). As with HR, the groups did not differ significantly during transfer. However, here no trials effect was observed for either the whole sample or for the HR and EMG groups considered separately.

A somewhat different picture is given by the respiration data. Heart rate control subjects evidently breathed more slowly and deeply, as well as more variably, during HR control periods. Figure 4, e.g., shows the change in median respiratory total period (RTP) for feedback trials; the changes are similar for both inspiratory and expiratory periods. The difference was significant whether the tracking group was present ($F=5.46$, $p<.025$) or absent ($F=5.31$, $p<.05$) from the analysis. Similar results occurred during transfer periods, although the levels of significance were marginal, apparently due to greater variance. A comparable picture emerged for the variability of respiration rate for both feedback and transfer.

The respiration amplitude data showed that HR subjects breathed more deeply during feedback than those in the other two groups, although the difference is only marginally significant ($F=3.27$, $p<.10$). As for respiration period, HR subjects were also more variable in the depth of their breathing during feedback ($F=6.32$, $p<.01$). Data for the transfer period were in the same direction as for feedback, but the effects were not as strong and failed to reach significance.

The skin conductance data were largely negative. All groups showed a marked decrease in skin conductance level over trials ($F=19.91$, $p<.001$), as well as a similar decrease in spontaneous activity (i.e., IQR of skin conductance; $F=13.23$, $p<.001$) for both feedback and transfer periods. However, no overall differences between the groups emerged.

Correlational analyses did provide some support for the hypothesis that arousal effects in the feedback situation may be detrimental to HR slowing. For all three groups, a more powerful initial values effect was observed for transfer periods than feedback in both skin conductance measures; i.e., for both median skin conductance and IQR of skin conductance, the negative correlation between resting level and magnitude of decrease was greater for transfer than feedback. This was the case for every group, session and measure except one (the IQR of skin conductance for the EMG group during session three). It is as though the initial values effect during feedback was obscured due to inconsistent decreases across subjects. During transfer, conversely, everyone relaxed sufficiently so that skin conductance activity declined more nearly to the level predicted by each subject's initial value.

The mean blood pressure readings taken before the session were 119.4 for systolic pressure and 66.4 for diastolic; the corresponding figures for post-session readings were 118.4 and 67.9. There were no differences between groups or between pre- and post-session values. Evidently the treatments had little effect on blood pressure, which might be expecped in a young, normotensive subject sample.

DISCUSSION

The results of this experiment were quite straightforward. During feedback trials, HR and EMG activity both decreased in the two groups attempting to reduce physiological activity. The control group, actively tracking the display, failed to reduce HR substantially during feedback and showed slight elevations of EMG. For transfer periods the HR and EMG groups achieved reductions in HR and EMG comparab'e to feedback. The control group, also asked to slow HR during this period, now exhibited decreases in HR and EMG which were not significantly different from the other two groups. While the HR group breathed rather differently than the other two groups, this seemed to produce little decrement or enhancement of HR change.

With respect to the role of feedback, three conclusions seem apparent. First, feedback of HR or EMG with appropriate instructions did result in significant decrements in HR compared to a tracking control task. However, feedback did not produce greater changes than subsequent no-feedback conditions, and also failed to enhance the transfer performance of subjects receiving feedback relative to those who did not. Finally, the EMG feedback display failed to produce greater reductions in EMG and/or HR than the HR feedback -- the original hypothesis of the study. Subjects rather seemed to respond with a generalized nonspecific pattern, in which instructions and feedback regarding either HR or EMG led to comparable decreases in both systems.

The results are in accordance with Obrist's theory, in that HR decreases were linked with EMG decrements; conversely, HR and EMG remained unchanged while the control group tracked the display. In a similar vein, these data are also consonant with Brener's notion (1975) of a generalized trophotropic response. That is, subjects instructed to reduce any physiological activity are hypothesized to respond with a generalized, non-specific reduction in all somatomotor and central systems; the converse would be true for instructed increases in any physiological system. With respect to the present data, the theory helps to explain the result that HR and EMG changes were both similar whether subjects were instructed to decrease HR or EMG. Brener (1975), in fact, cites a feedback study he performed in which increases and decreases in EMG were a prime response to instructions to increase and decrease HR. He further found a strong relationship between the presentation of a HR feedback display and pronounced respiratory changes, a result also consistent with the present data; thus, changes in EMG and respiration may be part of a broad pattern of responding which is called into play when HR instructions and/or feedback are presented.

With respect to the EMG feedback, the original prediction that it would lead to enhanced HR slowing was not borne out. In retrospect, it seems likely that the same factors which Lang (1975) hypothesized to inhibit HR feedback performance -- the demands of monitoring the display, processing the information, etc. -- may have also interfered with EMG reductions in the same manner. This is consistent with the correlational data for skin conductance in which correlations of initial values with change were lower for feedback than transfer in the EMG group as well as the HR group. A study by Alexander, French, and Goodman (1975) provides support for this interpretation. They presented subjects with either visual or auditory EMG feedback, and found that only auditory feedback was effective; visual feedback was no better than a control group. It is possible that such a problem with visual EMG feedback would be specific to the frontalis only, as that site is in close proximity to the eyes; other sites, however, have not been tested. At present, it seems possible that either or both of the two factors -- non-specific sympathetic arousal or detrimental effects of visual EMG feedback -- could have contributed to the failure of the EMG group to achieve more substantial reductions in EMG or HR.

The results from this study invited two options. First, further search could be made for ways of optimizing feedback, as by presenting other EMG sites, using multiple sites simultaneously or in combination, or trying to combine HR and EMG feedback in some manner. All such approaches, however, seem vulnerable to the problem mentioned above, that factors inherent in the feedback situation produce sufficient sympathetic activation to inhibit any marked decrements in physiological activity.

Accordingly, a second strategy is to forego feedback altogether and search for other approaches which might reduce arousal. One such group of techniques which come readily to mind might be termed cognitive approaches as they rely largely on specific instructions for their effects. Examples of such methods include Jacobson's progressive relaxation (Jacobson, 1938) and autogenic training (Schultz and Luthe, 1969).

In the last few years, reports have appeared of the use of Eastern meditation practices to lower metabolic levels. Wallace (1970) first reported decreased physiological activity in college students who had practiced transcendental meditation at least six months; he mentioned decreases in heart rate of about five beats per minute. These results were replicated and extended by Wallace, Benson, and Wilson (1971) and Wallace and Benson (1972).

More recently, Benson has developed a "secularized" version of transcendental meditation with which he has performed prospective studies on normal samples. Although the technique is not exactly an analog of transcendental meditation, many of its features are similar: the subject is instructed to sit quietly in a comfortable position, relax thoroughly, maintain a passive attitude, and keep the mind completely blank by silently repeating the word "one" each time exhalation occurs. Using this technique, given subjects achieved decrements in physiological activity comparable to those observed in practitioners of transcendental meditation (Beary and Benson, 1974). Because this method is simple, easily and quickly learned, and readily adaptable to an experimental format, it seemed to be an ideal model to use in a laboratory comparison of biofeedback and a cognitive approach as methods of inducing a lowered HR. Accordingly, Experiment II was carried out as a direct test of the relative efficacy of the two methods.

EXPERIMENT II

METHOD

Subjects. Twenty young males recruited from campus bulletin boards served as subjects. Each person was paid $10.00 for participating in the experiment. The subjects were carefully screened in a short interview for any history of cardiovascular disease, medications, drug usage, or meditation practice.

Apparatus. The apparatus was exactly identical to Experiment I. Appropriate changes were made to the computer software to present the meditation displays and instructions. The same physiological measures were recorded as in Experiment I.

Design. The design involved ten subjects in each of two groups. Each group was run for three sessions. The first two sessions for the HR feedback group were identical to the feedback sessions of Experiment I, with the vertical target line set so that 50% of the resting (baseline) distribution of heart beats were reinforced. Session three involved a 15-minute period during which the subjects were instructed to slow HR continuously without feedback; three-minute rest periods preceded and followed this extended task interval.

The patterning and sequencing of tasks for the meditation group was identical to that of the HR group, except that meditation instructions (described below) were substituted for HR feedback or transfer instructions. The meditation task was exactly the same for the periods corresponding to feedback and transfer, except that the scoreboard was presented following "transfer." During session three meditators were told to follow the meditation instructions for the entire 15 minutes, with an initial and three-minute final base as for the HR group. (The designation "meditation" is adopted for brevity and convenience, and does not imply equivalence to transcendental or other established forms of meditation.)

Procedure. The procedure for HR feedback subjects for the first two sessions followed the identical feedback-rest-transfer-rest trial pattern of Experiment I. Meditation subjects followed the same pattern, but for the task periods were given instructions very similar to those described by Beary and Benson (1974). Briefly, the subjects were told to sit quietly in the chair, close their eyes, relax completely from the toes upward, maintain a passive, relaxed attitude, and say the word "one" silently each time exhalation occurred. A passive attitude was emphasized throughout. The subjects were instructed to let their minds be completely blank during the task; when distracting thoughts occurred they were not to be forced out, but rather allowed to slip away as the subject maintained concentration on saying the word "one." Similarly, respiration was not to be paced, but allowed to occur naturally and passively.

Session three was somewhat different for both groups. For both, the task consisted entirely of one 15-minute period during which no feedback, scoreboard, or other information was presented. A three-minute base period was included before and after the task period. Subjects in the HR group were told to slow HR for 15 minutes; meditation subjects were instructed to carry out the procedure just as they had in the first two sessions.

Data reduction and measurement. The data reduction was almost identical to Experiment I. Session three was arbitrarily divided into five measurement blocks of three minutes each; this allowed a more refined look at temporal trends within the session, and also facilitated comparisons with the five trials of earlier sessions.

RESULTS

As in Experiment I, none of the scores for initial baseline periods differed on any session or variable; initial level differences were therefore not a factor in these analyses.

The HR changes for feedback periods of sessions one and two are presented in Figure 5; the results for the HR and EMG groups from Experiment I are also presented for comparison. Meditation clearly led to substantially greater slowing than feedback ($F=4.66$, $p<.05$), and was also slightly better (though not significantly) than either of the two groups from the previous experiment. Meditation also prompted greater slowing during the transfer period, when HR subjects were attempting to slow cardiac rate without feedback. The magnitude of the difference was comparable to that observed during feedback ($F=6.22$, $p<.025$).

The EMG results failed to parallel HR as closely as in Experiment I.

During feedback periods greater reductions in EMG occurred for the meditation subjects than for those in the HR group. Figure 6, plotting change across trials, shows that reductions in EMG by meditation subjects were more consistent and did not fluctuate from trial to trial as much as the EMG of the HR group ($F=3.10$, $p<.10$). Unlike the results for feedback, the significant difference in HR between the two groups for transfer periods was not mirrored in the EMG data: the two groups both reduced EMG levels and the difference between them was not reliable.

Respiration results for the HR group were similar to those for Experiment I: HR subjects breathed more slowly, more deeply, and more variably during work than baseline periods. Meditation subjects, conversely, were remarkable for their stability. Figure 7, e.g., shows the results for changes in respiratory total period ($F=4.61$, $p<.05$). HR subjects also increased their depth of breathing relative to the initial rest, while those in the meditation group maintained their respiration amplitude ($F=5.55$, $p<.05$). The variability of both respiration amplitude and rate were also increased for subjects in the HR group. Similar patterns of respiration changes were observed for transfer, with the effects somewhat less strong due to increased variance.

In general, the skin conductance data failed to yield significant differences between the groups, although greater decrements in skin conductance level were observed in the meditation groups during the task periods. Significantly lower skin conductance levels were found for the meditation subjects during the post-session resting period. ($F=5.48$, $p<.05$); since the two groups did not differ on the pre-session baseline, this must reflect a greater decline in skin conductance levels over the course of the session by meditation subjects.

The data for the third, 15-minute session showed that subjects in the HR group achieved only minimal decreases in rate, while meditation subjects exhibited a steadily decreasing rate over time with decrements of 130 milliseconds during the last six minutes ($F=20.64$, $p<.001$). Unlike the earlier sessions, the groups were not differentiated by the EMG results; however, respiration changes were similar to those seen in the first two sessions, with stable values for meditation subjects contrasting with the greater alterations and variability of the HR group. Skin conductance in both groups declined over trials, but did not differentiate the groups.

DISCUSSION

To summarize the results, a group given a specific set of cognitive instructions proved superior at HR slowing to a group provided with HR feedback, and this disparity was even more marked during a final session in which both groups performed without feedback. The meditation analog group displayed consistent stability in respiratory period and amplitude, while the HR group increased respiratory activity considerably during the task periods. Meditation subjects also lowered EMG and skin conductance levels more during the first two sessions, although these effects were only marginally significant for skin conductance.

The fact that meditation subjects in Experiment II were not significantly better than HR or EMG subjects from Experiment I suggests that over a series of experiments, meditation might not prove to be clearly superior to HR feedback in generating lowered states of arousal; however, it would appear to be at least equal to feedback. In either case, the results of these experiments present obvious implications for clinical practice. It appears that feedback, of HR at least, is not the best technique for generating maximal arousal reduction; if inherent characteristics of the feedback situation per se are responsible for this deficit, the same conclusion may apply to other organ systems as well. For example, White and Alexander (1976) have reported that self-induced muscle relaxation was as effective as frontalis feedback in reducing EMG activity and reported headache activity in headache patients.

For clinical use, cognitive techniques are also preferable to feedback for several other reasons: they are easy to administer, usually easy to learn, require no sophisticated and expensive apparatus, and -- because the technique is the same no matter where it is performed -- necessitate no assumptions or concerns about the transfer of performance from laboratory to extra-laboratory sessions. Thus, should cognitive techniques ultimately prove to be no better than equal to biofeedback in generating arousal reduction, there would still be compelling reasons to prefer their use clinically.

It is not yet known whether the meditation analog used in this study is a particularly powerful means of reducing activation, or whether other cognitive techniques such as progressive relaxation, autogenic training, etc. would be equally or more successful; direct comparisons of these various approaches should resolve this question. In any event, the results of the experiments reported here, together with other related findings (e.g., White and Alexander, 1976), suggest that clinicians should carefully explore simpler and less expensive techniques before settling on biofeedback as a treatment of choice where the reduction of arousal is a therapeutic goal.

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FOOTNOTES

[1]This research was conducted while the author was a graduate student at the University of Wisconsin-Madison.

[2]The nature of the study was thoroughly explained to potential subjects in the initial interview. All subjects signed a consent form which detailed the procedure and indicated that subjects were free to withdraw from the experiment at any time.

Figure Titles.

Figure 1 - A diagrammatic representation of the feedback display at the moment of reinforcement, showing the horizontal feedback line and the vertical target line.

Figure 2 - Change in median heart rate in seconds for feedback periods.

Figure 3 - Change in median EMG in microvolts for feedback periods.

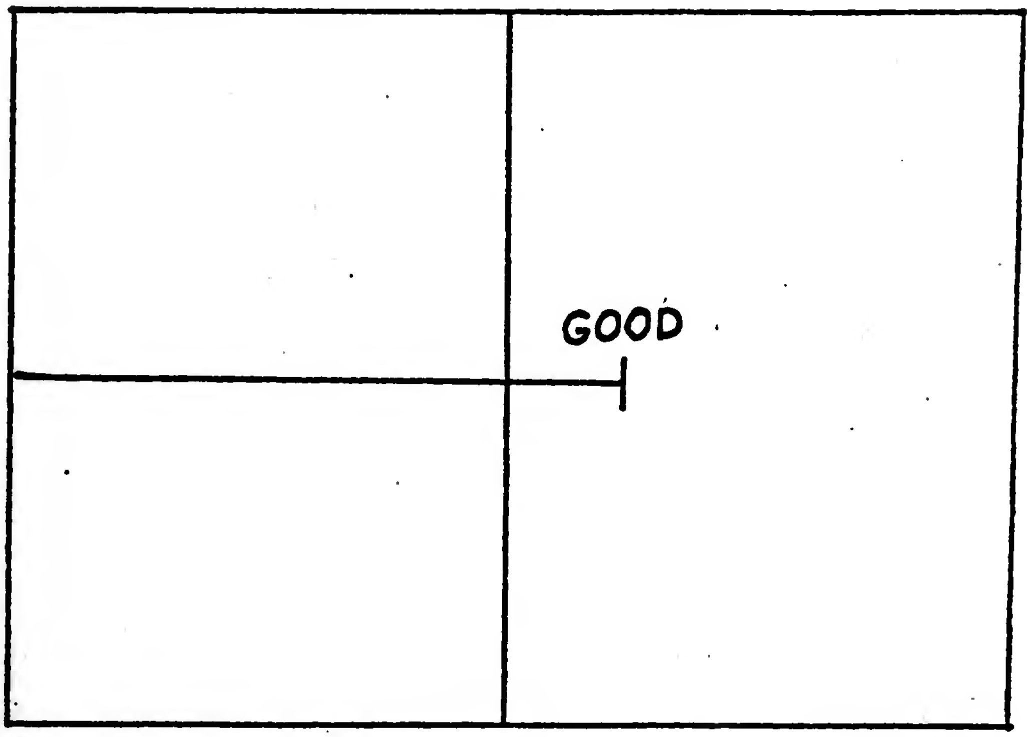
Figure 4 - Change in respiratory total period in seconds for feedback periods.

Figure 5 - Change in median heart rate in seconds for feedback periods of Experiment II, sessions 1 and 2.

Figure 6 - Change in median EMG in microvolts for feedback periods of Experiment II, sessions 1 and 2.

Figure 7 - Change in respiratory total period in seconds for feedback periods of Experiment II, sessions 1 and 2.

Figure 8 - Change in median heart rate in seconds for Experiment II, session 3.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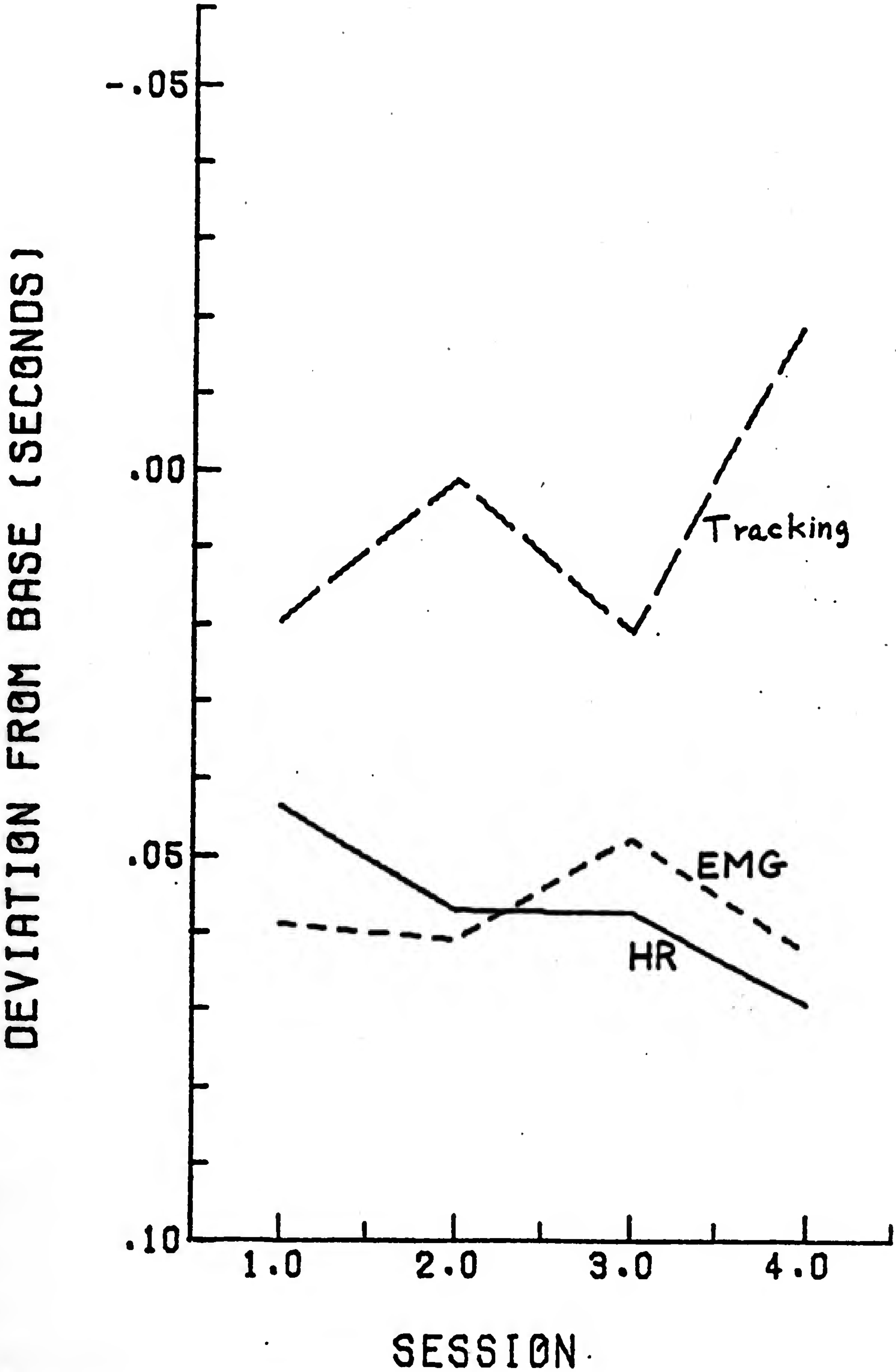

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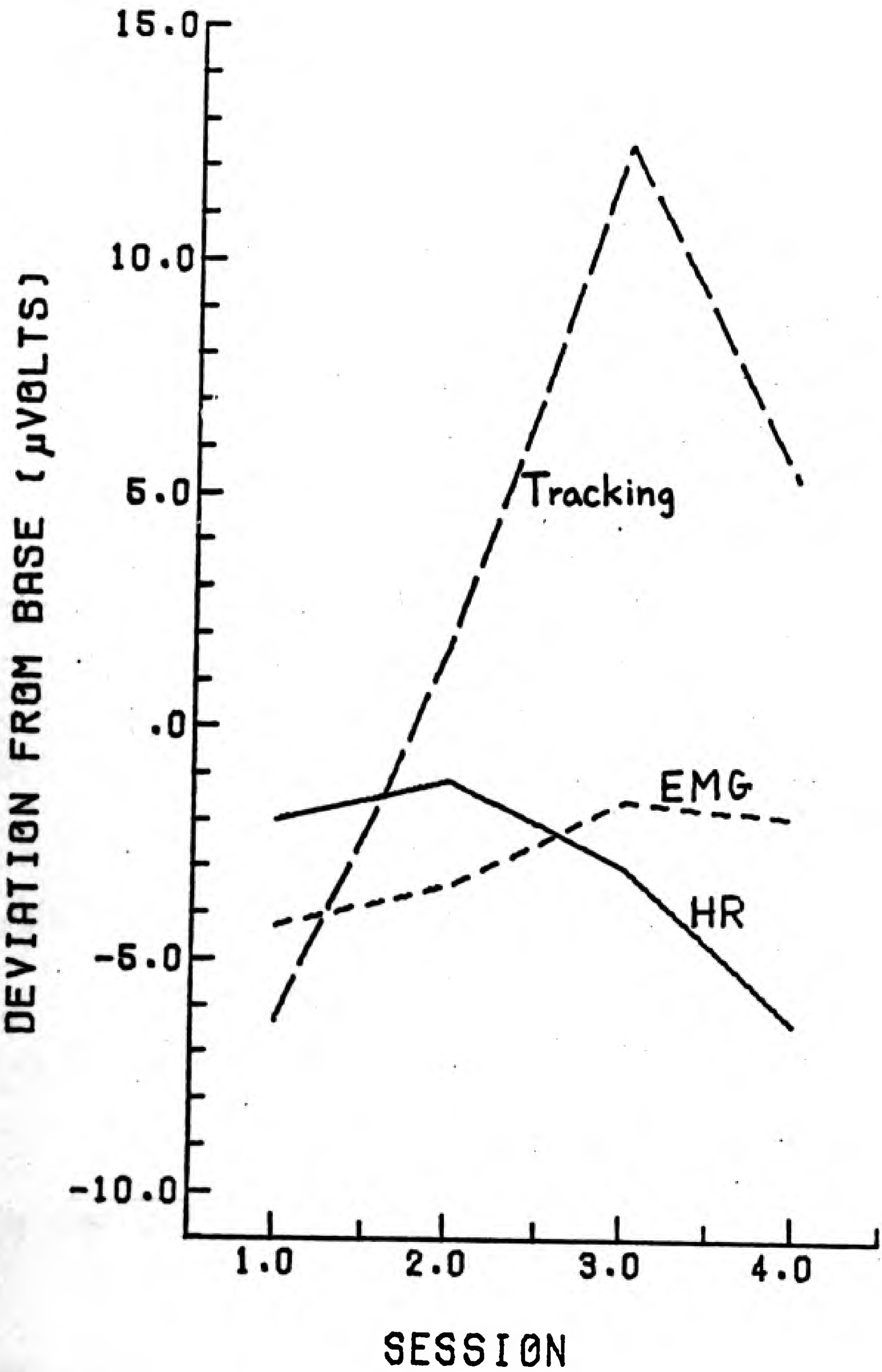
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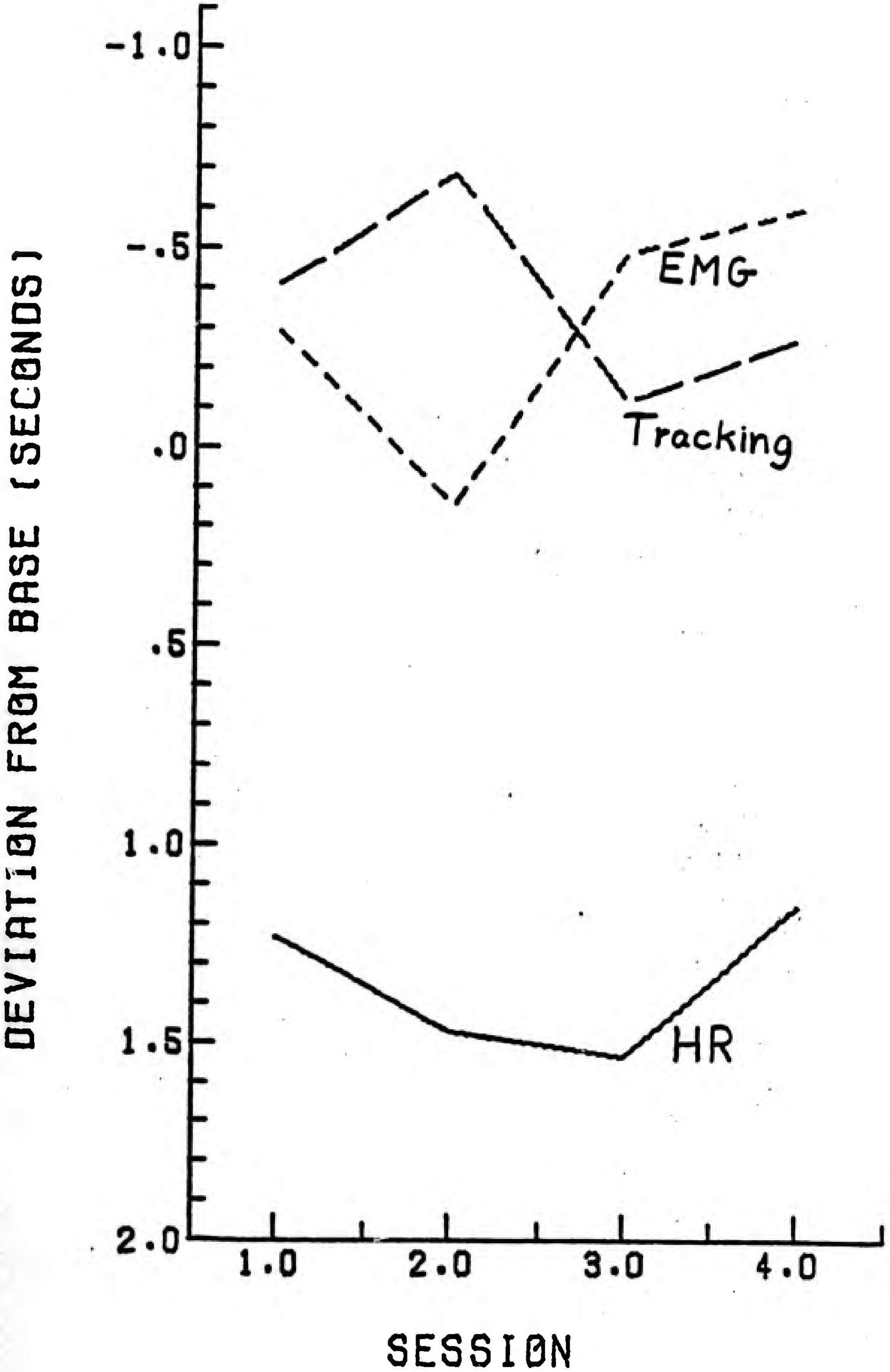

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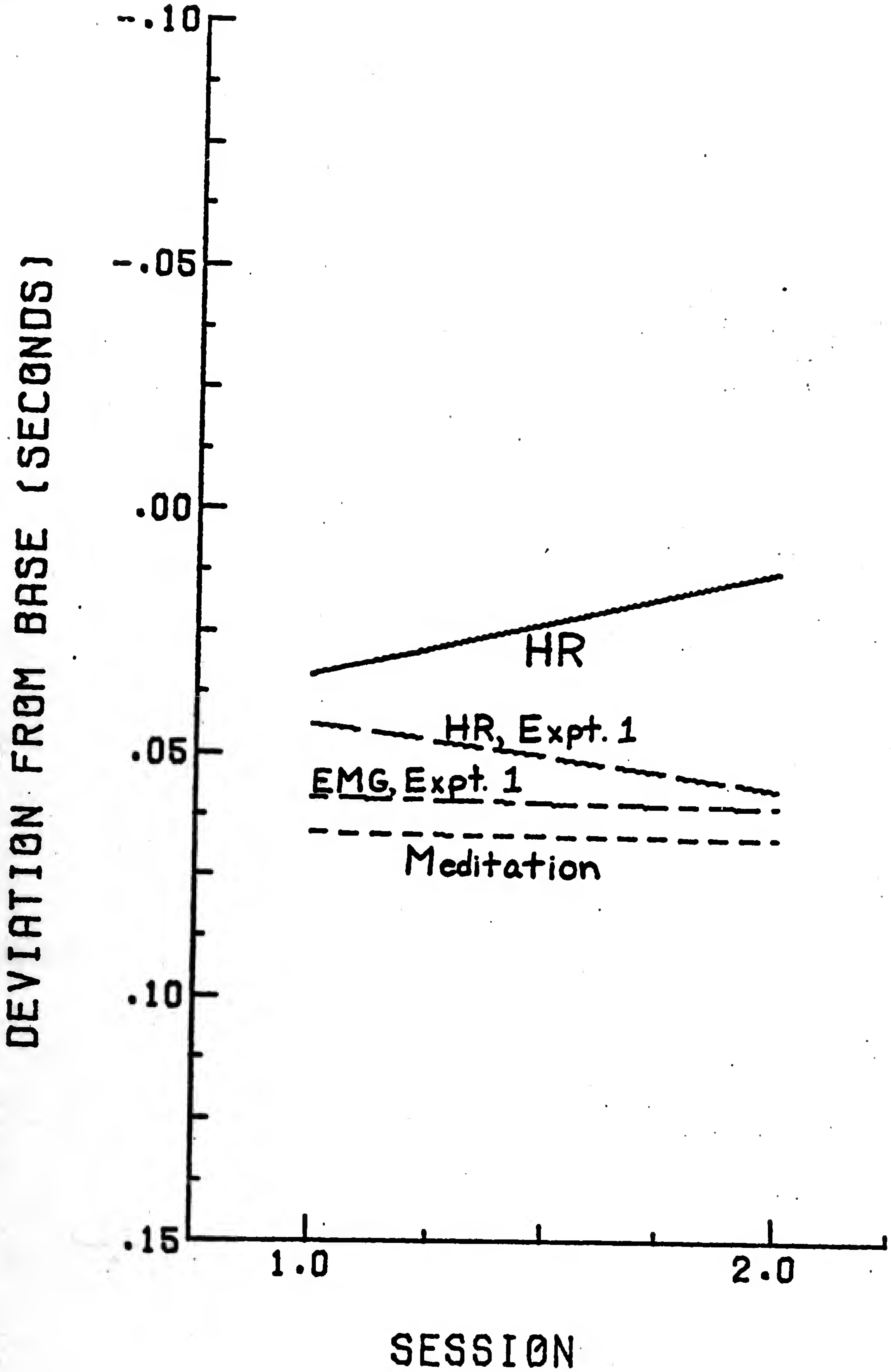
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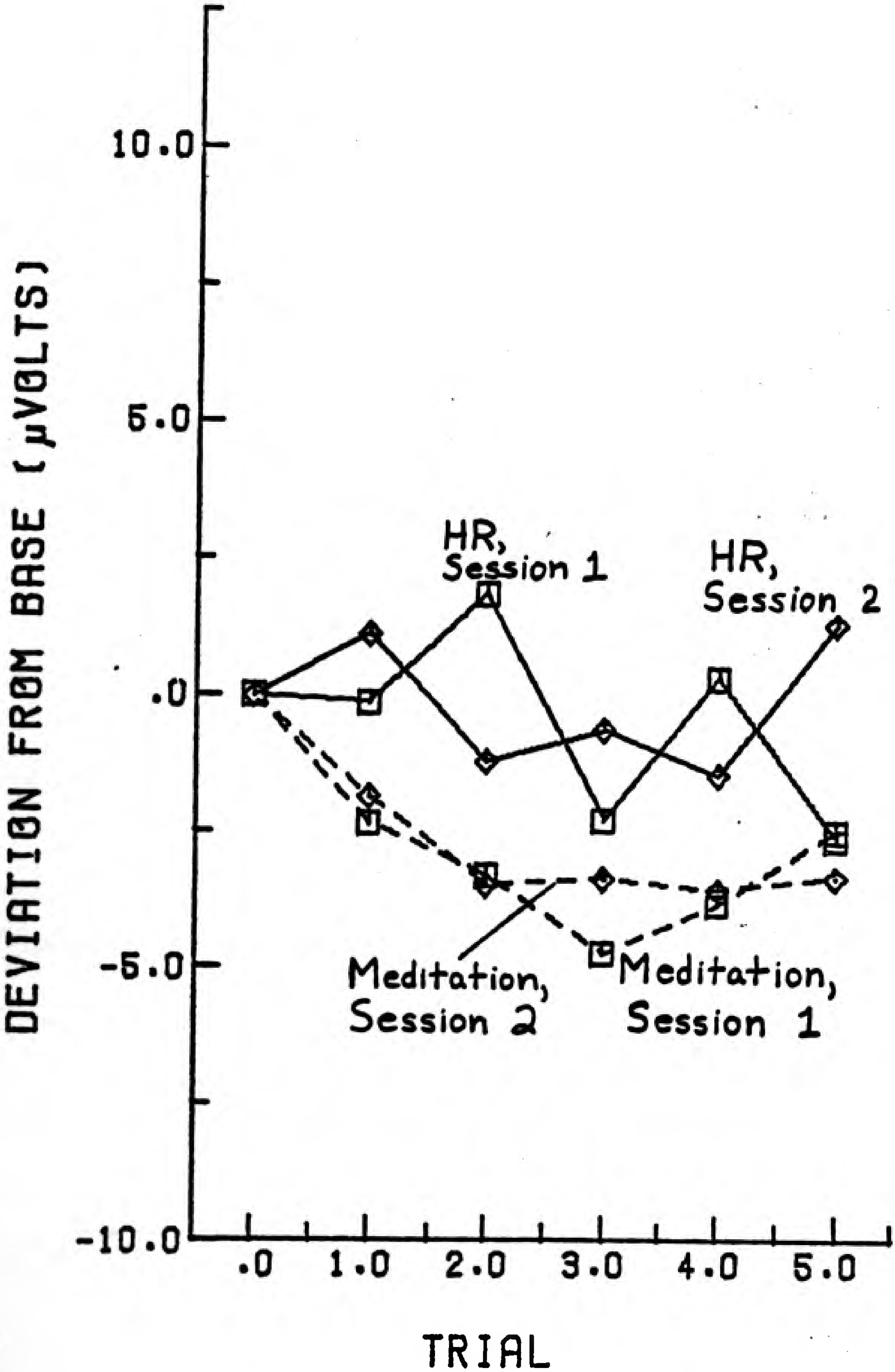
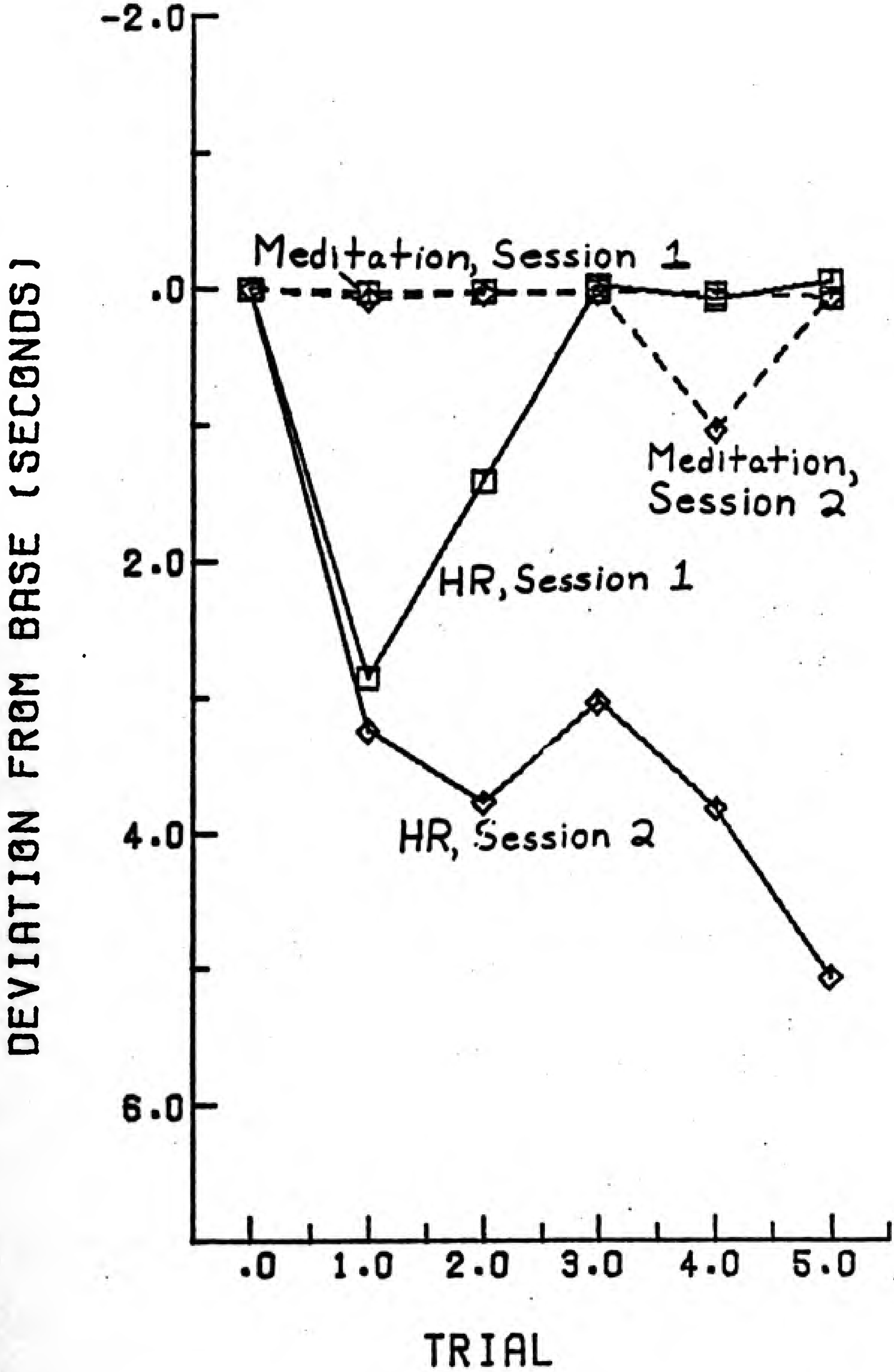
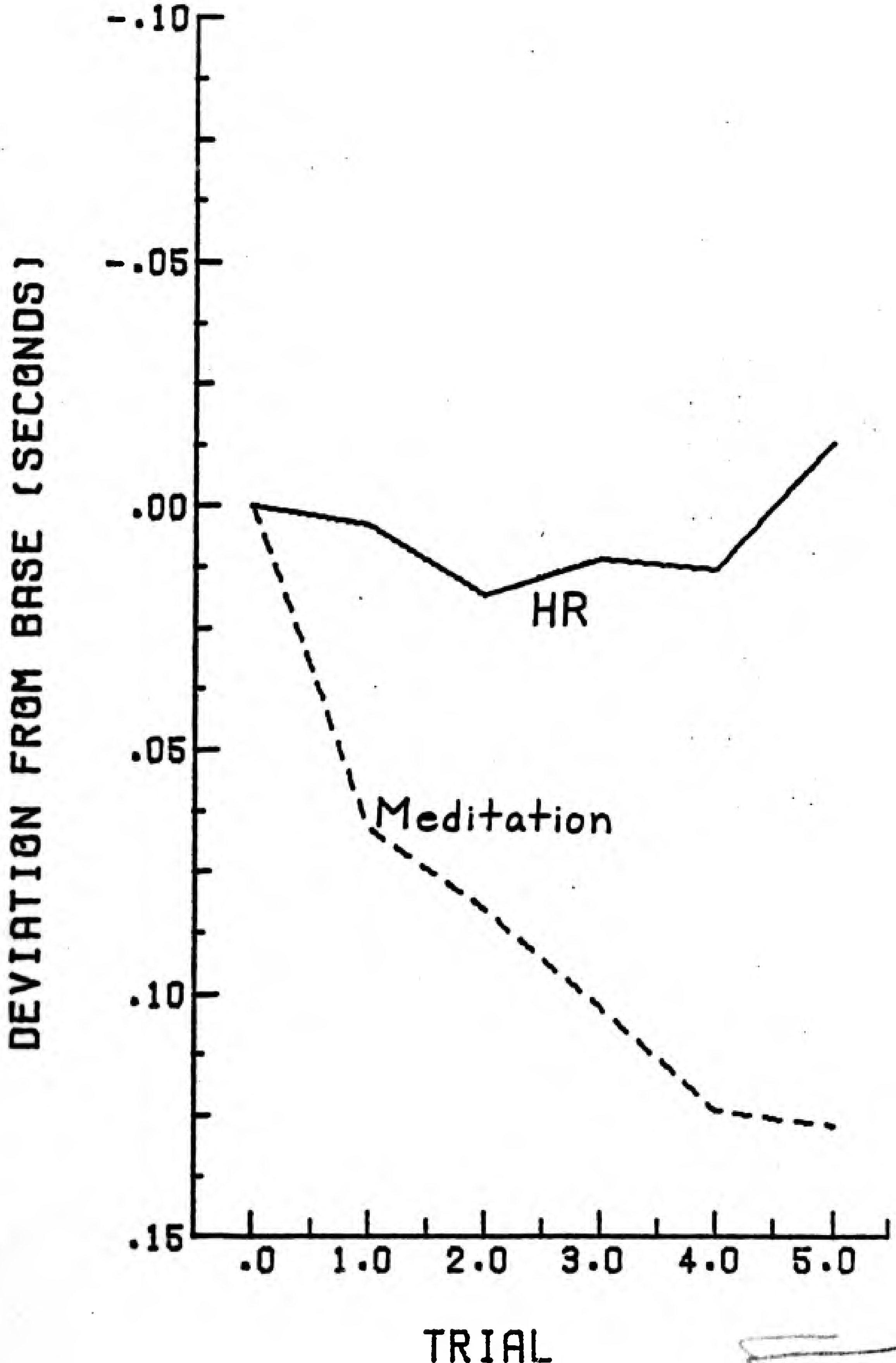
Meditation
1.0
2.0
SESSION


DEVIATION FROM BASE (μVOLTS)
10.0
5.0
.0
-5.0
-10.0
HR, Session 1
HR, Session 2
Meditation, Session 2
Meditation, Session 1
.0
1.0
2.0
3.0
4.0
5.0
TRIAL


-2.0
.0
2.0
4.0
6.0
DEVIATION FROM BASE (SECONDS)
Meditation, Session 1
Meditation, Session 2
HR, Session 1
HR, Session 2
.0
1.0
2.0
3.0
4.0
5.0
TRIAL


-.10
-.05
.00
.05
.10
.15
DEVIATION FROM BASE (SECONDS)
HR
Meditation
.0
1.0
2.0
3.0
4.0
5.0
TRIAL