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ATTENUATION OF THE CONTINGENT NEGATIVE VARIATION DURING INFORMATION PROCESSING

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ABSTRACT

Attenuation of the Contingent Negative Variation (CNV) has been reported to occur as a function of increased levels of arousal, task difficulty and distraction. The present study examined the possibility that a fourth variable, information processing load, might provide an alternative explanation of CNV attenuation.

Three conditions requiring three different levels of information processing load were run. In the EASY condition four one digit numbers (stimuli A,B,C, and D) were presented. The A-B and B-C intervals were variable; the C-D interval was two seconds. A tone and a series of clicks were presented simultaneously with stimuli C and D. The subject had to terminate the clicks with a button press and then verbally report the sums of stimuli A and C, and B and D. The DIFFICULT condition was identical, except that the numbers were two digit numbers (from 11 to 19). In the STANDARD condition stimuli A,B,C and D were not presented, leaving a fixed interval (2 seconds) reaction time task using the tone and clicks as the warning and imperative stimuli. Information processing load was expected to increase between the STANDARD, EASY and DIFFICULT conditions.

Tonic arousal level, determined by the novelty of the situation, was habituated by running the four male and four female subjects on four separate days. Incentive arousal was

also manipulated by using monetary rewards which were very high on two of the four days ($.15 for the correct sums) and very low on the other two days ($.01 for correct sums). For each subject monetary reward was constant within each day. High and Low sequences of rewards over the four days were counterbalanced across subjects.

Bipolar recordings were made at four midline electrodes, ranging from frontal to parietal placements (Fpz, Fz, Cz and Pz), and an eye electrode. Four measures were taken from the CNV waveform: early, middle, late and total CNV magnitude. P300 amplitude, a positive potential occurring 300 milliseconds after a stimulus, and an indicant of information processing load, was also measured. Heart rate was recorded during trials as a measure of both arousal (which produces cardiac acceleration) and/or attention (cardiac deceleration). Galvanic Skin Potential and reaction time were also recorded. Analyses of variance were done on all measures.

It was hypothesized that the CNV would decrease in negativity and P300 increase in positivity as information processing load increased. Second, measures of arousal such as the Galvanic Skin Potential and heart rate would initially be positively related to information processing load, but after habituation no relationship would exist. Third, subjects at different incentive levels would continue to show differences in CNV magnitude following habituation.

While a clear difference between the STANDARD, and the EASY and DIFFICULT conditions occurred for reaction times for both sexes, only the females showed effects of information processing load as indicated by the CNV and P300 measures (the former showing significant attenuations between the three conditions and the latter significantly increasing in amplitude between the STANDARD and DIFFICULT conditions, with the amplitude in the EASY condition being intermediate).

Heart rate decreased over days and reflected incentive level (cardiac deceleration occurring for the high incentive subjects) for both sexes, but males showed heart rate increases with increasing levels of information processing. Galvanic Skin Potential variability decreased as information processing load increased.

It was concluded that information processing load was the best explanation of CNV attenuation for female subjects. The processing load affected the males arousal levels, but not their evoked potentials. As levels of arousal have not been recorded in previous studies investigating information processing, the results conflict hypotheses that attenuation in these situations is due to variations in arousal.

For Peter, with love.

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INTRODUCTION

The Contingent Negative Variation (CNV) is a negative-going potential which may be seen in an Electroencephalographic record between the evoked potentials to the warning and imperative stimuli in a fixed-foreperiod reaction time task. The amplitude of the CNV is usually largest when it is recorded at the vertex, and neither the intensity nor the modality of the stimuli affect CNV variations to any extent. Instead, variations in psychological constructs attributed to the subject show the clearest effects. The CNV has been hypothesized to reflect many psychological constructs, including: motivation (Irwin et al., 1966; Rebert et al., 1967), attention (McCallum and Walter, 1968), expectancy (Walter, 1966), conation (Low et al., 1966), stress (Knott and Irwin, 1967, 1968), arousal (Tecce, 1971), distraction (Tecce et al., 1976) and information processing (Weinberg, 1976).

From an extensive review of the CNV literature, Joseph Tecce has recently proposed (Tecce 1970, 1971, 1972; Tecce and Hamilton, 1973, Tecce et al., 1976) a two process theoretical model to account for CNV variations. According to this model, the amplitude of the CNV is positively and monotonically related to attention and non-monotonically related (inverted-U) to arousal levels.

A corollary of this hypothesis is that attention improves as levels of arousal increase up to a optimum level, and becomes impaired with further increases in arousal. Excessive arousal evokes distraction stemming from internal stimuli. Furthermore, Tecce suggests that distraction, however initiated, tends to produce elevated levels of arousal. A positive feedback cycle arising from a combination of arousal and distraction could be constrained by focused (narrowed) attention (Tecce et al., 1976).

Therefore, according to this hypothesis, distraction is not simply a reduced level of attention. It may be given impetus by arousal and actively oppose attentional processes. A more precise definition of the hypothetical nature of distraction is given by Tecce et al. (1976), who state that "the CNV distraction effect is a central process involving information processing and memory functions" (p. 284).

On the basis of this theory, it is possible to predict that the production of high levels of information processing and memory functions would be associated with CNV attenuation due to related increases in arousal levels. It is unfortunate that a theoretical analysis of this prediction is limited by a scarcity of experimental data. The majority of CNV experiments require only simple perceptual decisions, such as are found in discriminative reaction time tasks.

CNV studies have typically been based upon a standard reaction time paradigm. Two stimuli (S1 and S2) are presented consecutively with a short (1 - 2 seconds) interstimulus interval (ISI). The first stimulus warns the subject of the imminent occurrence of S2, to which the subject must make a motor response. Within this paradigm, the task may vary in complexity. For example, the subject may be required to respond to only one of two S2s. An example of a typical CNV waveform in a reaction time task may be seen in Figure 1 (page 44). (Note that on the vertical axis, distance above the baseline increases with increasing negativity.)

Even within these simple tasks, however, the amplitude variations of the CNV have suggested a complex neurological basis. They appear to reflect the summation of activity from a number of functionally independent and spatially distinct processes. In one of the few studies of recorded CNV variations during high levels of information processing, CNV amplitudes and topographical distributions differed between an active problem solving task and a disjunctive reaction time task (Poon et al., 1974). The authors found a small parietal-dominant CNV in the task requiring a considerable amount of information processing and a central-dominant CNV in the type of task more usual in the CNV literature.

This thesis will primarily investigate the hypothesis that in some instances CNV attenuation is due to information processing during the CNV interval. A selective literature review will be used to examine and delineate this hypothesis.

LITERATURE REVIEW

THE CNV AND AROUSAL

CNV attenuation may occur when the subject experiences very high or very low levels of arousal during the performance of a reaction time task. Although the effects of high levels of arousal (typically induced by electrical shocks) have been given more attention than the effects of low arousal levels, results have generally been in agreement with Tecce's proposal that an inverted-U relationship occurs between CNV magnitude and arousal levels.

The well-observed tendency for the CNV to decrease over trials (Kagichi et al., 1975; Borda, 1970; McAdam, 1967) has been attributed to fatigue, attentional decrements, reduced arousal, and situational adjustments. Low et al. (1967) investigated the relationship between CNV amplitude and a measure of alertness. He reported that when the EEG showed signs of decreased alertness (fragmentation of the alpha rhythm, appearance of central theta), there was an increase in the variability and a decrease in the magnitude of the CNV. Furthermore, Tecce, Cole and Savigno-Bowman (1975) chemically induced low levels of arousal using chlorpromazine. The results showed reduced CNV amplitudes two and three hours after drug administration.

Although the above studies show a decrement in CNV amplitudes from the norm with low levels of arousal, other studies have shown that induced enhancements in motivation, interest, or attention appear to be associated with increased CNV magnitudes. A common factor in the latter studies is a presumed increase in arousal levels.

Rebert (1972) used two different S2s in a reaction time paradigm. In separate blocks of trials, the subject responded to either a single flash or to a flicker stimulus that was terminated by the subject's response. An increase in CNV amplitude occurred in the trials with the more interesting S2 (the flicker stimulus). Increased CNV amplitudes also followed the introduction of a monetary reward for correct responses (McAdam and Searles, 1969). Finally, Rebert et al. (1967) reported increased CNV amplitudes when S2 was made more difficult to detect or when the muscular effort necessary to respond to S2 was increased. CNV amplitudes were smaller when the subject was not required to respond to S2 than in those trial blocks where a response was required.

In the above studies the arousal levels of the subjects were indirectly varied. Irwin et al. (1966) were able to induce different arousal levels during the ISI through the use of discriminable S1s to signal two different levels of shock. CNV amplitudes were augmented when S1 predicted (and was followed by) the higher shock level.

Two studies by Knott and Irwin (1967, 1968) were the first to show that as arousal levels became very high, CNV attenuation could occur. In addition to using high and low levels of shock, they used high and low anxiety subjects (anxiety was measured by the Bendig Scale of emotionality, Bendig, 1962). In the high shock condition, the high anxiety subjects had smaller CNVs than the low anxiety subjects. Previous studies had shown a positive relationship between CNV amplitude and arousal levels, therefore this combination of high anxiety subjects and a high arousal-inducing situation had been expected to produce the highest level of arousal and hence the largest amplitude CNV. In fact, the amplitude of the CNV with this particular combination was even smaller than for the same high anxiety subjects in the low shock condition.

The authors generated a new theory, the "ceiling hypothesis", which suggested that the rising negativity of the CNV rested upon a standing negative potential which was raised to near the physiological limit of negativity by high levels of anxiety or arousal. Thus, while a positive relationship between arousal and CNV magnitude was still assumed to occur, at high levels of arousal the additional negativity of the CNV was attenuated.

These results were replicated by Knott and Irwin (1973) in a similar study. A study reporting comparable results without the use of electrical shocks was that of Low and Swift (1971). The 10 highest and 10 lowest scorers on a Manifest Anxiety Scale (IPAT Self-analysis Form) were run on a discrimination paradigm which became progressively more difficult. Errors were punished with a loud buzzer. In this study the CNV was again shown to decrease as the variables inherent to the situation, such as stress, anxiety or task difficulty, increased.

Tecce (1971) proposed an alternative explanation to the ceiling hypothesis by suggesting that high anxiety subjects are more distracted by irrelevant stimuli and the anticipation of painful shock, and thus, in accordance with his distraction-arousal hypothesis, show CNV attenuation. As will be reviewed in a later section, a majority of recent studies have found a negative relationship to occur between distraction levels and CNV amplitude. However, while this proposal has the advantage of tying together the results of arousal and distraction studies, a number of studies in the literature report findings which are consistent with neither Tecce's distraction-arousal hypothesis, nor the ceiling hypothesis of Knott and Irwin.

Knott et al. (1973) replicated the procedure of Knott and Irwin (1967, 1968) and found the results to be of a much more complex nature than previously assumed. They, and Van Veen et al. (1973), concluded on the basis of independent experiments that perceptual mode, sex and whether or not the subject must respond to the imperative stimulus have, in addition to anxiety proneness, been shown to influence CNV amplitude. For example, Knott and Peters (1973, 1974) found that the CNV amplitude of the female subjects was attenuated more than that of males in high stress conditions.

The relationship between arousal levels and CNV magnitude is therefore in need of further research. It is notable that in these studies the use of the term "arousal" has rarely been defined by concurrent measurement of various autonomic measures of arousal such as heart rate and GSR. In fact, Irwin and Knott (1967) found no relationship between the levels of arousal defined by their procedures and recorded GSR activity.

THE CNV AND ATTENTION

The second major factor related to CNV variation is attention, which, in combination with moderate levels of arousal, appears to show a positive and monotonic relationship with CNV amplitude.

Tecce's proposal that CNV amplitude and the attention level of the subject are positively related reflects a long history of experimentation. Numerous authors have found increments in CNV amplitude resulting from increased levels of attention. Walter (1965) varied S2, so that the task became more interesting; similarly, Ellis (1971) used focused and unfocused slides as S2. Researchers have also used procedures which necessitated increased attention levels in certain trials. For example, Rebert et al. (1967) used as S2 an easy or difficult-to-detect auditory stimulus. Donchin et al. (1972) had the subject respond to only one of two possible S2s. Similarly, Gatchel and Lang (1973) made the middle three tones in a series of five the most difficult to rank. A third procedure has been to select those trials which on the basis of post hoc analysis showed evidence of increased attention. For example, Hillyard (1969) compared trials with correct and incorrect responses in a signal detection task. Cohen (1973) chose those trials in which the subject had correctly identified words and pictures used as S2. All of these studies found increased CNV amplitude with induced increases in attention levels.

Moreover, Low et al. (1967) found that there was a tendency for the greatest amplitude CNVs to cccur when the stimuli at S2 were near threshold auditory stimuli, subjects were making consistently correct responses to S2 and EEG showed a desynchronized pattern suggesting increased alertness. This illustrates that, while attention and arousal are presumably independant processes, an experimental procedure designed to increase the attention levels of the subjects may also raise their levels of arousal.

The studies in this section show the course of the CNV waveform in what are, essentially, reaction time tasks. In the few short seconds that comprise the CNV interval (the interval between S1 and S2), the subject is only required to wait (and prepare) for S2. Differential CNV magnitudes in distinguishable tasks must reflect differential preparation. The subject is not required to process any information during the CNV interval. It might, in fact, be proposed that as performance level in the attention task improved, any unnecessary information processing occurring would tend to decrease as the subject's involvement in the task at hand increased.

THE CNV AND TASK DIFFICULTY

In the studies contained in the previous section, a few could be said to show enhancement of CNV amplitude with increases in task difficulty. However, experiments investigating this relationship have found CNV enhancement to be positively related to increasing task difficulty in some experiments, and negatively related in others. This apparent contradiction between results may be resolved by an examination of the information processing level required of the subject during the ISI by the experimental paradigms.

An example of a study involving increasing task difficulty without increased amounts of information processing, in addition to the studies by Rebert et al. (1967) and Donchin et al. (1972) outlined in the previous section, is that of McCallum and Papakostopoulos (1973), who used situations of increasing complexity.

In the least complex task, paired stimuli were presented to the subjects with a short ISI. After recording the CNV tc these stimuli, the researchers added the requirement of making a motor response to S2. In a third, and more complex condition, a third stimulus occurred randomly in the ISI; its occurrence signalled the subject to cancel the response to S2. Twc trial blocks of the third condition were run; in the first, S2 would occur midway in the ISI; in the second, S3 sometimes occurred late in the ISI.

CNV amplitude tended to increase when the third stimulus was added, but when this stimulus could also occur late in the ISI, the CNV increased for some subjects and decreased for others. Reaction times decreased. The authors pointed out a tendency for those whose CNV amplitudes increased in the last condition to be less anxious than other subjects (according to the Middlesex Hospital Questionaire). Thus high arousal levels are associated with CNV attenuation in the more difficult task; for the less anxious subjects, a positive relationship between CNV amplitude and task difficulty occurred.

Warren (1964) found CNV amplitudes to be larger in difficult visual discrimination tasks than in easier discrimination tasks. In this study, S1 (a high or low tone) informed the subject whether a difficult or an easy visual discrimination would follow. The subject was required to state whether S2 and S3 were different or identical circles. The CNV was recorded in the S1-S2 interval.

In contrast to the two studies outlined above, a deceptively simple experiment conducted by Delse et al. (1972) found that CNV amplitude decreased as task difficulty increased. The distinction between the two levels of difficulty was the ease of deciding whether or not S2 had the same pitch as S1. The two levels of difficulty were randomly mixed. The subjects were informed before each trial as to the level of task difficulty to be used.

Both male and female subjects were used, but no differences between conditions were found for the male subjects. For the female subjects, CNV amplitude was attenuated in difficult as compared to easy trials, and the greatest attenuation of the CNV (height and area measures) occurred for female subjects in the difficult pitch discrimination task when the response was correct. The authors attributed this attenuation to the requirement of having to remember S1 during the S1-S2 interval. They conjectured that for easy discriminations, a good memory representation was unnecessary; incorrect trials implied no memorization of S1. The authors suggested that the distraction hypothesis of Tecce might explain the attenuation, although no difference in reaction times occurred between the two conditions (a requirement of Tecce's theory).

Similarly, Roth et al. (1975) presented from one to four digits, a tone (S1) and then a probe digit (S2). The subject's task was to respond only if the probe digit had been contained within the preceding digits. With a more difficult task (more digits to remember), there were fewer and smaller CNVs.

It might be concluded that CNV enhancement occurs when the subject need only wait for S2 in the CNV interval, and CNV attenuation when subjects must actively process information in this interval. However, the subject's task in a study by Poon et al. (1976) required only a state of expectancy during the ISI and CNV attenuation occurred in the differential as compared to the simple reaction time task.

In this study a red warning light (S1) was illuminated for 1.4 seconds preceding the visual presentation of two letters

(S2). In the reaction time task the subject made an immediate motor response to the onset of S2. In the vowel-consonant task a differential motor response was made, indicating the similarity or difference of the two letters (S2) with respect to their categorization as vowels or consonants. The differential reaction time task resulted in a shift towards smaller CNVs and longer reaction times.

In a study by Poon et al. (1974) the subjects were told that they were in a binary choice gambling situation. They were required to predict whether S2 would be a red or a green flash. A tone, separate from S1, signalled the beginning of the trial. In the 3-5 seconds before the onset of S1 the subject announced his choice and placed a bet. To respond correctly, the subject had to discover the pattern of presentation of the red and green flashes. Initially, the red and green flashes were simply alternated. Then the pattern was changed to a repeating sequence of five red or green lights. In comparison to a standard reaction time task (using only S1 and S2) there was CNV attenuation in the prediction task. As in previous studies only a vigilance task was required of the subject in the CNV interval. However, it is apparent that the pattern identification task required memory, encoding and recall processes while the reaction time task did not.

It is notable that CNV enhancement apparently occurs if simple perceptual decisions are required at S2, and CNV attenuation if the task involves basically higher order processes such as recall or pattern analysis. It is possible that although the subject need only wait for S2, the preparation for simple reaction time or perceptual discrimination tasks at S2 and that for more complex analytical tasks may require qualitatively or quantitatively different cognitive processes.

Studies investigating the effects of distraction on CNV amplitude typically necessitate more information processing in one condition than in the other (control) condition. The distractors may be irrelevant stimuli presented during the CNV interval which require only a simple perceptual decision by the subject, or, in a more difficult situation, the subject may be required to count or recall the distractors. These studies will allow the hypothesis to be further pursued through the selection of reports of previous studies.

THE CNV AND DISTRACTION

When tasks or stimuli in addition to the standard reaction time paradigm are presented, they may be seen as distractors. The immediate effects may include increased stress, decreased attention to task stimuli, and increased task difficulty. On the basis of the results of previous studies, CNV attenuation is to be expected. This has generally been found to occur.

Distracting and irrelevant stimuli have been presented within the interstimulus or intertrial intervals, including buzzes (Walter, 1968), and tones and music (McCallum and Walter, 1968). Interesting illustrations have been used as S1, without instructions to the subject (McCallum and Walter, 1968). These resulted in decreased CNV amplitudes.

In other studies the subject performed a specific task during the ISI in addition to the standard reaction time task. The amplitude of the CNV was attenuated in situations involving mental subtraction (Low and McSherry, 1968) and when the subject was required to attend to, and later recall, numbers or letters presented within or before the ISI (Tecce and Scheff, 1969). However, mental calculation (Gauthier and Gottesman, 1976) did not result in CNV attenuation.

Tasks continued throughout the entire trial have included conversation (Walter et al., 1967; McCallum and Walter, 1968), reading (Walter et al., 1967), watching TV (only one subject showed CNV attenuation in this situation; McCallum and Walter, 1968), and adding sevens ad seriatum (Tecce and Hamilton, 1973). Other "distractors" that have decreased CNV amplitude include walking about (Walter et al., 1967), or having a full bladder or personal problems (McCallum and Walter, 1968).

Certain of these results require comment. First, in the Walter study (1968), the buzz reliably came before S2 and may have been used by the subjects, instead of S1, to prepare for the response to S2. The CNV would thus have less time to develop and would be of smaller amplitude. Second, when the subject was conversing (Walter et al., 1967), he sometimes didn't respond, implying that he didn't attend to the stimuli in these trials.

Decrements in CNV amplitudes in these cases need not be attributed to the effects of distraction.

In contradiction to the hypothesis presented at the end of the previous section, some of the above studies report CNV attenuation when only simple perceptual decisions are required in the ISI. However, the attenuation observed may be only temporary. In the study by McCallum and Walter (1968) all subjects showed marked reduction of the CNV for the first few trials, but at the end of 25 trials the amplitude was about 70% of its original value. It is reasonable to assume that a considerable amount of information processing occurs during initial trials while the subject interprets the distractors, a process which may be prolonged if the experimental task is very dull. In this case, attenuation would only occur initially, as was reported.

McCallum and Walter (1968) suggested that the amount of CNV decrement in distraction experiments reflected the amount of attention directed to the distracting stimuli. It was claimed that distracting stimuli which were very similar to the experimental stimuli utilized more of the subject's attention and caused greater decrements.

Yet, another study, by Miller et al. (1973), found CNV enhancement if the distractor (music) was of the same modality as S2, and CNV attenuation if they were of different modalities. S2 was either a tone or an electrical shock (the use of an electrical shock tended to increase CNV amplitude); the task was a fixed foreperiod reaction time task. CNV amplitude was largest when S2 was a tone and music was used as a distractor. The authors distinction between focused and divided attentional processes, however, points tc the fact that divided attention (close similarity between stimuli in the McCallum and Walter study or attention to both music and the impending shock in the Miller study) is, in both cases, associated with CNV attenuation.

A later study illustrated both CNV attenuation and enhancement in association with distraction. Tecce et al. (1976) introduced distracting letters in the ISI of the control condition (a reaction time task). In one condition the subjects were instructed to ignore these stimuli. In a second condition the subjects were required tc recall the letters. In all three conditions the subjects had to make a motor response as quickly as possible to the onset of S2. At Cz (the electrode site used in all previous studies referred to in this review) the letters-no recall was larger than the control condition, which was larger than the recall condition. Reaction times in the recall condition were significantly smaller than in the letters-no recall and control conditions.

According to Tecce et al. (1976), distraction is a hypothetical process which directs attention toward task irrelevant stimuli in the environment, thereby interfering with the selection of task relevant stimuli and resulting in a response decrement to the relevant stimuli. As expected, CNV amplitude was attenuated when the subjects were required to attend to the distracting stimuli (in the recall condition) in comparison to the control condition. However, the CNV magnitude increased when the subject was specifically instructed to ignore the distracting stimuli.

It appears reasonable to theorize that all of the distractors are interpreted by the subject and thus information processing occurs. Yet, when the subject is little inclined to react to the distractor, either because the subject was instructed to disregard these stimuli or because it is a continuous stimulus of the same modality as the imperative stimulus, then CNV enhancement occurs. In this type of situation, only stimulus "filtering" is occurring. The subject does not have attentional, and hence response, conflicts.

Donald and Goff (1973) suggested that the CNV is related to response set and state that "processing interposed stimuli does not block the CNV...unless the stimuli trigger a conflicting response set." (p. 316). They presented a study (Donald, 1970) in which the subject multiplied a number by a constant and gave a verbal response following S2. A large CNV preceded the response. Although they were obviously discussing a motor response, this analysis may be extended to evaluating the complexity of the responses to be made to an environment, where complexity may increase with the number of stimuli to which a mental response must be made, or with the level of the mental processes being tapped.

Interpretations of the CNV have now become multitudinous, particularly with respect to the numerous inferred mental activities of the subject. Attenuation of the CNV has occurred in studies involving memory storage and recall, response decisions, and information processing. Nor is this proliferation of mental processes limited to the CNV. A late positive component of the evoked potential, frequently designated P300, has also been associated with these concepts. Evoked potentials occur to both stimuli in a standard CNV paradigm, thus allowing the possibility of a P300 potential occurring to either or both stimuli. Therefore, the amplitude of P300 might serve as a measure of information processing loads, although the research in this area does not decisively support the ocurrence of a positive relationship between P300 amplitude and information processing load.

P300

Within the evoked potential (EP) to a stimulus, a late positive component with a peak latency of approximately 250 to 500 milliseconds (P300) may be recorded from vertex and posterior scalp locations. In general, it occurs when the stimulus provides significant information or is in some way salient for the subject (Sutton et al., 1965; Sutton et al., 1967; Paul and Sutton, 1972; Picton and Hillyard, 1974; Donald and Goff, 1971).

P300 amplitude is generally larger for relevant than irrelevant stimuli (Sheatz and Chapman, 1969; Donchin and Cohen, 1967; Donchin and Smith, 1970; Debecker and Desmedt, 1966; Squires et al., 1973, 1975; Picton and Hillyard, 1974; Donald and Goff, 1971, 1973). In signal detection tasks, P300 is largest for detected signals (hits) and small or absent for failures to detect signals (misses), incorrect reports of signals (false alarms), and correct reports of signal absense (correct rejections) (Hillyard et al., 1971; Ritter and Vaughan, 1969). If a vigilance task is very difficult, P300 will occur to both hits and misses (Ritter and Vaughan, 1969). Cael et al. (1974) found P300 in all but the false alarm categories of response.

The occurrence of a large P300 for hits but not for false alarms might be thought to suggest that a stimulus is necessary. However, P300 may also occur when a stimulus is expected but does not occur (Sutton et al., 1967; Klinke et al., 1968; Weinberg et al., 1970).

In such experiments, the interpretation has been that P300 reflected confidence in the response (Hillyard et al., 1971, Paul and Sutton, 1972), stimulus significance (Ritter and Vaughan, 1969), and resolution of uncertainty or information delivery (Donchin and Cohen, 1967; Sutton et al., 1965, 1967; Tueting et al., 1971).

Donchin and his colleagues have often related P300 to information processing (Donchin et al., 1975, 1973; Donchin and Cohen, 1967), as have other authors (Rohrbaugh et al., 1974; Price, 1974; Jenness, 1972; Hillyard et al., 1971). Donchin et al. (1975) suggest that the results of Donchin and Cohen (1967) and Donchin et al. (1973) show enhancement of P300 when the eliciting stimulus invokes information processing activities and that those of Sutton et al. (1967), Klinke et al. (1968) and Weinberg et al. (1970) show that P300 represents endogenous cortical processes invoked by the information processing requirements of the task (p. 449).

With respect to higher level processes, P300s are largest in situations where discriminative decisions are required (Davis, 1964; Spong et al., 1965; Donchin and Cohen, 1967; Naatanen, 1967; Ritter and Vaughan, 1969), when stimuli require cognitive processing (Chapman and Bragdon, 1964) and when stimuli are necessary and sufficient (in conjunction with previous stimuli) to solve a problem rather than when it is simply necessary to store them (Sheatz and Chapman, 1969). Furthermore, Squires et al. (1973) found P300 increased with increasing disparity between judgement and feedback information (also found by Sutton et al., 1965).

The possibility of a positive relationship occurring between P300 and information processing load is further supported by a study by Donchin et al. (1973), who used a tone followed by a flash which illuminated an "A" or a "B". Subjects guessed what S2 would be preceding the onset of S1. P300 amplitude decreased as the predictability of S2 increased. In ascending order with respect to P300 amplitude the conditions were: the S2 stimulus alternated; subjects were told the pattern of S2 presentation before the condition began; subjects were told that there was a pattern (most subjects easily discovered the pattern); subjects were told there was a pattern but the patterns were actually random; patterns were random. The number of errors in each series correlated well with P300 amplitude; but if only "correct" trials are averaged, the same results occur. The authors argue that if the subject is attempting to discover the pattern then both errors and correct guesses are informative. They put forward the hypothesis that "P300 reflects the activity of a general purpose processor which is invoked on demand by a host of data processing requirements...(which)...may be invoked whenever they require computations of a certain accuracy" (pp. 322-323). They also suggest that the complexity of memory search may be important, but do not elaborate on this.

P300 is also seen to occur in response to novel stimuli. Ritter et al. (1968) found a late positive component (LPC, a positive component occurring in the same latency range as P300, the terms not being mutually exclusive) occurred when subjects were reading and unpredictable stimulus changes occurred randomly embedded in a series of standard stimuli (which did not elicit a LPC). The authors felt that the LPC could reflect momentary shifts of attention and they suggested that the LPC was a cerebral correlate of the orienting response.

A number of studies have found P300 amplitudes to be very large in response to low probability stimuli (Sutton et al., 1965; Tueting et al., 1971; Ruchkin et al., 1975; Squires et al., 1975; Donchin et al., 1973, 1975; Ritter et al., 1968; Roth et al., 1973, 1976; Courchesne et al., 1975; Friedman et al., 1973). Tueting (1969) showed that even if the subjects were told what stimuli to expect, P300 was still largest in response to the low probability stimuli.

One explanation of this effect was given by Tueting et al. (1971), who found that P300 amplitudes increased as the probability of occurrence (four different levels) decreased, except in conditions where the probability of stimuli being repeated was high. If the subjects were told what stimuli to expect in each trial, or if the probability of alternation or repetition was high, the amplitude was attenuated. The results for misses were similar, but more complex. This led to a reanalysis of results, and lead to the conclusion that P300 amplitude is large when the subject makes a high risk guess. Thus, if they guess that a high probability stimulus will occur, this is a low risk guess. If they guess that a low probability stimulus will occur then it is a high risk guess. Alternately, P300 is large when the outcome probability (the joint probability of stimulus and guessing frequencies, or the probability of being correct with respect to the particular stimulus event) is low and small when the outcome probability is high.

Although these results could be explained by assuming that a positive relationship exists between P300 magnitude and information processing levels, P300 has been hypothesized to actually reflect at least two functionally and spatially distinct generators. Squires et al. (1975) distinguished an early positive peak at a slightly earlier latency than P300, approximately 270 milliseconds (labelled P3a). Its occurrence did not relate to stimulus relevance, but may be part of an orienting response to unexpected, irrelevant stimuli.

Courchesne et al. (1975) found a large P300 with a centrofrontal topography to novel, unrecognizable stimuli (P300 shows a centroparietal topography). If these stimuli were presented repeatedly, the wave shifted towards the parietal region. A posteriorly distributed potential (latency 380-430 milliseconds) was evoked by easily recognized irrelevant and relevant stimuli; these parameters suggest that this potential is P300. The latency of the frontal response was 360 to 450 milliseconds, thus disallowing a distinction soley on the basis of latency; however the more anterior potential was typically preceded by a large negative potential (N2). Due to the fact that most studies did not use a series of midline electrodes, a literature search neither confirms nor disconfirms suggestions that only parietally centered late positive potentials are of importance with respect to higher processes.

P300 AND THE CNV

Since P300 does show indications of an association with information processing load, then the effect of this load upon CNV amplitude may be assessed in studies which measure both P300 and CNV amplitudes.

As previously stated, it is possible that P300 may occur to either S1 or S2 of a CNV paradigm. In fact, the positivity associated with the resolution of the CNV has been suggested to be the cause of the P300 to S2 (for example, see Wilkinson and Lee, 1972; Donchin et al., 1975) although the results of numerous experiments show them to be separate and distinguishable entities (Lombroso, 1969; Tueting and Sutton, 1973; Donchin et al., 1975; Friedman et al., 1973; Donald and Goff, 1971). In addition, a number of authors have suggested that CNV and P300 amplitudes reflect electrocortical arousal (which is itself related directly or indirectly to attention) rather than processes invoked by the stimuli: Karlin, 1970; Naatanen, 1967; Papakostopoulos and McCallum, 1973; Donchin and Smith, 1970; McAdam, 1969; and Hartley, 1970.

If correlations between CNV and P300 amplitudes are computed, they may range from a high negative correlation (Roth et al., 1976), to none (Donchin et al., 1975; Donald and Goff, 1971, 1973).

Studies have usually measured both P300 and CNV without correlating their amplitudes. It has been reported that significant variations in P300 can occur without corresponding changes in the CNV (Donald and Goff, 1971; Donchin et al., 1972). Hillyard (1969) found both P300 and CNV amplitudes were large for hits in a signal detection task, small for correct rejections, and the CNV large and P300 small for correct rejections.

Donald and Goff (1973) investigated the relationship between

P300 and CNV amplitudes in an auditory discrimination task. S1 was a click and S2 was a tone of any one of six different frequencies immediately followed by a click train terminated by the subjects' motor response (pressing the correct, of six, buttons). On 75% of the trials a shock was administered during the ISI. In some trials the shock was irrelevant to the task. In others, the non-occurrence of the shock required the subject to omit the experimental task and press a "no shock" button instead.

The amplitudes of the CNV and P300 to the shock and to S2 correlated better with accuracy than with each other. The authors suggest that P300 is related to non-specific facilitation of sensory information processing, and the CNV is a stable, proactive mechanism related to response set. They outlined five differences between the CNV and P300:

(1) amplitude fluctuations were not clearly associated
(2) the fluctuations of P300 were rapid and labile, while the CNV changes were more gradual and stable
(3) P300 and CNV correlated highly with task accuracy, but less well with each other
(4) a change in task relevance affected P300 and performance, but didn't affect the CNV
(5) the task relevance of a stimulus modified the recovery of P300 from a previous stimulus, but increased CNV amplitude had no comparable

effect.

Another study which did not find a relationship to occur between P300 and CNV amplitudes was that of Friedman et al. (1973). Subjects were told which of two stimuli would occur next, or were required to guess. The relative probability of each stimulus in a trial block varied such that each occurred at 20, 40, 60, and 80% probabilities. A negative and monotonic relationship between stimulus probability and P300 occurred, with no consistent CNV relationship, although CNVs were large if the subjects had to guess what S2 would be.

It is important to note that these studies required the subjects to perform few higher order analytical processes. In certain recent papers, there are indications that higher order cognitive activities may result in an increase in P300 and a decrease in CNV amplitudes (though little correlation) and a different distribution on the scalp (Donchin et al. 1975).

Peters et al. (1976) found the CNV to decrease and the EP to increase during an anticipatory paired associates verbal learning paradigm. Similarly, Poon et al. (1976, see section on task difficulty), found that in the condition requiring a discriminative response to letter-pair stimuli, in contrast to the simple reaction time experiment, the CNV and the first negative wave of the evoked potential (N1) to S1 decreased, and the late positive components of the evoked potential to S2 (P2 and P3) increased. That is, there was a shift to greater positivity.

Poon et al. (1974) found greater amplitude P300s in a pattern learning experiment during acquisition than during over-learning (where the amount of cognitive processing could be assumed to decrease). Interestingly, the late positive component was larger in incorrect trials during acquisition, than in correct trials. This supports its relationship to cognitive processing, although the authors suggest that its relation is to certainty and immediate event outcomes. In this study there was also a suggestion of smaller CNVs and larger P300s with increased cognitive processing demands.

Results conflicting with the hypothesis that a positive relationship occurred between information processing load and P300 amplitude were reported by Roth et al. (1975, see previous section for outline of experimental paradigm). The amplitudes of P300 and the CNV decreased as the size of the target set increased.

In conclusion, CNV and EP amplitudes may be negatively correlated, but there is enough evidence of disassociation (eg. Donald and Goff, 1971) to conclude that that they are not reflecting the same processes or constructs. The pattern of results in tasks concerned with information processing is still unclear, yet suggestive of attenuation of the CNV and enhancement of P300 amplitude in tasks requiring significant information processing loads.

Moreover, it must be emphasized that the positivity or negativity of the CNV is measured against a baseline calculated from the average amplitude during a short (for example, one second) interval preceding S1. The CNV amplitude simply reflects the change in the record during the S1-S2 interval. However, as mentioned in the introduction, the CNV is held to be the summation of activity from a number of functionally independent and spatially distinct processes or generators. It is possible that CNV attenuation reflects, not decreased negativity, but increased positivity of these processes.

HEART RATE AS A MEASURE OF ATTENTION AND AROUSAL

In conjunction with the interest in relating the CNV to arousal, attention, distraction and information processing levels, these constructs have been investigated with respect to heart rate.

Arousal is, of course, the concept usually related to heart rate variations. Studies by Walter et al. (1964), Walter (1965) and McCallum and Walter (1968) found that an inverse relationship occurred between the CNV and autonomic function; that is, as the CNV developed into a stable response (decreased in amplitude variability), there was a decrease in general autonomic excitement as indicated by tachycardia, tachpnoea and GSR activity. In addition, chronic anxiety patients have lower CNV amplitudes and higher heart rate levels than normal subjects (McCallum and Walter, 1968).

Distraction has been shown (Tecce and Scheff, 1969; McCallum and Walter, 1968) to be associated with attenuated CNV amplitudes and increased heart rate, although this may be due to a positive relationship between distraction and arousal levels.

The majority of heart rate experiments in recent years have been concerned with orienting and attention. The heart rate is recorded, beat by beat, during the interval between two paired stimuli. A triphasic pattern typically occurs in the ISI: the rate decreasing, increasing, and decreasing again. The experiments have usually employed simple reaction time paradigms, although with a longer ISI (for example, four seconds) than CNV experiments. Strong heart rate decelerations, associated with strong CNV amplitudes and short reaction times have been reported by Godaert et al. (1973) and Lacey and Lacey (1970).

Klorman et al. (1975) outlined some parallels between CNV amplitude and cardiac deceleration in a reaction time task: late cardiac and CNV waves covaried across sessions, there was a parallel between early heart rate and early CNV habituation, and there was a parallel between late heart rate and late CNV development. The early components in both cases perhaps relate to orientation to external stimuli (see Borda, 1970).

In more complex tasks, cardiac deceleration has been found to occur preceding difficult perceptual discriminations (Gatchel and Lang, 1973; Wilson and Duerfeldt, 1967).

Lacey (1959) and Lacey et al. (1963) suggested that the direction of the cardiac response varied with perceptual set. Acceleration was related to rejection of environmental input (occasioned by noxious stimuli or mental work). Deceleration reflected sustained attention to external visual or auditory signals. This clearly parallels the hypothesized distinction between CNV enhancement and attenuation in studies of task difficulty. In a similar vein, Graham and Clifton (1966) suggested that acceleration reflected startle or defense reactions, whereas deceleration reflected orienting behavior.

Connor and Lang (1969) found that cortical negativity and the amplitude of the biphasic heart wave (the accelerative and decelerative components) were positively correlated, with the strongest relationship occurring in high intensity (in contrast to low intensity) stimulus and signal conditions. The authors interpreted the results as being inconsistent with any simple, directional interpretation of the relationship between heart rate and slow-wave cortical responses. Instead, they suggested that a number of relatively independent processes continuously occur, modifying both systems. They hypothesized that heart rate acceleration could reflect energy mobilization (Chase, Graham, and Graham, 1968) and deceleration a suspension of activity during attention (Obrist, 1968), while cortical negativity could reflect both.

The triphasic wave is superimposed upon the tonic heart rate level. Papakostopoulos and McCallum (1973) replicated both the tonic acceleration within conditions and the phasic deceleration within the ISI. The two components usually changed in opposite directions. Thus, the more difficult condition showed an increase in tonic heart rate and stronger deceleration in the phasic heart rate.

Thus, in general, attending to external stimuli appears to result in large decelerative heart rate change during the ISI. Mental work or arousal not involving perceptual analysis perhaps results in an accelerative component. (The latter conclusion is tenuous due to the small amount of data available.)

THE EXPERIMENT

It is evident that further studies investigating the CNV and P300 waveforms during complex information processing could clarify some of the issues. However, information processing is a term encompassing a number of activities including memory encoding and retrieval, decision making, perceptual analyses, and abstract processes such as arithmetic calculations.

The intent of this experiment was to define situations which required simple and complex information processing of a broad nature; that is, including storage into and recall from memory, preparation for and conclusion of a motor response, and higher order processing and decision making. Concurrent measures of arousal were taken to investigate the relationship of CNV and P300 amplitudes to arousal. The experiment was designed to habituate arousal in order to determine if relationships between EPs, including the CNV, were influenced by information processing load independent of arousal. Moreover, two levels of incentive were used, so that although the subject habituated to the situation, variations in variables associated with motivation and attention, in addition to alertness or arousal, might be controlled and any effects assessed.

It was hypothesized that a negative relationship existed between the CNV and P300 with respect to information processing load even after habituated arousal. It was expected that the CNV would decrease in negativity and P300 increase in positivity as the amount or level of information processing increased.

Second, it was hypothesized that the topographical distribution of the CNV would be affected by information processing load, becoming more parietally distributed in information processing tasks (as observed by Poon et al., 1974, 1976).

Third, it was hypothesized that neither the GSP nor the heart rate would show changes between the conditions representing three different levels of information processing after habituation of arousal. This would implicate information processing as a factor of major importance in determining the amplitude of the CNV, and eliminate the possibility that variations in arousal level were the determinant of CNV amplitude.

Fourth, it was expected that incentive level would show a positive relationship with CNV amplitude, and would show differences in CNV amplitude between high and low incentive subjects even after the habituation of arousal.

Fifth, reaction time of an undiscriminated response was expected to show an increase as a result of the additional mental activity accompanying increased processing complexity. This would reflect distraction from the reaction time task.

would reflect distraction from the reaction time task.

METHOD

SUBJECTS

The subjects were 4 males and 4 females, all right-handed, recruited from the university community. They ranged in age from 19-29 years. All subjects were naive with respect to the particular hypotheses under investigation. The subjects were each run on four different days, receiving $3.00 each day plus a bonus of $0.01 for each correct response on two of the four days, and a similar bonus of $0.15 on the other two days. One additional male and one female subject were run but their data discarded due to excessive artifact in the record.

RECORDING TECHNIQUES

Brain electrical activity (EEG) was recorded from Grass silver-silver-chloride electrodes placed at Fpz, Fz, Cz, and Pz sites in accordance with the International 10-20 system. Active electrode sites were referenced to linked mastoids. A ground electrode was placed on the subject's forehead. All electrode sites with the exception of the prefrontal ground site were thoroughly abraded with redux and cleansed with alcohol. The electrodes were affixed to the scalp with collodion impregnated gauze squares, and filled with EKG sol (Burton, Parsons and Co.).

Occular potentials (EOG), heart beats, and galvanic skin potential (GSP) were recorded from Beckman Biopotential electrodes filled with EKG scl and secured to the skin with double adhesive collars. All sites except the active GSP electrode were first abraded and cleansed as above. The EOG was recorded between the left infraorbital ridge and the outer canthus of the eye. Heart electrodes were placed left of the upper sternum, and referenced to the anterolateral lower rib area. GSP electrode sites were the palmar surface of the distal phalynx of the first and second fingers of the right hand (which received only gentle swabbing with an alcohol moistened cotton), and the anterior surface of the right forearm near the wrist (reference electrode).

Interelectrode impedances of the scalp electrodes did not exceed 2 K ohms, those of the EOG did not exceed 5 K ohms and those of the GSP and the heart did not exceed 20 K ohms.

Collection of GSP data utilized two very high impedance DC amplifiers constructed around OP-10 and OP-1 (Precision Monolithics) instrumentation operational amplifiers. The input impedance was 100 Giga ohms. The gain was set at unity with low and high filters set at dc and 100 Hz. (3 db point) settings. A manual offset control varied a voltage applied to the final amplifier stage rather than to the electrodes (+/- 999 mV).

Low and high filters were set at dc and 30 Hz. for the scalp and EOG electrodes, and at .03 seconds and 100 Hz. for the heart electrodes. Timing intervals were automated by a Grasson Stadler Series 1200 programmable logic system. A PDP-12 on-line program digitized and displayed each trial. The trial was then stored on magnetic tape for off-line analysis. Each trial consisted of a two second ISI, however the EEG was digitized for one second preceding and following each trial resulting in a total digitized interval of four seconds. Intertrial intervals were varied according to random variations between 10 and 50 seconds.

Stimuli consisted of single or double digit numbers (described below), clicks and pure tones. The tones were of 100 millisecond duration. The clicks were generated by a Grass S-4 stimulator at a rate of 15 per second. All auditory stimuli were delivered through speakers and were approximately 30 db in loudness at the subjects ear. The visual stimuli were visually presented on 35 millimeter slides which were back-projected on a frosted glass screen. A TV camera modified for tachistoscopic control and placed in front of the screen transmitted the image to a monitor which was placed approximately two meters in front of and above the subject. The visual stimulus exposure duration was 300 milliseconds.

Reaction time was recorded to the nearest millisecond using an EAI 6200 counter device driven by a Grass S-4 stimulator at a frequency of 1Khz. Reaction time was measured from the onset of S2 (which will be described later) in each trial and terminated by the subject's response. The subjects response was a button press. Response manipulandum was held in the left hand.

THE EXPERIMENTAL SESSION

An experimental session was defined as one days testing (for each subject). Each subject received four experimental sessions, on four separate days. Three conditions, designated STANDARD, EASY and DIFFICULT, were given to each subject on each day. Two blocks of trials of each condition were run, resulting in six possible orders of presentation as the STANDARD condition was always presented first and last. Each subject was run on four of the orders over four days, such that the condition following the first STANDARD condition was the EASY twice and the DIFFICULT twice. In addition, the number of times each condition was presented immediately following the first STANDARD condition was equal within subjects over days, across sexes on any one day, and across incentive conditions on any one day.

There were two levels of incentive, held constant for a subject on any one day. The subjects received each level of incentive once on days 1 or 2, and once on days 3 or 4. Given this restriction, only four possible orders of high and low incentive levels were possible. One subject of each sex was run on each of the four orders. A complete table of the incentive and stimulus conditions for all subjects may be found on page 110 in the appendices.

The independant variables were the level of information processing in three separate conditions, the incentive level, and the day of the experimental session. The dependent variables were the amplitude of the CNV (four measures), P300 and the EOG, the heart rate, and the variability of the GSP.

STANDARD CONDITION

The STANDARD condition was a standard fixed ISI CNV reaction time task. A tone preceded a series of clicks by two seconds. Subjects were instructed to press a button held in their left hand as quickly as possible following the onset of the 10 Hz. clicks; the response terminated the clicks.

Trials were aperiodicaly initiated, such that the ITI varied unpredictably from 10 to 50 seconds.

This STANDARD condition was always presented first and last in each experimental session. A total of 16 trials were collected.

EASY CONDITION

In this condition an arithmetic task was superimposed on the simple reaction time task. Four numbers (A, B, C and D) were visually presented, one at a time. The A-B and B-C intervals varied randomly from 2 to 8 seconds. The C-D interval was fixed at 2 seconds and superimposed on the tone and clicks, respectively.

The numbers were unpredictable one digit numbers between 1 and 9. Stimuli A and B were presented first in a trial. C was presented simultaneously with the tone, and D simultaneously with the onset of the clicks. Subjects were instructed to add A to C and B to D, and to report the sums at the end of the trial. They were also required to press the button at the occurrence of D. This sequence of presentations constituted one trial.

After S2 a variable interval between 10 and 50 seconds ocurred before presentation of A for the next trial. A total of 16 trials were collected in this condition.

DIFFICULT CONDITION

This condition was exactly the same as the EASY condition with the following exception: two digit numbers from 11 to 19, rather than one digit, were presented.

INCENTIVE CONDITIONS

Two levels of incentive were used, each remained constant within days. On high incentive days the subjects were paid $0.15 for each correct response in the EASY or DIFFICULT condition trials, including those trials rejected due to excessive eye movement. On low incentive days $0.01 was paid for a correct response. A correct response required both sums to be correct and in addition the button press response must have occurred within 500 milliseconds of S2 (as a slower reaction time would have indicated inattention to the experimental task). All subjects were informed of these criteria.

PROCEDURE

During the experimental session the subject reclined on a hospital bed located in an electrically shielded, sound attenuated cubicle (Bell-Croft Industries). The subject's position was adjusted for viewing a closed circuit TV monitor. A 5 millimeter diameter black dot in the center of the screen served as a fixation point. The subject was continuously monitored via closed circuit TV. A 5-10 minute period following the subject's placement in the cubicle allowed for electrode balancing and the subject's adjustment to the situation.

In session 1 the subject was first given instructions for the STANDARD stimulus condition. The subject was asked to relax face and neck muscles and to refrain from blinking during the trial, if possible. The experimenter then answered any questions. Two practice sessions (the second was recorded) and the first STANDARD condition were run. Five minutes rest period occurred between each condition which allowed feedback to the subject following the practice session. After the STANDARD condition instructions for either the EASY or the DIFFICULT condition were given, depending on the order of conditions for that subject on day 1. The subject was informed that the intercom in the cubicle was always on, and that she/he need only softly verbalize the sums to be heard by the experimenter.

Following a question period, a short practice session was allowed in order to insure familiarity of the subject with the requirements of the conditions. Before the first run of the other condition (EASY or DIFFICULT) on the first day a practice run was also allowed. When two EASY and two DIFFICULT conditions had been completed, another STANDARD condition was run.

With the exception of the order of stimulus conditions, the level of incentive used, and the omission of the practice runs, the procedure on the next three days was identical.

RESULTS

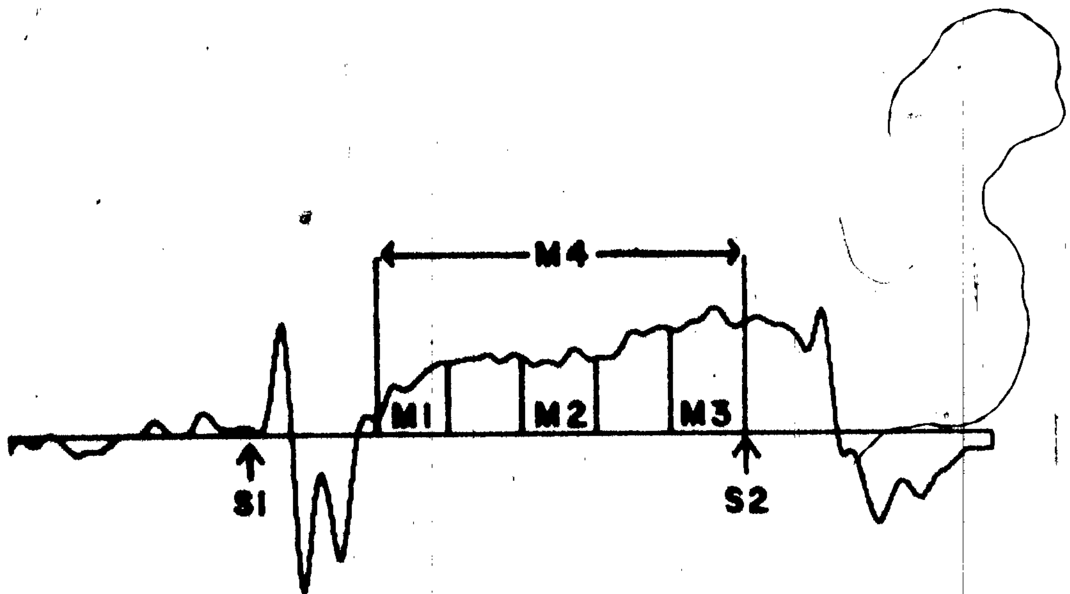
All data were quantified and studied with analyses of variance. Single trial data were used. The first two days and last two days made up two blocks of data. Within these blocks, each subject had been run at the two levels of incentive on consecutive days. Therefore subjects were nested within a blocks by incentive by order interaction. All other effects were crossed.

Single ANOVAs were used for the heart rate, reaction time, GSP and EEG results. The results for the CNV and P300 measures were analysed separately for each block of days. Four measures were taken from different areas of the CNV waveform (described below). These were analysed separately.

All references to significance refer to the .05 level. The Tukey B test was used to analyse differences between means.

CNV RESULTS

Four different area measurements were performed on the CNV waveform (see Figure 1). Measure 1 is the area 0.5 to 0.8 seconds after S1. Measure 2, (the middle of the CNV waveform), is the area from 1.1 to 1.4 seconds after S1. Measure 3 represents the area within the 300 milliseconds preceding S2 (measured from 1.7 to 2.0 seconds after S1). Measure 4 includes the total area from 500 milliseconds after S1 to S2.



MEASURE 1: 500-800 msec. post S1

MEASURE 2: 1100-1400 msec. post S1

MEASURE 3: 300 msec. pre-S2

MEASURE 4: 500 msec. post S1-S2

FIGURE 1 - CNV MEASURES

(a) CNV RESULTS FOR THE FIRST BLOCK OF DAYS

All CNV measures show significant recording site effects. However, the patterns of amplitude variations from different sites vary and higher order interactions with respect to sites typically occur.

For measure 1 (F 3,12 = 14.55), the activity at Fpz is significantly smaller than that at Fz and Cz, and larger than that at Pz. For the other measures the electrode activity shifts to a more clearly central distribution. For measure 2 (F 3,12 = 35.49), central activity predominates: Cz > Fz > Pz > Fpz. Measure 3 (F 3,12 = 27.00) shows a relative increase in parietal and decrease in frontal activity such that, while Cz and Fpz are still significantly the largest and smallest, Pz is significantly more negative than Fz. Measure 4 (F 3,12 = 24.90), in effect averaging the measures, shows the same pattern as measure 2.

The graphs of these results shown in Figure 2 suggest that the sites of largest CNV amplitude moved in a posterior direction over time within the CNV interval.

Only measure 1 does not show higher order electrode site effects. All other measures show electrode by information processing interactions (in addition to other interactions described below). For measure 2 (F 6,24 = 3.34) the pattern of electrode activity clearly differs in the STANDARD condition (see Figure 3a) from the EASY or DIFFICULT conditions. First, the STANDARD condition shows clear and significant ordering of

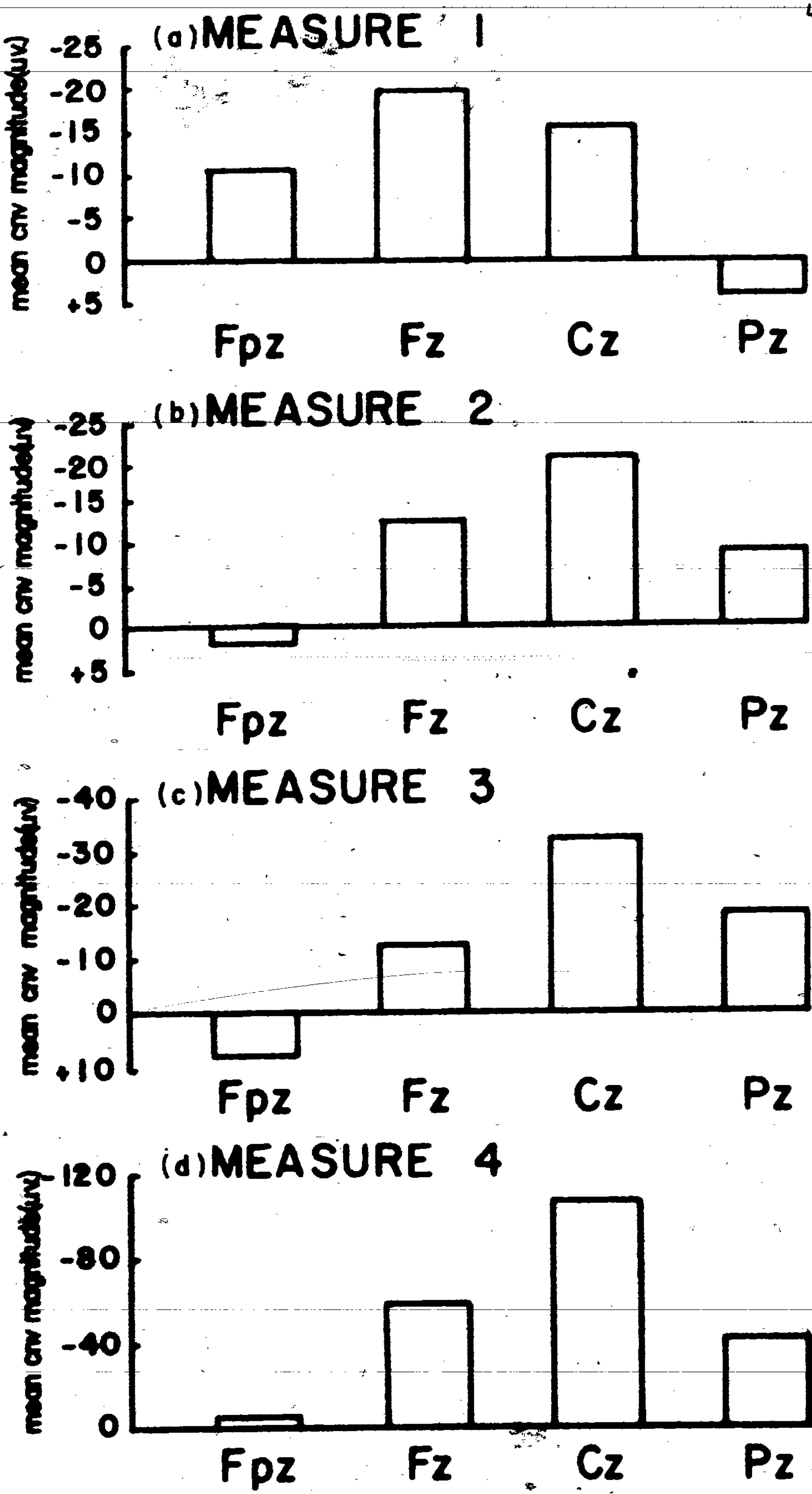


FIGURE 2 - CNV DAYS 1 & 2 - SIGNIFICANT ELECTRODE SITE MAIN EFFECT

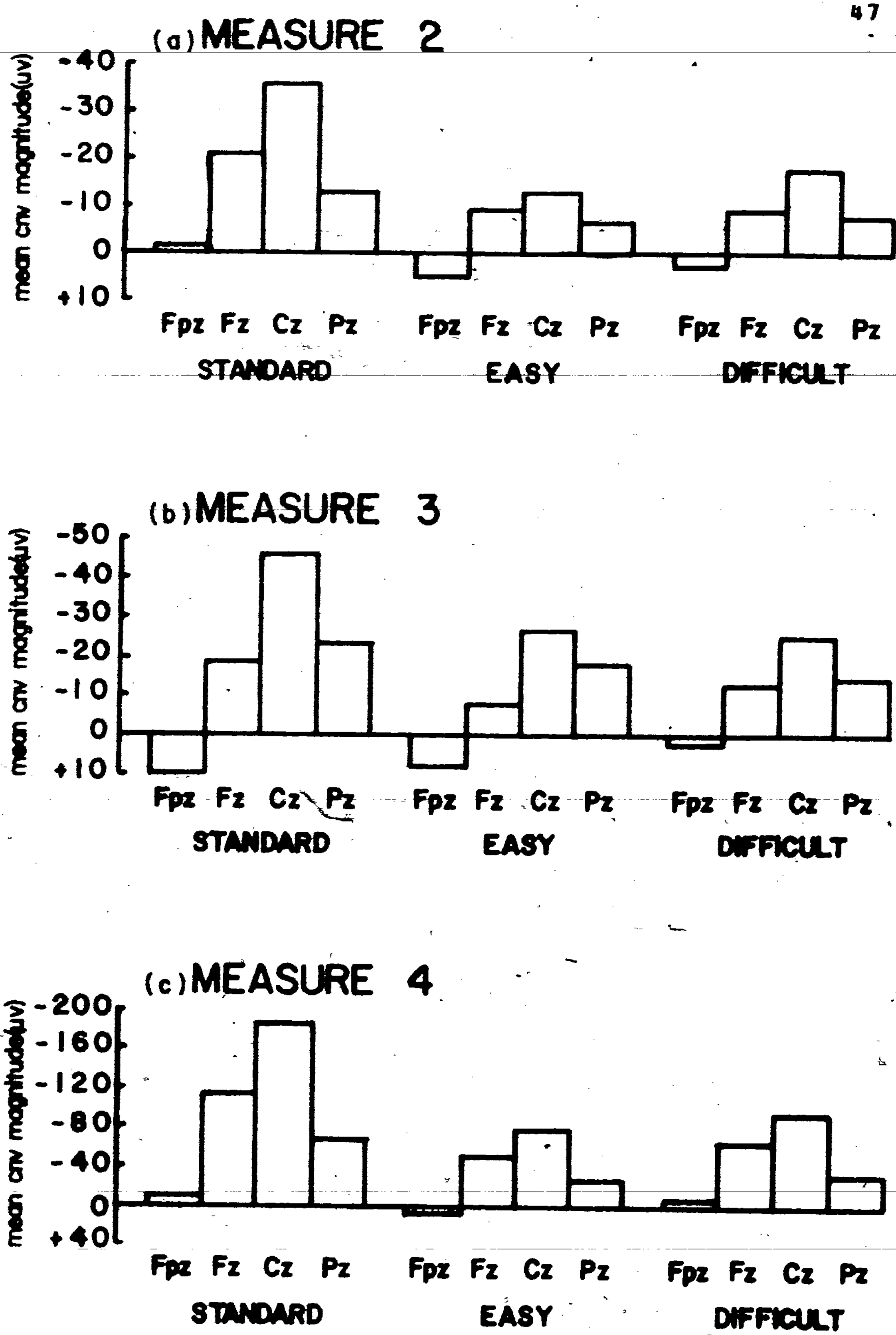


FIGURE 3- CNV DAYS 1&2 - SIGNIFICANT ELECTRODE SITE BY INFORMATION PROCESSING INTERACTION

electrode activity (reflecting the pattern in the electrode site main effect), whereas in the other conditions the only differences that occur are amplitude differences between Cz and all other electrode sites, Cz being more negative. Second, for Pz and Cz electrode sites the negativity in the STANDARD condition is significantly larger than in the EASY or DIFFICULT conditions. At Pz the STANDARD condition is significantly more negative than the EASY condition. Therefore, activity in the middle part of the CNV waveform tends to be larger and more variable across electrode sites in the STANDARD condition than in the EASY and DIFFICULT conditions.

For measure 3 ($F_{6,24} = 3.46$) CNV amplitude in the STANDARD condition again tends to be largest, it is significantly more positive than the DIFFICULT condition at Fpz, more negative than the EASY condition at Fz, more negative than both EASY and DIFFICULT conditions at Cz, and more negative than the DIFFICULT condition at Pz (see Figure 3b). Within each of the three information processing conditions, the ordering of electrode site means remains the same, and Cz is always significantly larger than the other sites. However, significant differences in patternings between Fpz, Fz and Pz exist. In the STANDARD and DIFFICULT conditions, Fpz is significantly smaller than Pz and Fz. In the EASY condition, Pz is significantly larger than both Fpz and Fz.

For measure 4 ($F_{6,24} = 4.15$), as in measure 3, the electrode sites show similar patterns of significant differences

(Cz > Fz > Pz > Fpz) for the STANDARD and DIFFICULT conditions. However, there is a different pattern for the EASY condition; Cz is still larger than Fz but the difference does not achieve significance. (See Figure 3c.) Amplitudes are significantly more negative in the STANDARD than in the EASY and DIFFICULT conditions for all electrode sites except Fpz (which shows no information processing level effects).

In this CNV interval (measure 4) the information processing main effect ($F_{2,8} = 4.92$) is significant; the STANDARD condition has significantly larger negative activity than the EASY and DIFFICULT conditions (see Figure 4b). The CNV amplitude in the EASY and DIFFICULT conditions does not significantly differ.

The information processing main effect was also significant for measure 1 ($F_{2,8} = 11.60$), where all differences are significant (see Figure 4a) and in the hypothesized direction.

A significant ($F_{3,12} = 8.50$) electrode by order (of incentive) effect occurs for measure 2. Analysis shows that this is due to significantly larger activity at all electrode sites for the group that received first low and then high incentive days (see Figure 5a). This group was designated the "LOW-HIGH" group. The HIGH-LOW group (that is, the group which received the high incentive reward on day 1 and the low incentive reward on day 2) had largest CNV activity at the Cz electrode site, then, in descending order, Fz, and Pz and Fpz sites (the latter two were not significantly different). For the LOW-HIGH group, Cz > Pz Fz > Fpz.

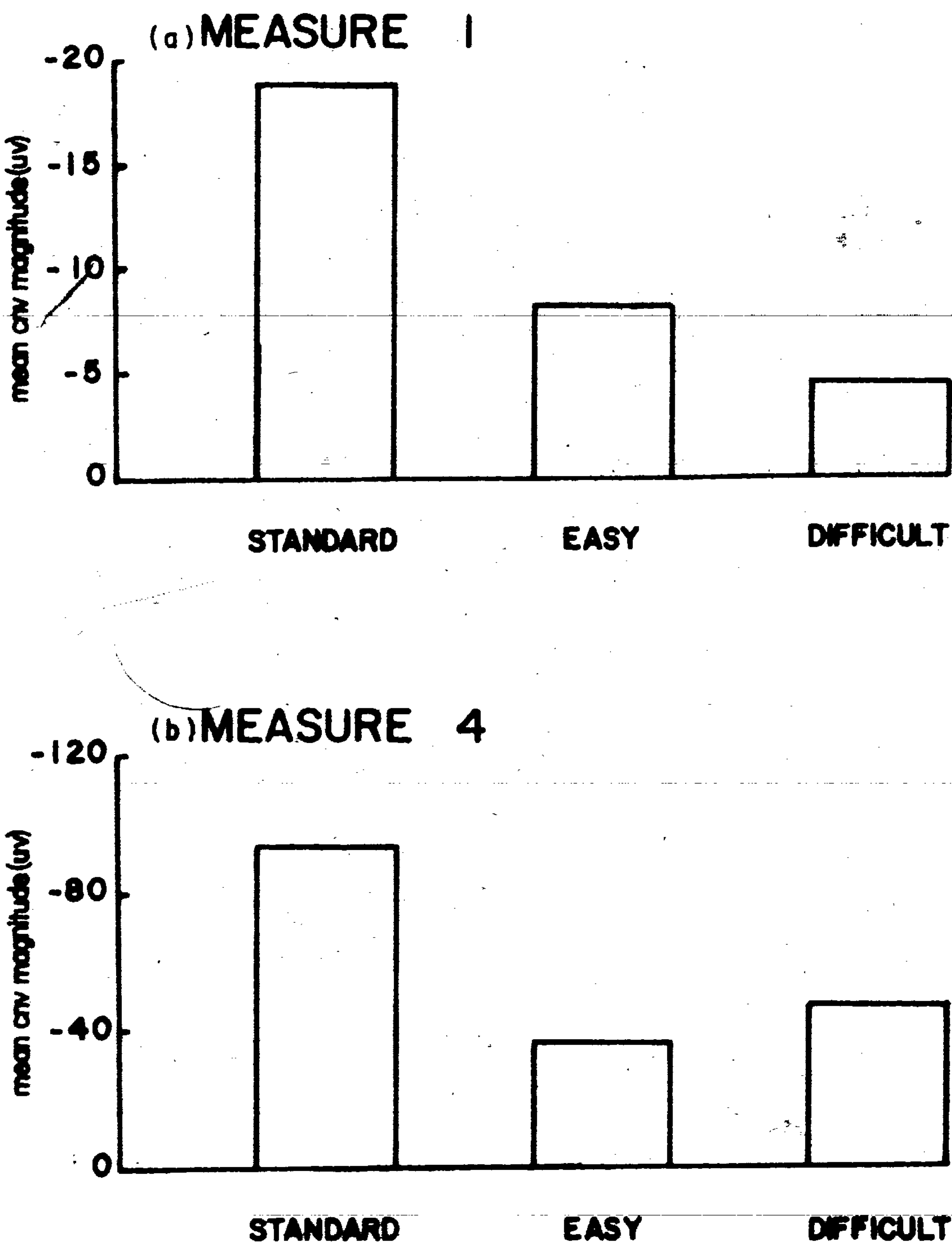


FIGURE 4- CNV DAYS 1&2 - SIGNIFICANT INFORMATION PROCESSING MAIN EFFECT

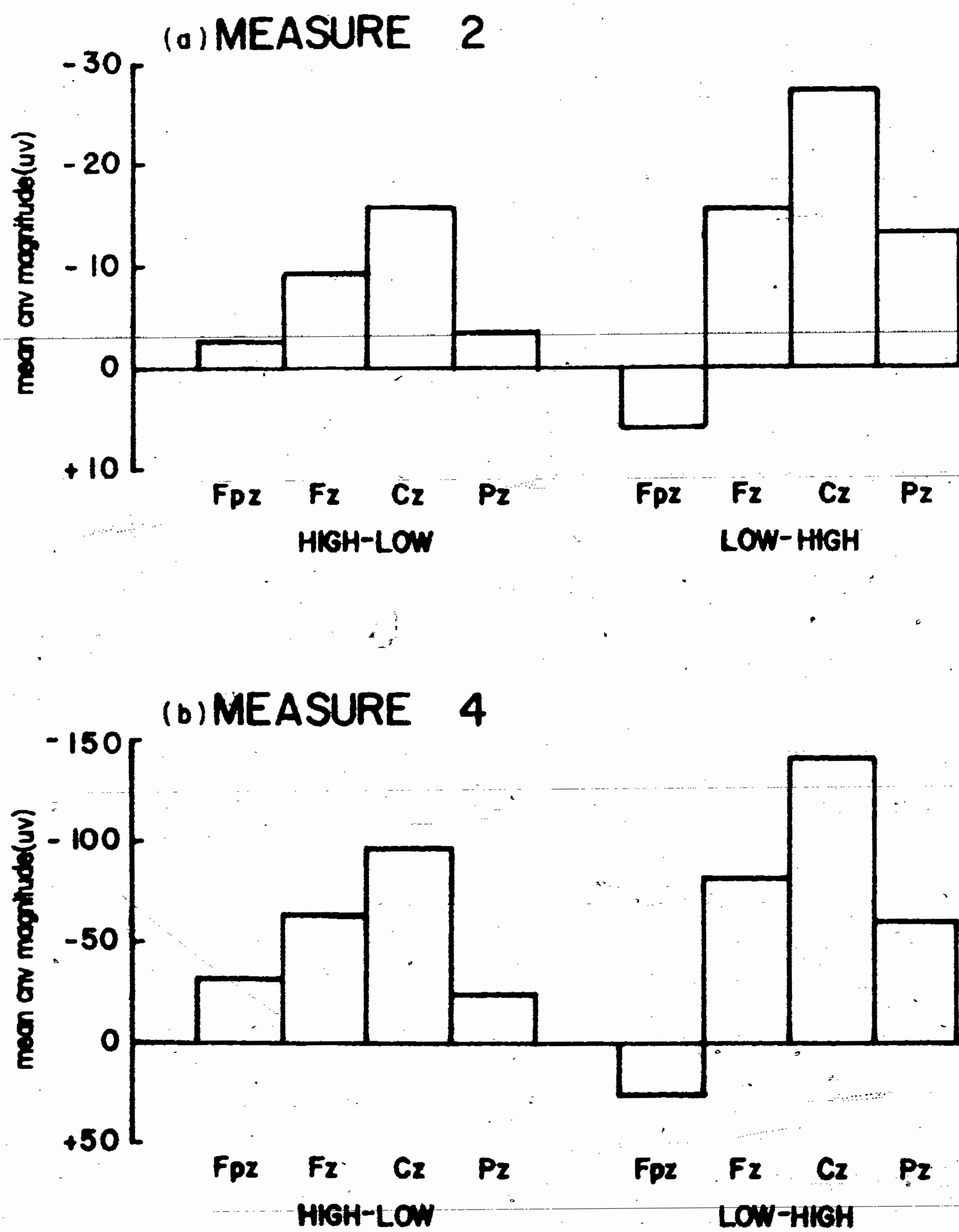


FIGURE 5 - CNV DAYS 1&2 - SIGNIFICANT ELECTRODE SITE BY INCENTIVE ORDER INTERACTION

An order by electrode effect ($F_{3,12} = 5.50$) also occurred for measure 4 (see Figure 5b). The LOW-HIGH group had significant increases in Cz and Pz negativity over the HIGH-LOW group. For the HIGH-LOW group, Cz Fz > Pz Fpz. For the LOW-HIGH group, Cz > Fz Pz > Fpz.

Measure 2 shows a significant sex by electrode interaction ($F_{3,12} = 5.24$). Cz was always largest for both sexes; for the females Pz was significantly smaller than Fz, and not significantly different from Fpz; for the males, Fz and Pz are significantly larger than Fpz and significantly smaller than Cz. Fpz is significantly more positive for males, and Cz more negative (Figure 6).

Finally, for measures 2, 3 and 4 significant incentive by order by sex interactions occur, in conjunction with lower level interactions. Interpretation of the higher order interactions (as described below) result in the conclusion that electrode activity decreases over days 1 and 2 for females and electrode activity for males is always greatest for the high incentive subjects. This may be clearly seen in Figure 7.

For measure 2, an incentive effect ($F_{1,4} = 18.08$) reveals high incentive conditions to result in more negativity than low incentive conditions (Figure 8a).

An incentive by order (of incentive) effect ($F_{1,4} = 46.54$) shows that CNV amplitude decreases in negativity for both the LOW-HIGH and HIGH-LOW groups between days 1 and 2, but high incentive subjects on day 2 have greater electrode negativity

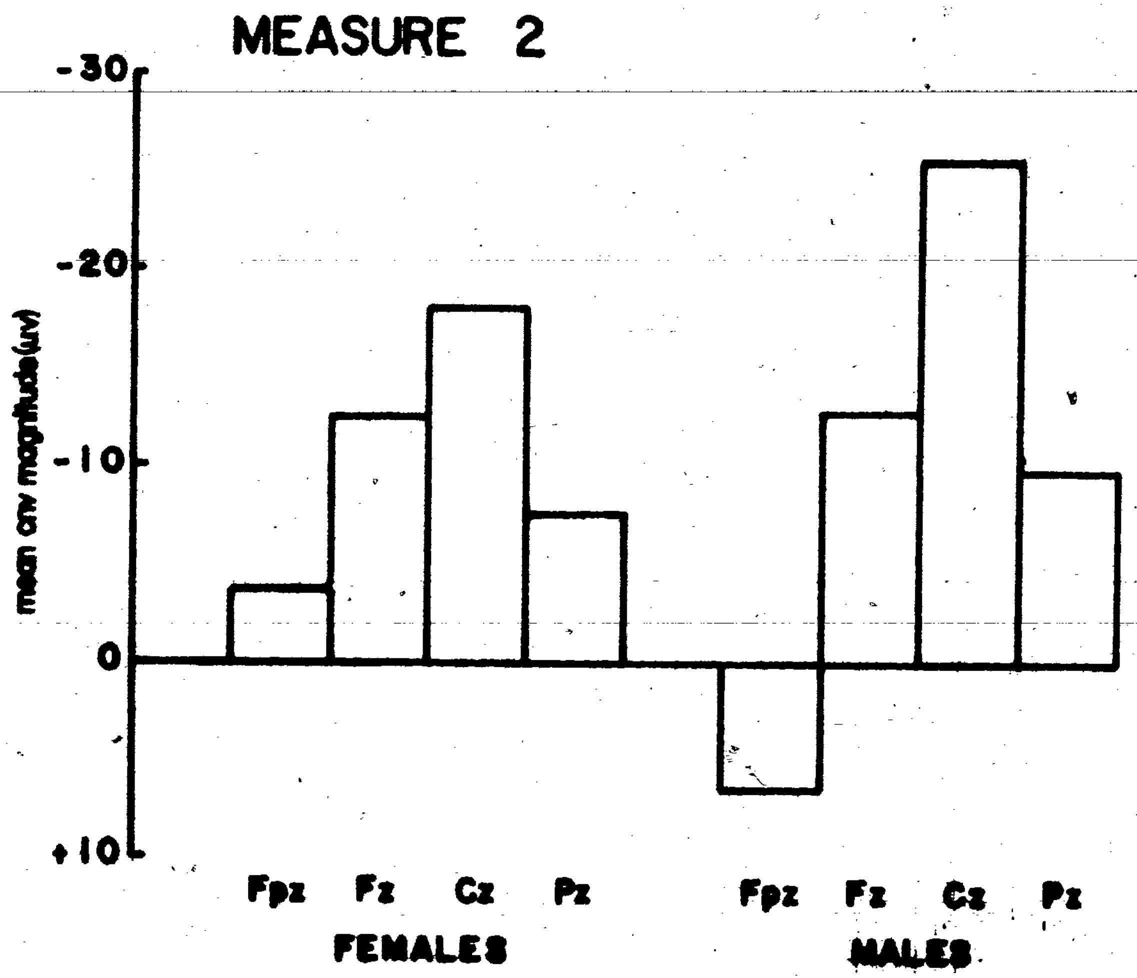


FIGURE 6- CNV DAYS 1&2 - SIGNIFICANT ELECTRODE SITE BY SEX INTERACTION

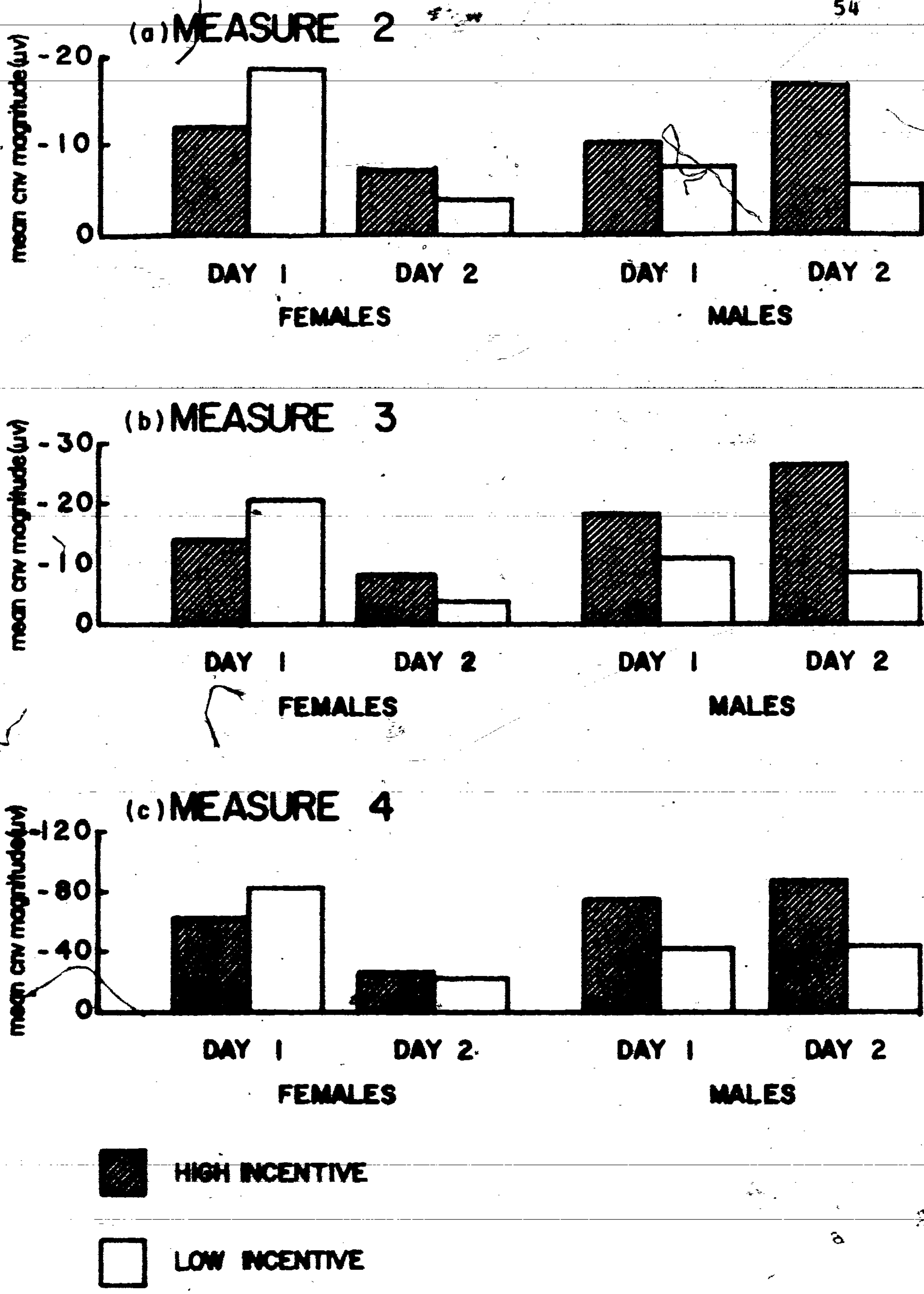


FIGURE 7 - CNV DAYS 1&2 - SIGNIFICANT INCENTIVE BY INCENTIVE ORDER BY SEX INTERACTION

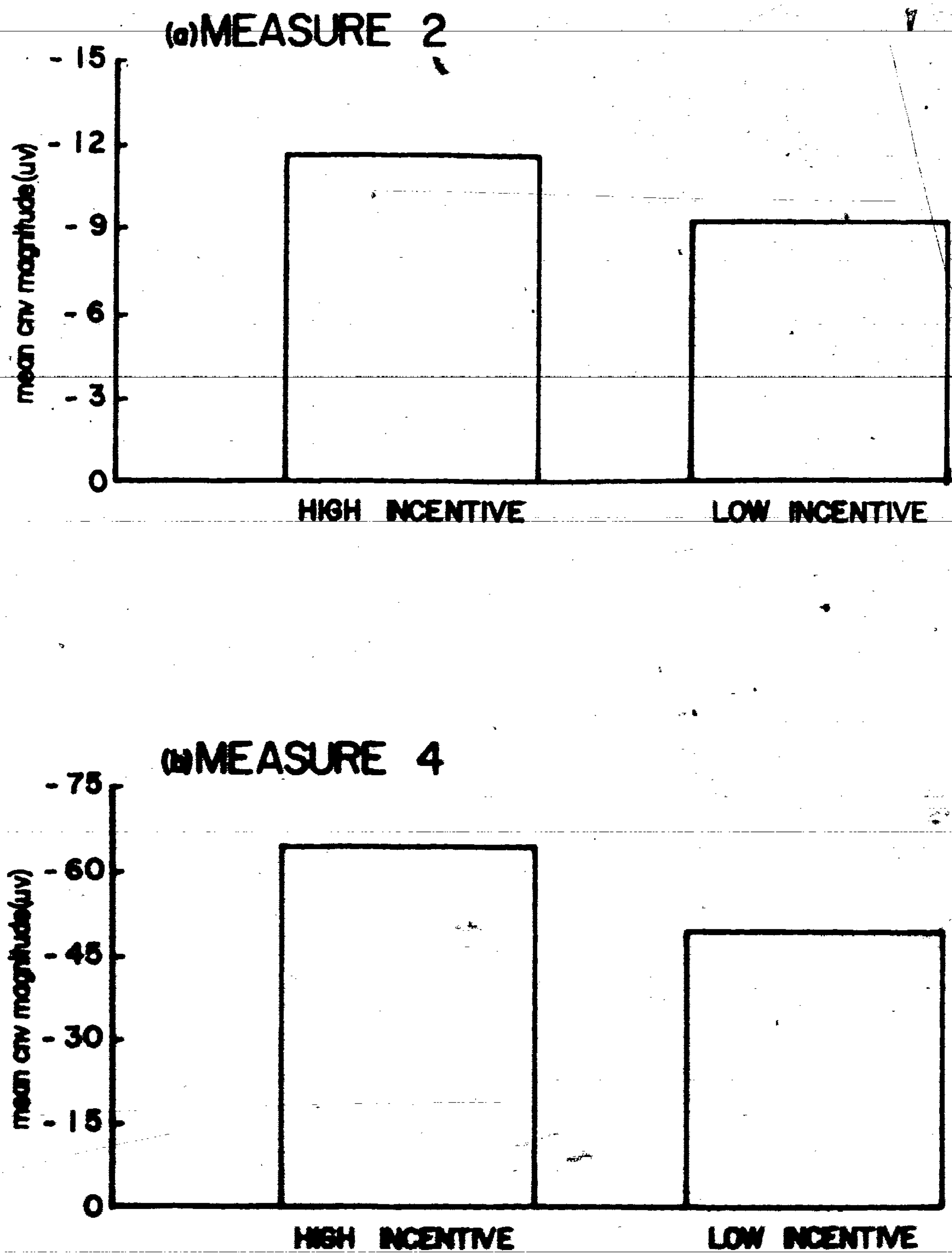


FIGURE 8- CNV DAYS 1&2- SIGNIFICANT INCENTIVE MAIN EFFECT

than low incentive subjects on day 2 (see Figure 9a). In adddition, day 2 activity (the HIGH-LOW group) was smaller than day 1 activity (the LOW-HIGH group) for the low incentive condtions.

Furthermore, a sex by incentive effect (F 1,4 = 59.98) shows that the mean CNV amplitudes are, in descending order: male high incentive subjects, female low incentive subjects, female high incentive subjects, and male low incentive subjects (all differences being significant). Male subjects show increased aplitude with increased incentive level. Female subjects show decreased amplitude with increased incentive level. Therefore, the effect of incentive is oppcsite for males and females (see Figure 10a).

The sex by incentive by order (of incentive) effect (F 1,4 = 130.34) shows that for females day 1 activity is larger than day 2 activity. Incentive levels show no significant differences for the female subjects. For males, high incentive subjects show greater negativity than low incentive subjects, with high incentive day 2 subjects showing the greatest negativity (Figure 7a).

Additional significant differences in this interaction are: female low incentive subjects on day 2 show smaller activity than all male subjects; female low incentive subjects on day 1 show larger activity than all male subjects; female high incentive subjects on day 1 show significantly smaller activity than male high incentive subjects on day 2, and larger activity than male

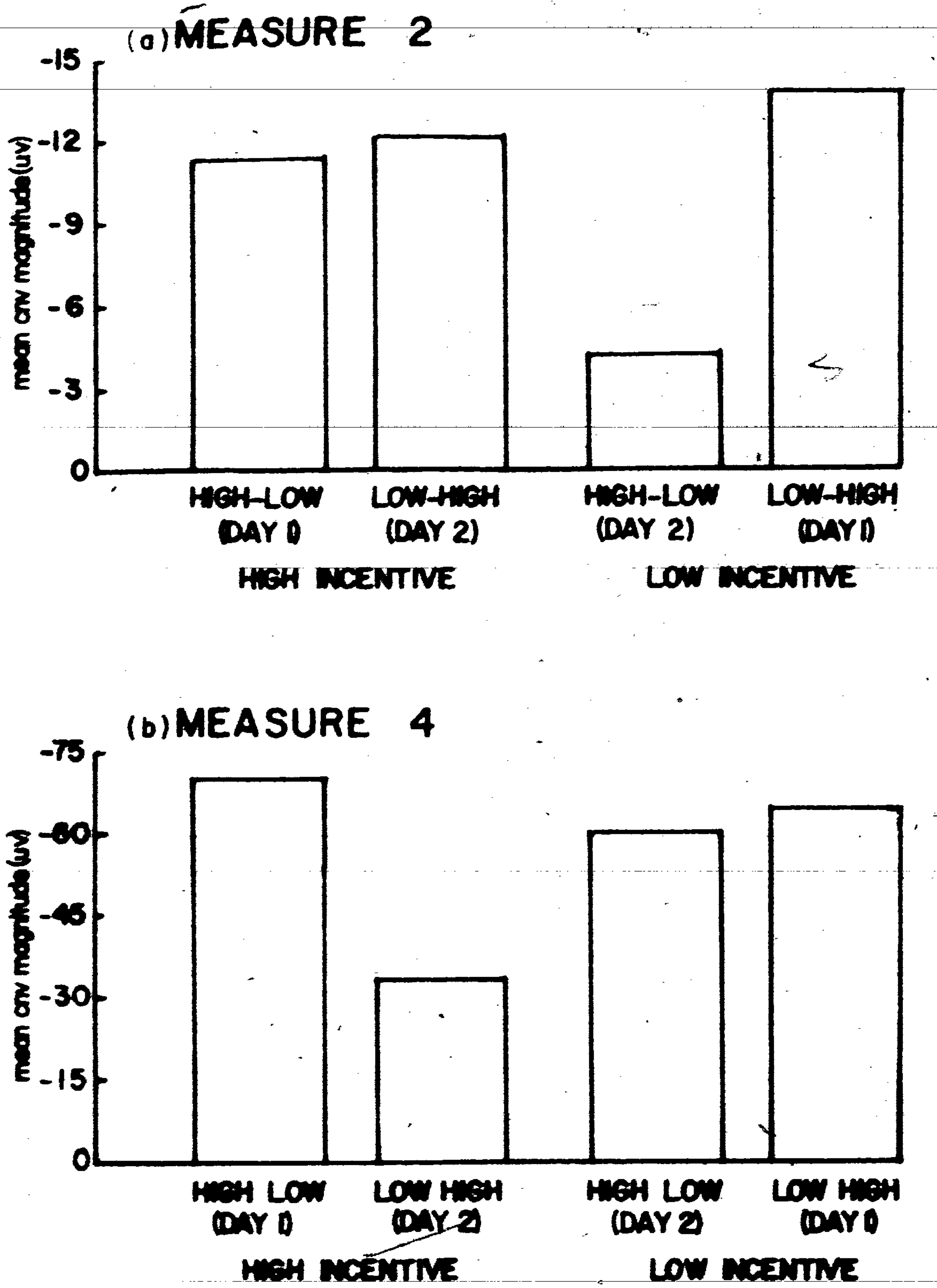


FIGURE 9- CNV DAYS 1&2- SIGNIFICANT INCENTIVE BY INCENTIVE ORDER INTERACTION

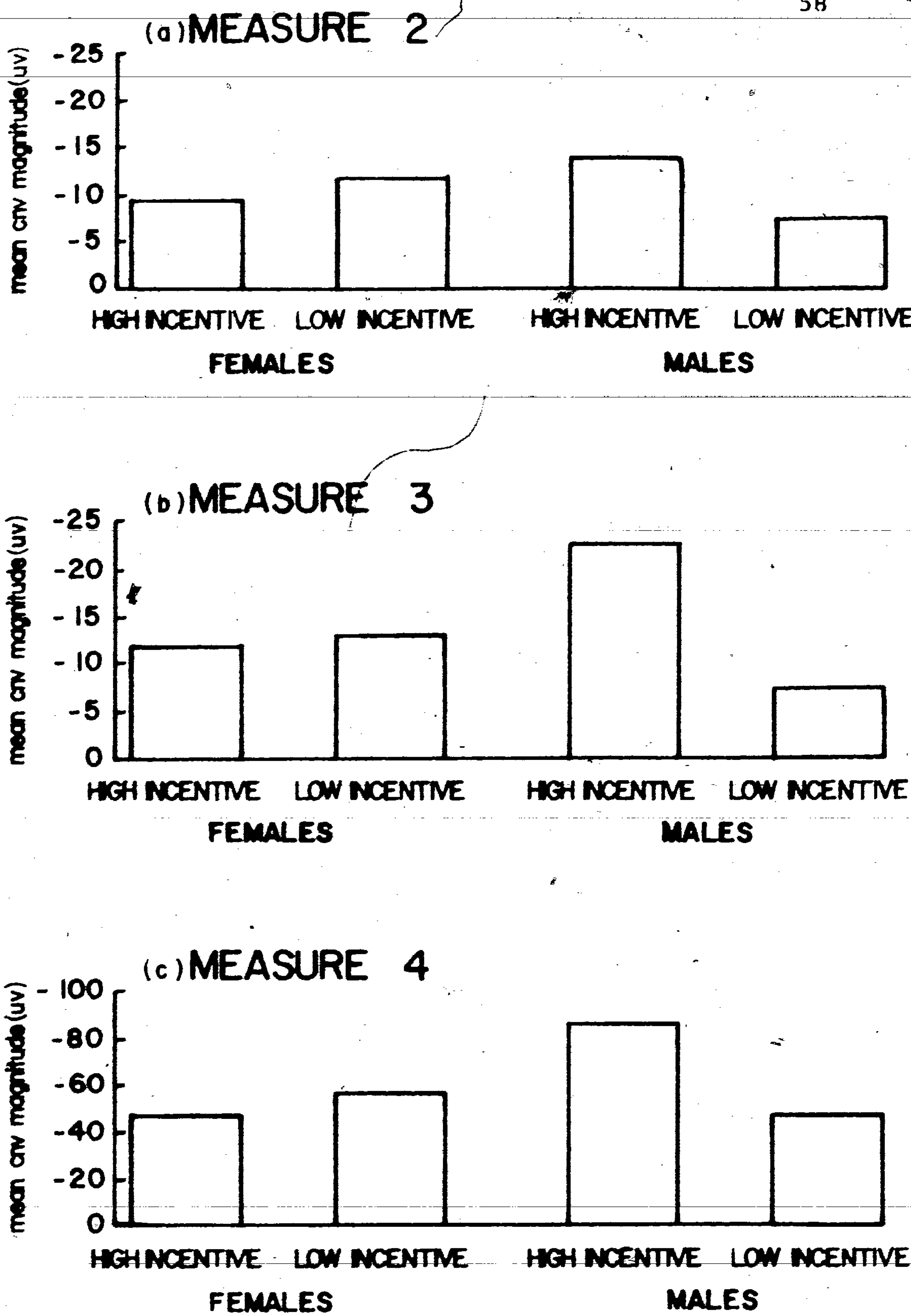


FIGURE 10 - CNV DAYS 1&2 - SIGNIFICANT INCENTIVE BY SEX INTERACTION

low incentive subjects; female high incentive subjects on day 2 show significantly smaller activity that all high incentive males.

For measure 3, a significant sex by incentive interaction (F 1,4 = 10.65) shows that high incentive males show more negativity than low incentive males while, again, the females show no incentive effect whatsoever (Figure 10b, the male high incentive subjects show significantly larger activity than all other subjects). The sex by incentive by order effect (F 1,4 = 10.69), however, shows that electrode activity is always smaller for females on the second day (whether with respect to the same subjects over days or incentive levels). Again, males show an incentive effect with the values for the high incentive subjects larger than for the low incentive subjects and larger on day 2 than on day 1 (Figure 7b). Additionally, male low incentive subjects show significantly smaller activity than female low incentive subjects on day 1; male high incentive subjects on day 1 show significantly greater activity than all female subjects with the exception of the low incentive subjects on day 1; and male high incentive subjects on day 2 show significantly greater activity than all female subjects on day 2.

Measure 4 shows incentive (F 1,4 = 15.21), incentive by order (F 1,4 = 27.65), incentive by sex (F 1,4 = 42.88), incentive by order by sex (F 1,4 = 51.41) and incentive by order by sex by information processing (F 2,8 = 5.18) effects (Figures 8b, 9b, 10c, 7c and 11, respectively.) The final interaction is

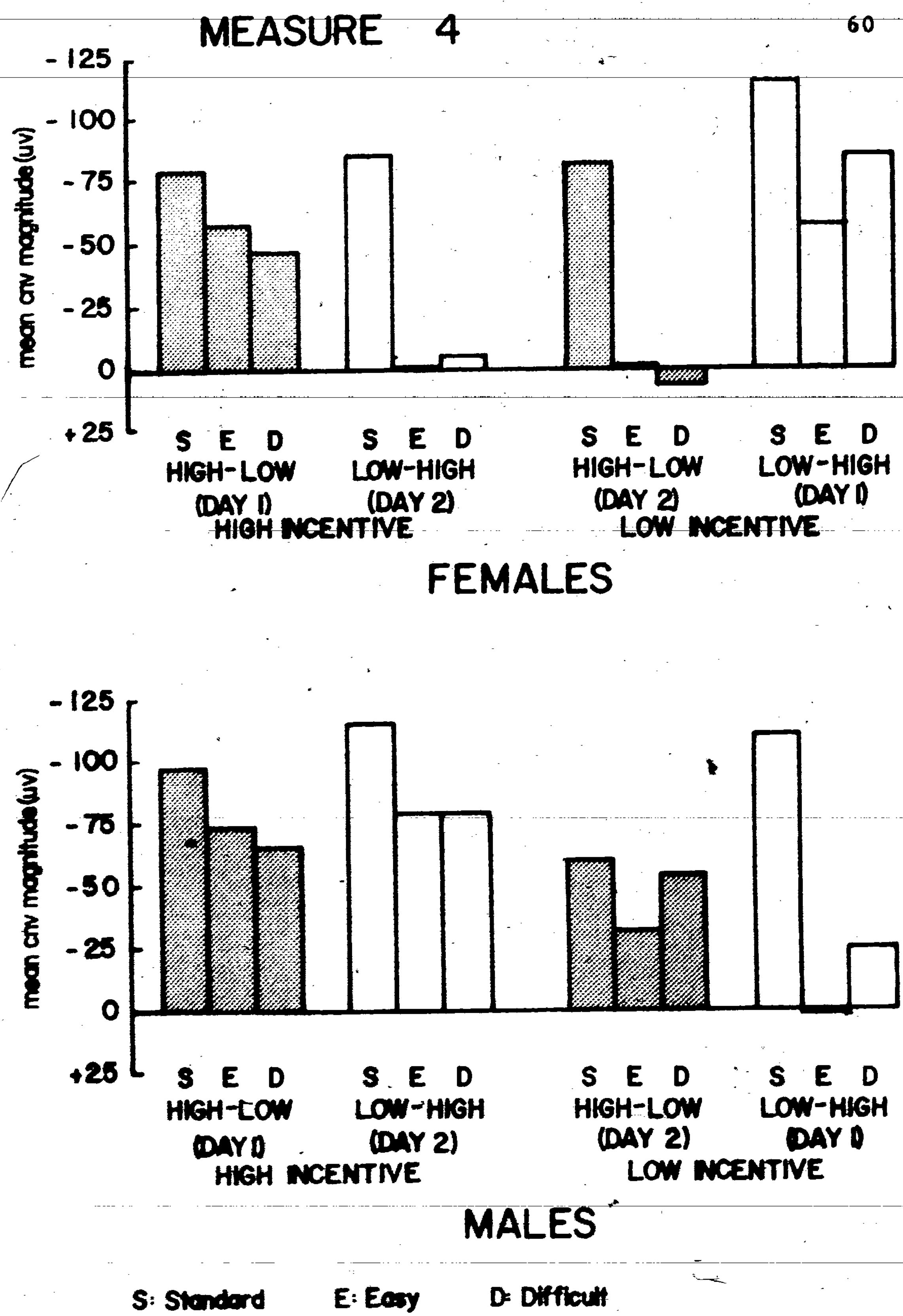


FIGURE 11- CNV DAYS 1&2- SIGNIFICANT INCENTIVE BY INCENTIVE ORDER BY SEX BY INFORMATION PROCESSING INTERACTION

very complex, showing that the above generalities with respect to male and female activity are for the most part correct.

CNV amplitudes are larger for high incentive than low incentive subjects. The incentive by order interaction shows significant decreases in CNV amplitude between days 1 and 2 for the LOW-HIGH and HIGH-LOW groups, and smaller activity for the high incentive than the low incentive subjects on day 2. However, the sex by incentive interaction reveals that high incentive subjects show larger activity only for the male subjects; for the female subjects CNV amplitude is significantly larger for the low incentive subjects.

The incentive by order by sex interaction shows that, while for male subjects significantly larger amplitudes occur for the high incentive subjects, for female subjects the CNV amplitude decreases significantly between days 1 and 2.

In addition, male high incentive subjects on day 1 show significantly larger activity than females on day 2; and male high incentive subjects on day 2 show significantly larger activity than all female subjects with the exception of the female low incentive subjects on day 1. The male low incentive subjects show significantly larger activity than the female subjects on day 2, and significantly smaller activity than the female subjects on day 1.

The information processing by sex by order by incentive interaction shows that the STANDARD condition is significantly larger than the EASY and DIFFICULT conditions for all females on day 2, but only for high incentive males on day 2 and low incentive males on day 1.

The low incentive females on day 1 have significantly larger negativity in the STANDARD than the EASY condition. High incentive results are more negative for the males EASY and DIFFICULT conditions on day 1, and for the males STANDARD and EASY conditions on day 2. The opposite relationship, low incentive results being larger than those of high incentive subjects, occurs for females in the STANDARD and DIFFICULT conditions on day 1.

Female results show decreases in activity over days, except for the high incentive STANDARD conditions, and the STANDARD condition for the HIGH-LOW group. The male results show decreases over days between low incentive subjects for the STANDARD condition, and for the EASY condition for the LOW-HIGH group. The males in the LOW-HIGH group showed increased negativity on day 2 for the EASY and DIFFICULT conditions.

Therefore, females show clearer information processing effects than males, especially on day 2, and males tend to show effects of the incentive levels. Females show a stronger general decrease in CNV amplitude over days than males.

(b) CNV RESULTS FOR THE SECOND BLOCK OF DAYS

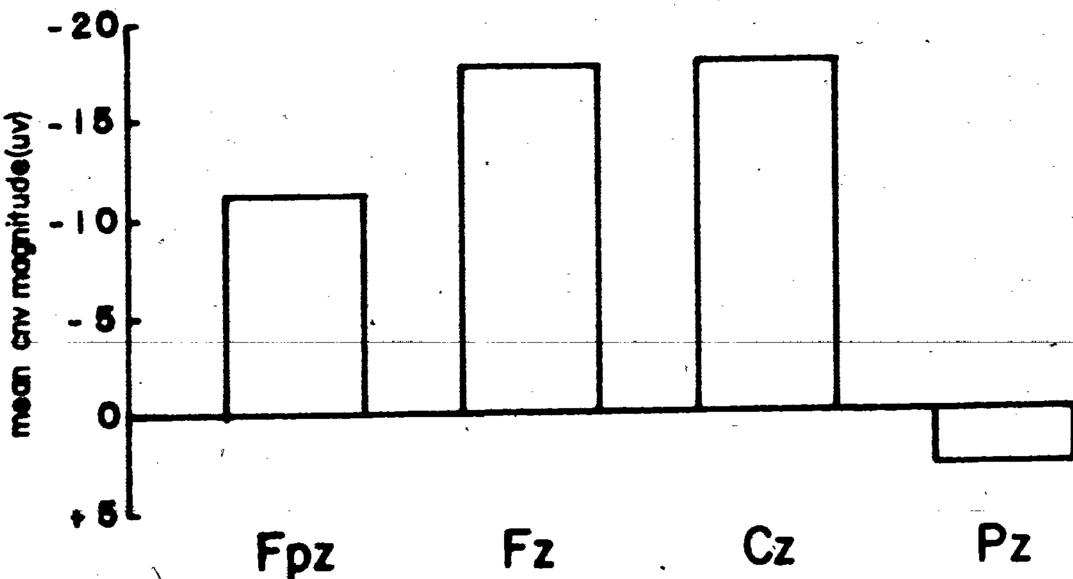
Again, electrode main effects occur for all measures. For measure 1, Pz Cz > Fpz > Pz. For measure 2 and 3, Cz > Pz Pz >

Fpz. For measure 4, Cz > Fz > Pz > Fpz.

Measure 1 shows significant electrode site ($F_{3,12} = 8.57$), information processing ($F_{6,24} = 7.12$), electrode by information processing ($F_{2,8} = 4.68$), and sex by information processing ($F_{6,24} = 5.86$) effects (see Figures 12a, 12b, 13a and 13b, respectively). Thus, overall, Cz and Fz are significantly larger than Fpz, which is significantly larger than Pz. Analysis of the main information processing effect reveals all differences to be significant and in the hypothesized direction. Furthermore, the information processing by electrode site interaction allows inspection of the information processing effect at each electrode site. At Fz, Cz and Pz electrode sites there is a decrease in negativity of CNV amplitude as information processing load increases, but only the difference between the STANDARD and DIFFICULT conditions at Cz is significant. In the STANDARD condition, activity is significantly greater at Cz than at Pz, with Fz and Fpz showing intermediate levels. In the EASY and DIFFICULT conditions, however, negativity is largest at Fz and significantly greater than Pz, with Cz and Fpz intermediate.

The sex by information processing effect reveals that the information processing effect is only significant for females. For them, activity decreases significantly in negativity from the STANDARD to EASY to DIFFICULT conditions. Between the males and females, higher negativity occurs for females in the STANDARD condition and for males in the DIFFICULT condition (see Figure 13b). For the male subjects, mean CNV magnitudes in all three

(a) SIGNIFICANT ELECTRODE SITE MAIN EFFECT



(b) SIGNIFICANT INFORMATION PROCESSING MAIN EFFECT

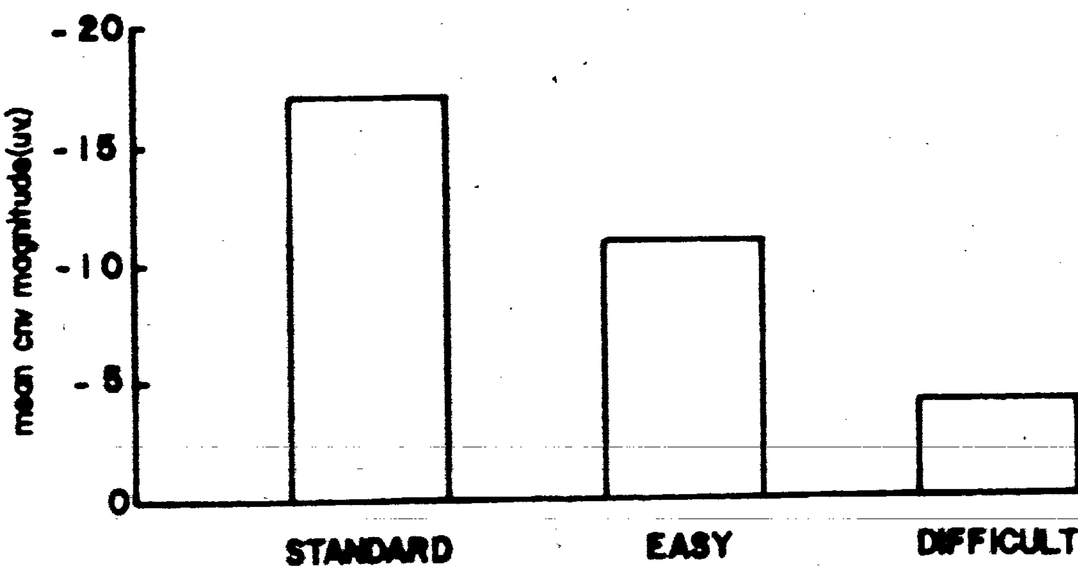
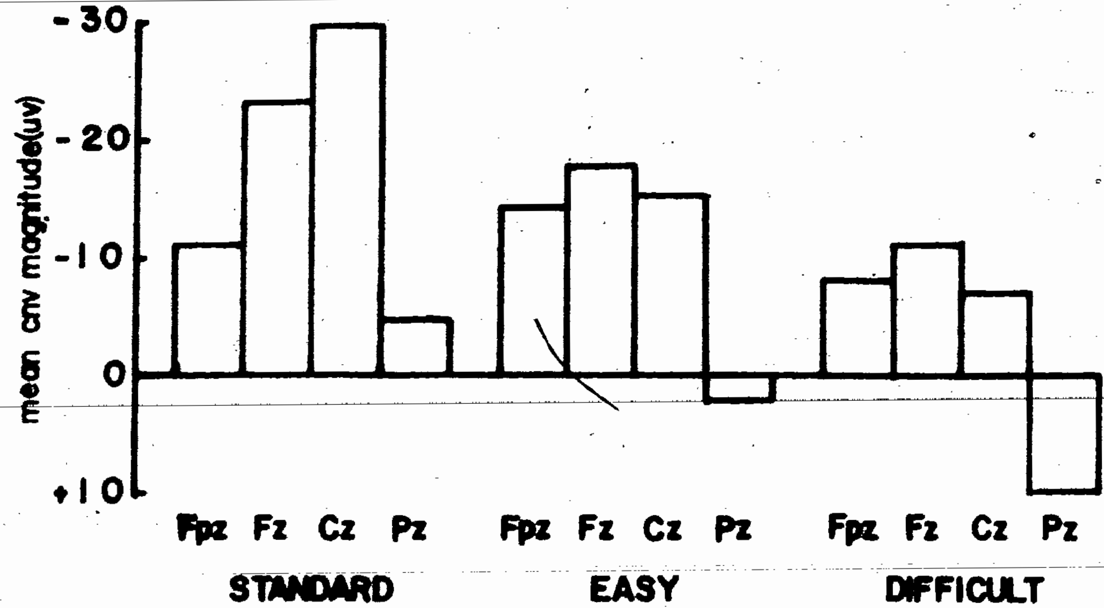


FIGURE 12 - CNV DAYS 3 & 4 - MEASURE 1

(a) SIGNIFICANT INFORMATION PROCESSING BY ELECTRODE SITE INTERACTION



(b) SIGNIFICANT INFORMATION PROCESSING BY SEX INTERACTION

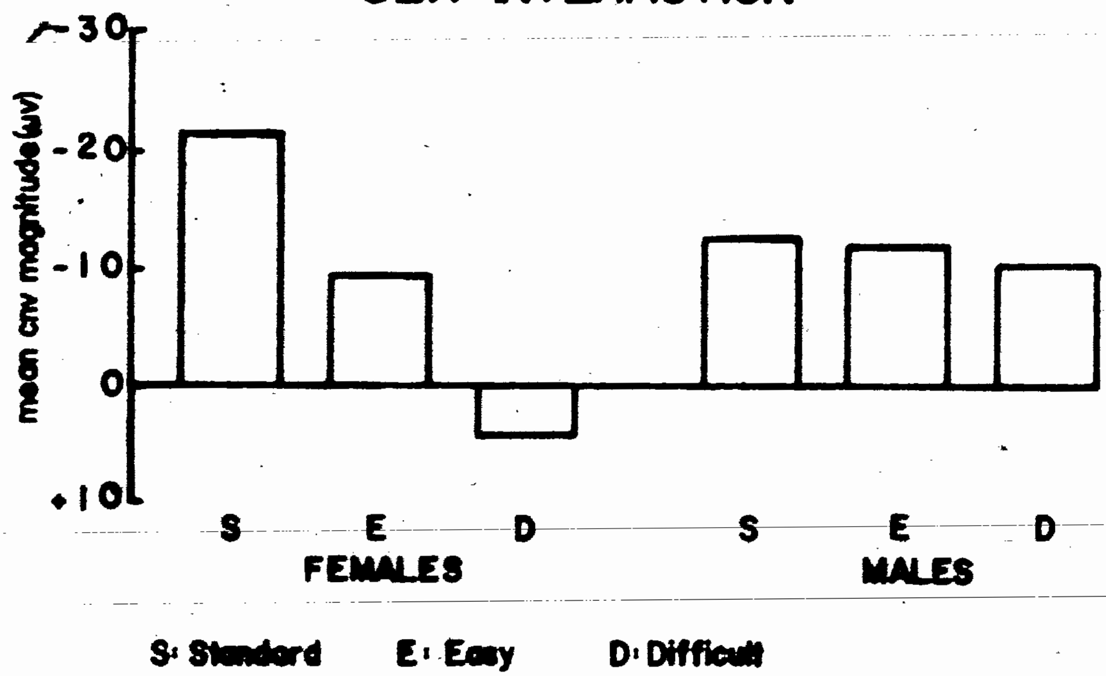


FIGURE 13-CNV DAYS 3 & 4 - MEASURE I

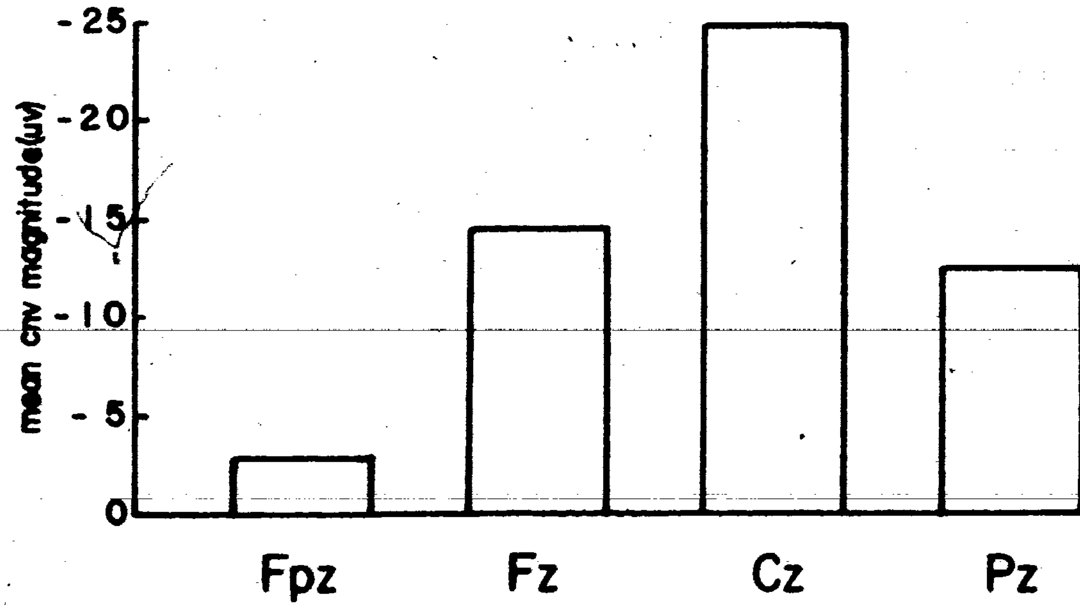
conditions are extremely similar; no effect of information processing load is visible.

Measure 2 has the same significant effects as measure 1, with the addition of an electrode by incentive interaction. The electrode effect ($F_{3,12} = 20.27$) shows that Cz is significantly larger than all other electrode sites and Fpz smaller (Figure 14a). The electrode by incentive interaction ($F_{3,12} = 5.27$) shows that this pattern holds only for high incentive subjects (Figure 15c). For low incentive subjects significant decreases in negativity at Cz and Pz result in Pz now being significantly smaller than Fz.

The electrode by information processing effect ($F_{6,24} = 5.67$) shows that the same pattern of electrode activity holds for all conditions, but the differences between information processing conditions vary at different electrode locations (see Figure 15a). Although a significant information processing main effect occurs ($F_{2,8} = 7.57$) such that the STANDARD is greater than the EASY condition, and the EASY condition is greater than the DIFFICULT condition (see Figure 14b), this is only significant at Pz and Cz. Fpz has significantly more negativity in the EASY than the DIFFICULT condition; at Fz the DIFFICULT condition is significantly smaller than the others.

The information processing by sex effect ($F_{2,8} = 6.29$) again shows the information processing effect to be significant only for females (all differences were significant and in the hypothesized direction), although the only significant difference

(a) SIGNIFICANT ELECTRODE SITE MAIN EFFECT



(b) SIGNIFICANT INFORMATION PROCESSING MAIN EFFECT

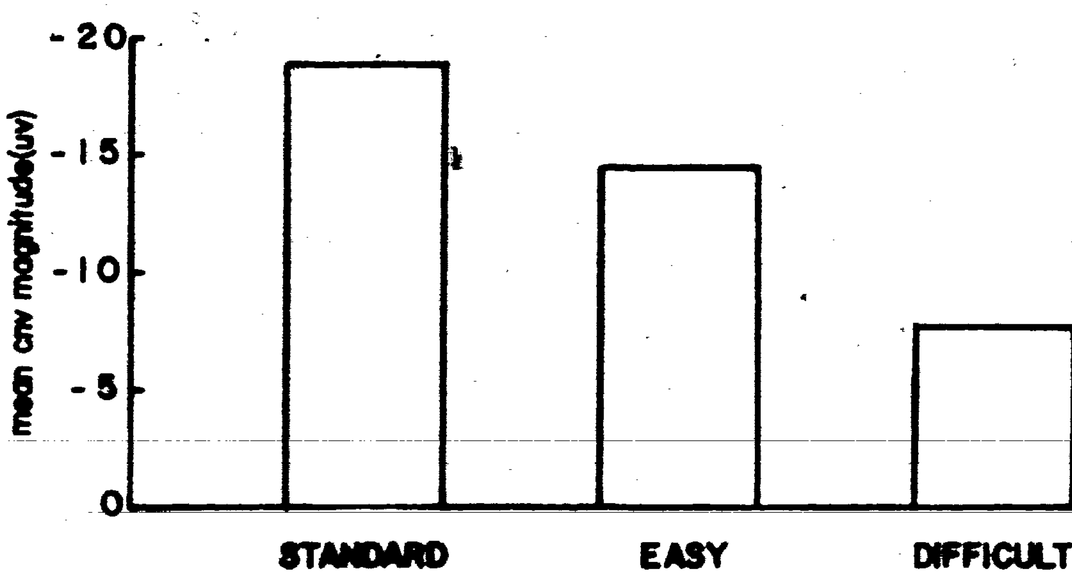
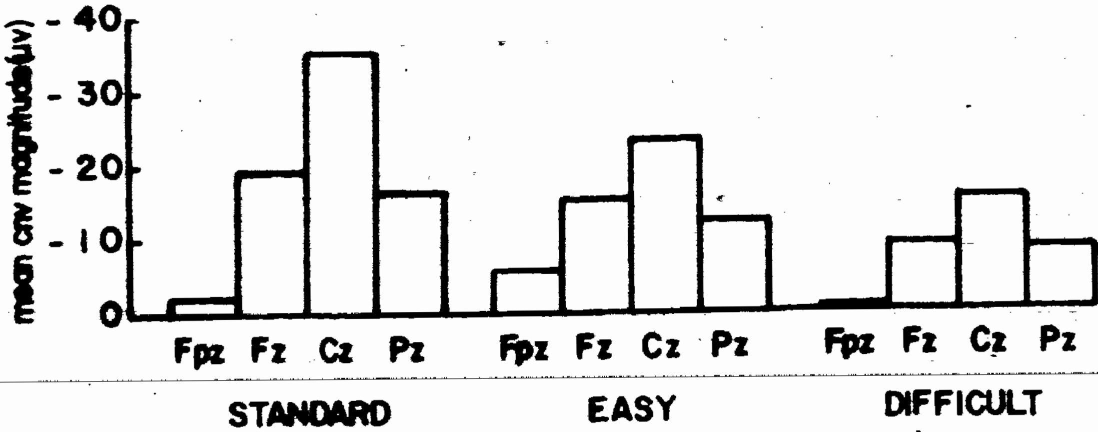
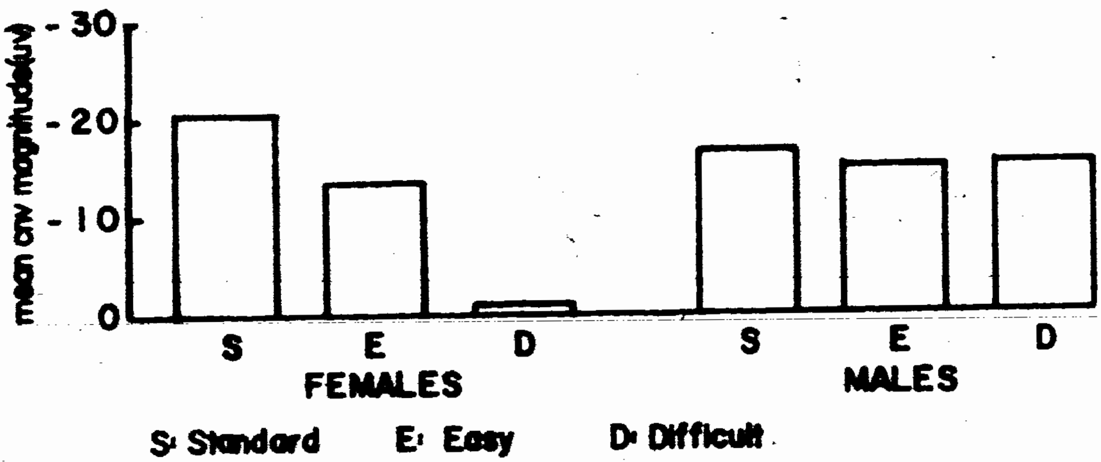


FIGURE 14 - CNV DAYS 3 & 4 - MEASURE 2

(a) SIGNIFICANT INFORMATION PROCESSING BY ELECTRODE SITE INTERACTION



(b) SIGNIFICANT INFORMATION PROCESSING BY SEX INTERACTION



(c) SIGNIFICANT ELECTRODE SITE BY INCENTIVE INTERACTION

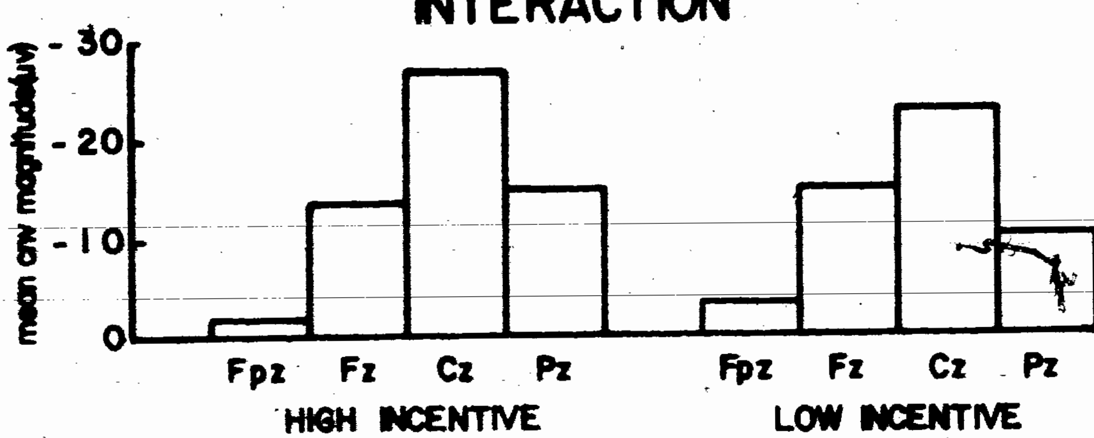


FIGURE 15 - CNV DAYS 3 & 4 - MEASURE 2

between the male and female results is a significant increase in negativity in the DIFFICULT condition for the males (see Figure 15b).

For measure 3 the electrode effect (F 3,12 = 21.98) shows the same pattern (Cz > Pz Fz > Fpz) as in measure 2 (Figure 16a). The electrode by information processing effect (F 6,24 = 3.90) shows that this pattern of electrode activity occurs in the STANDARD and EASY conditions, but in the DIFFICULT condition Pz activity is now significantly greater than Fz activity (Figure 16b). There are significant decreases in negativity over information processing conditions at Cz and non-significant tendencies for CNV activity to decrease over information processing conditions at Fz and Pz.

The incentive by information processing effect (F 2,8 = 8.25) shows that high incentive subjects show a general information processing effect such that conditions are significantly ordered EASY, STANDARD and DIFFICULT; while for low incentive subjects only the difference between the STANDARD and DIFFICULT conditions is significant (Figure 16c). In addition, information processing by incentive by order (F 2,8 = 8.37) and sex by incentive by order by information processing (F 2,8 = 6.02) effects occur (Figures 17a and 17b). The first shows that the information processing effect outlined above for high incentive subjects is only true for day 4; and that when days 3 and 4 are analysed separately the low incentive group show no information processing effects. Activity increased between days

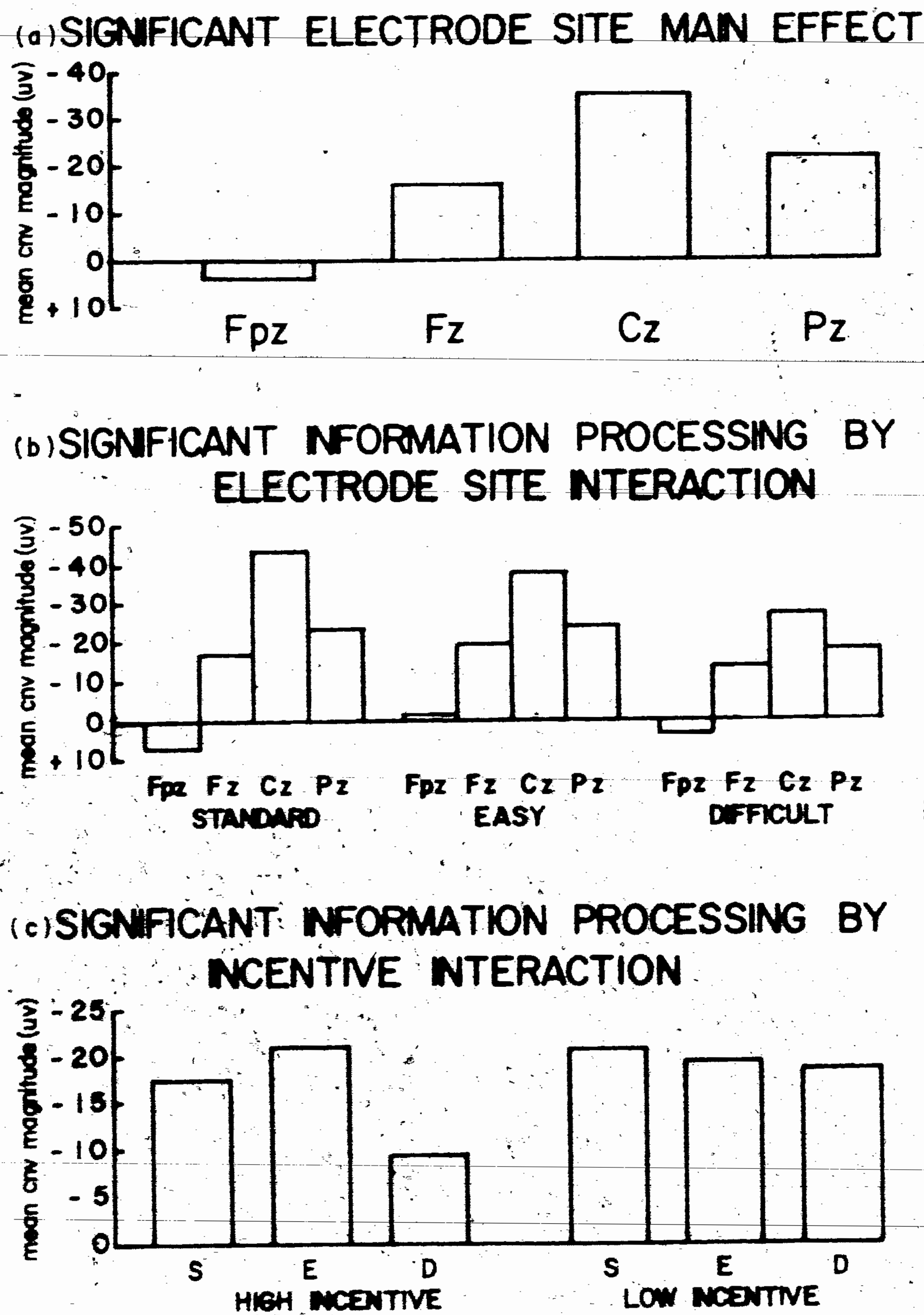
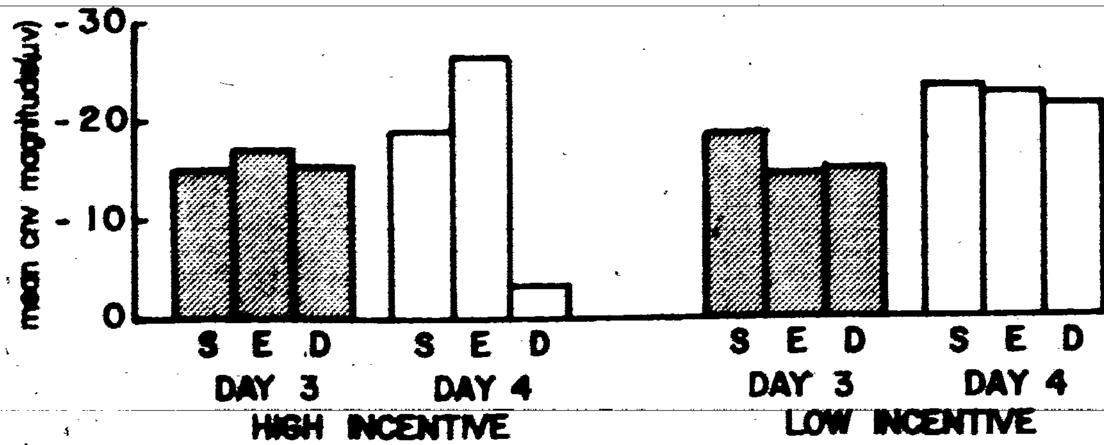
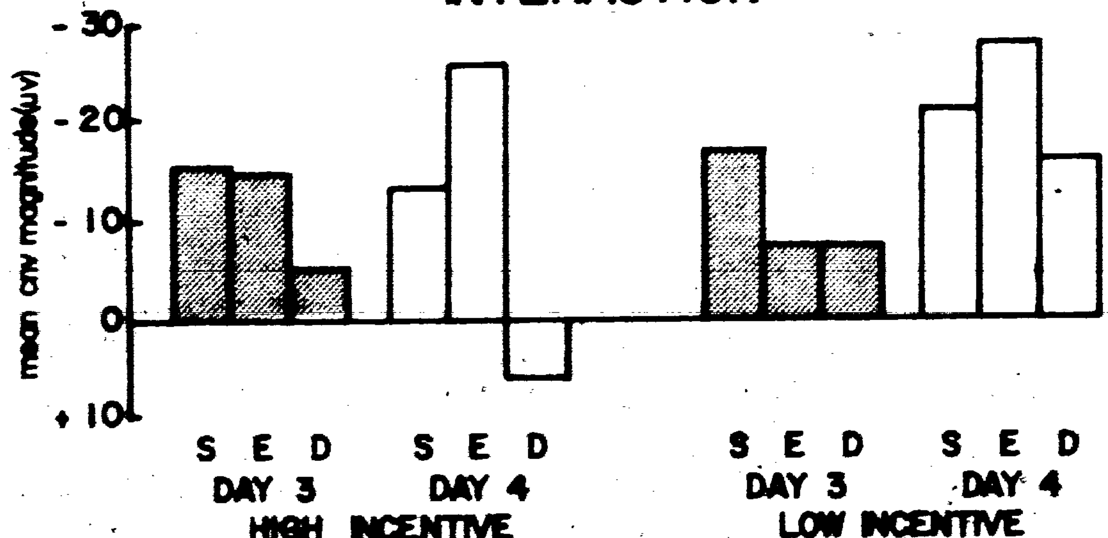


FIGURE 16 - CNV DAYS 3 & 4 - MEASURE 3

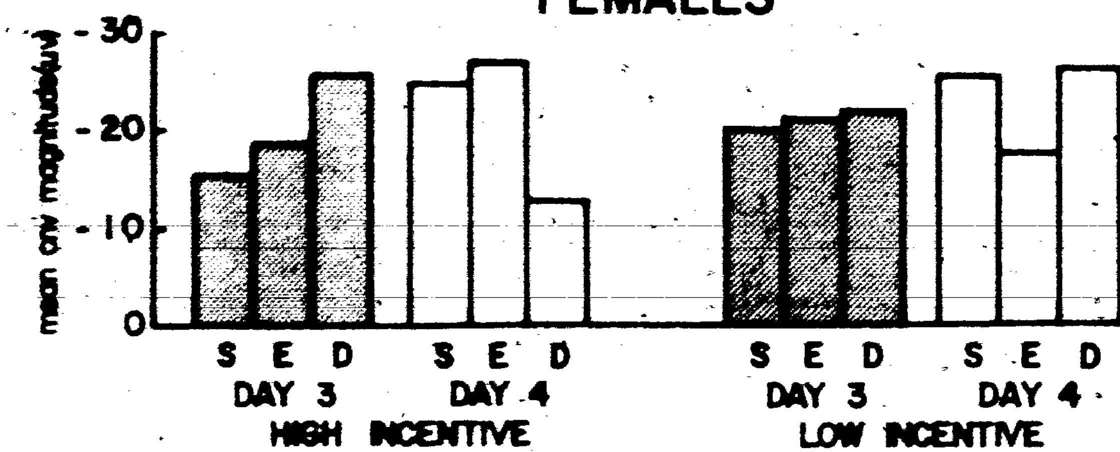
(a) SIGNIFICANT INFORMATION PROCESSING BY INCENTIVE ORDER BY INCENTIVE INTERACTION



(b) SIGNIFICANT INFORMATION PROCESSING BY INCENTIVE ORDER BY INCENTIVE BY SEX INTERACTION



FEMALES



MALES

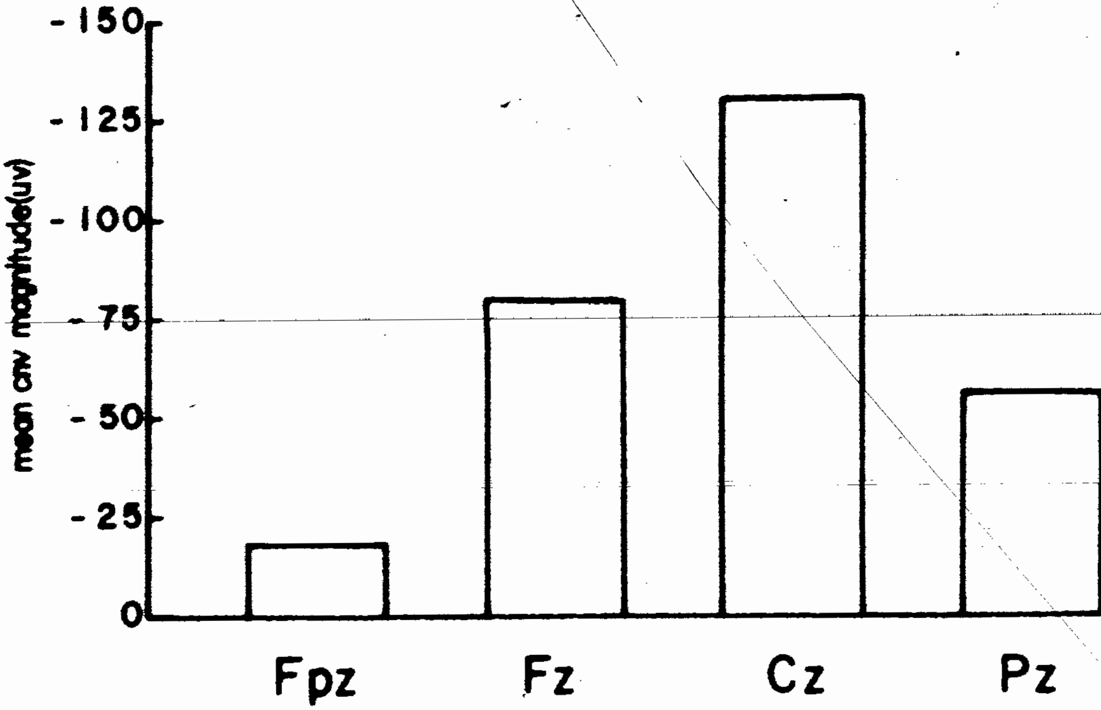
FIGURE 17 - CNV DAYS 3 & 4 - MEASURE 3

3 and 4 for the high incentive subjects in the EASY condition and the low incentive subjects in the DIFFICULT condition. Activity decreased between days for the low incentive subjects in the EASY condition and the high incentive subjects in the DIFFICULT condition.

The large four-way interaction shows a more complex pattern. Activity decreased significantly between the EASY, STANDARD, and DIFFICULT conditions for the high incentive females on day 4. The STANDARD and EASY conditions were larger than the DIFFICULT condition for high incentive subjects on day 3 and male high incentive subjects on day 4. The EASY condition was larger than the DIFFICULT condition for the female low incentive subjects on day 4. The STANDARD condition was significantly larger than the other conditions for the female low incentive subjects on day 3. The EASY condition was smaller than the other conditions for the male low incentive subjects on day 4. The relationships outlined above in the incentive by order by information processing interaction were true with respect to the EASY condtion for female subjects and high incentive male subjects, and with respect to the DIFFICULT condition for the male high incentive and female low incentive subjects. However, for the female high incentive subjects the DIFFICULT condition was larger on day 4 than day 3.

The measure 4 results were similar (see Figures 18 and 19). Electrode (F 3,12 = 15.98), information processing (F 2,8 = 8.48), electrode by information processing (F 6,12 = 6.06) and

(a) SIGNIFICANT ELECTRODE SITE MAIN EFFECT



(b) SIGNIFICANT INFORMATION PROCESSING MAIN EFFECT

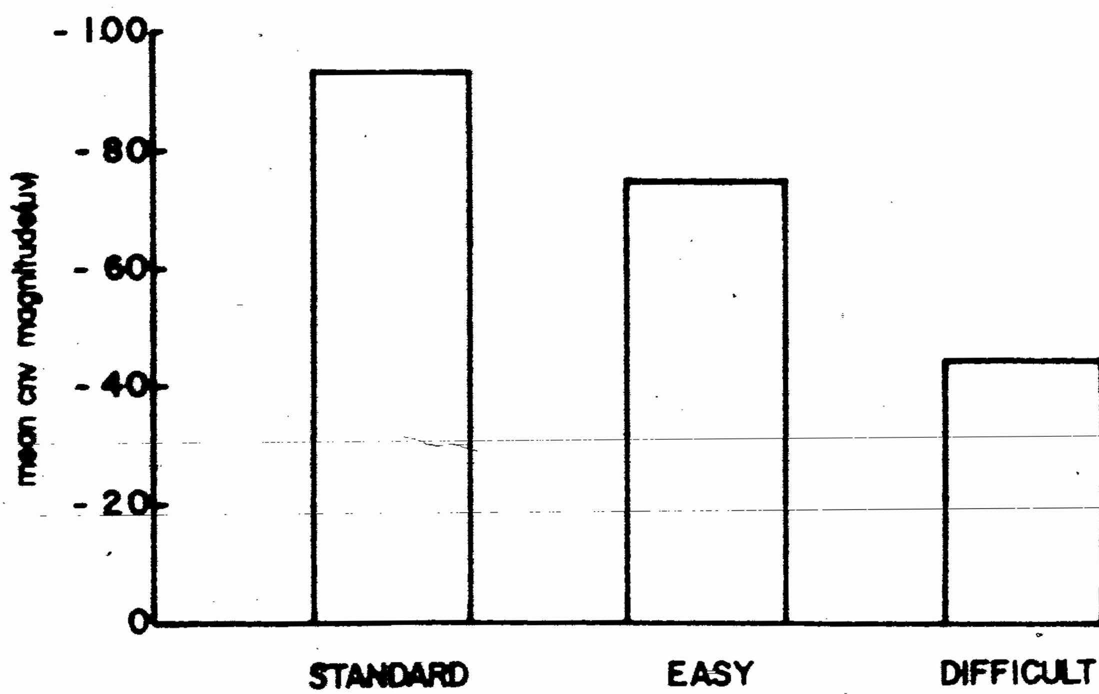
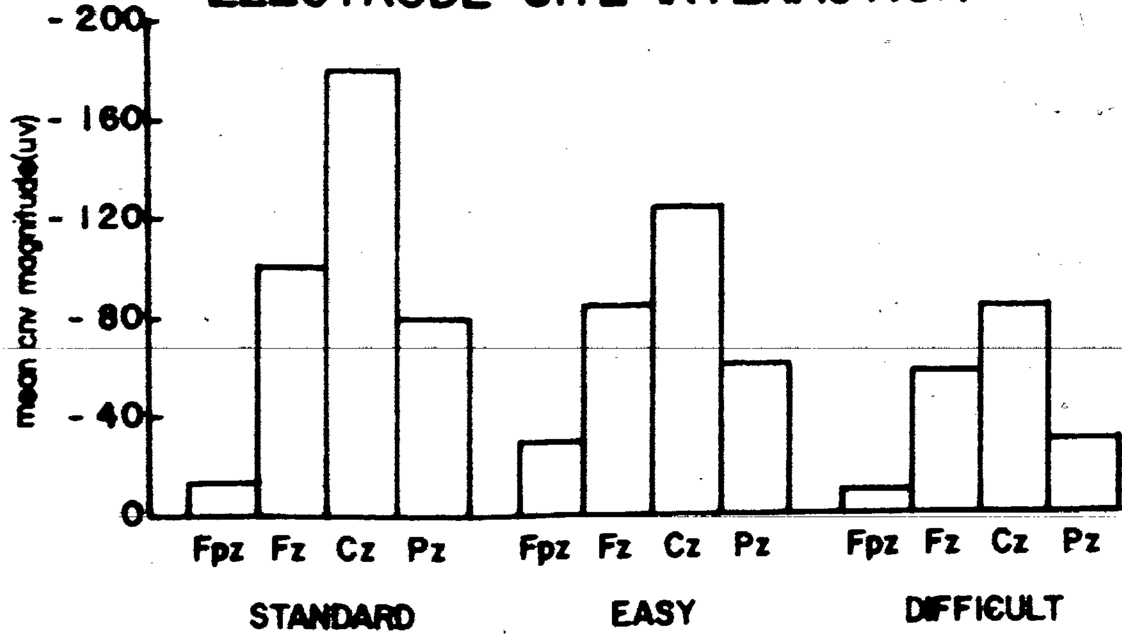


FIGURE 18 - CNV DAYS 3 & 4 - MEASURE 4

(a) SIGNIFICANT INFORMATION PROCESSING BY ELECTRODE SITE INTERACTION



(b) SIGNIFICANT INFORMATION PROCESSING BY SEX INTERACTION

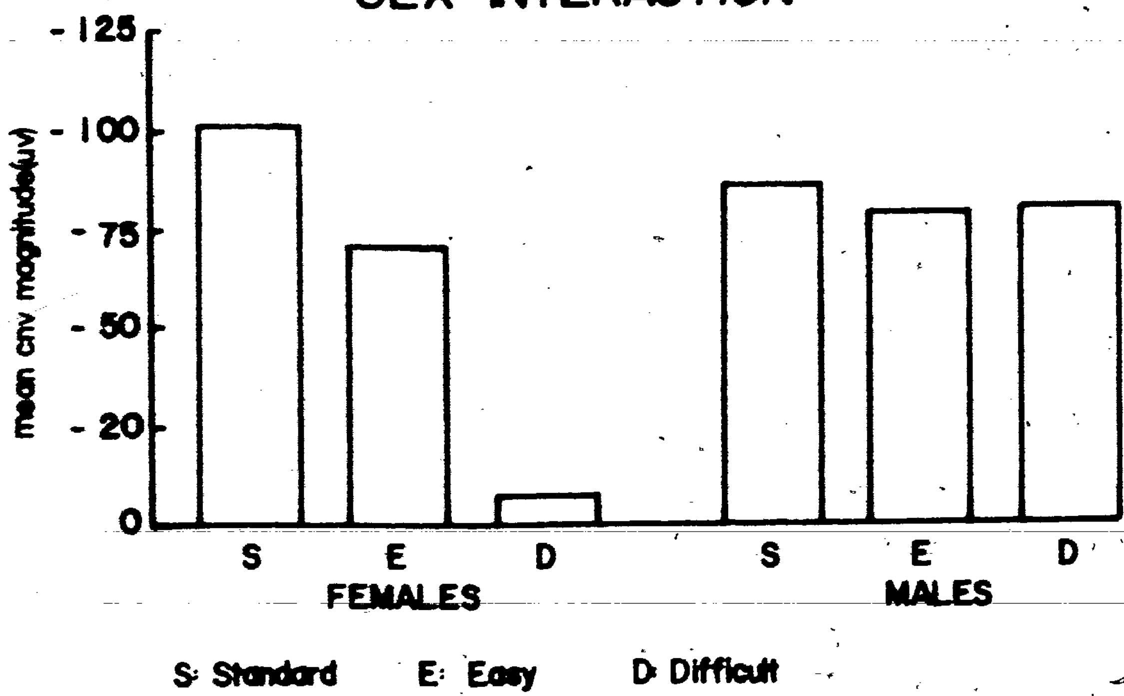


FIGURE 19 - CNV DAYS 3 & 4 - MEASURE 4

information processing by sex ($F_{2,8} = 6.83$) effects occur. Electrodes, both in general and with respect to information processing conditions, show significant decreases in negativity from Cz to Fz to Pz to Fpz. CNV negativity significantly decreases over information processing conditions, but this is significant only for females and only for Fz, Cz and Pz electrode sites. Males show significantly more negativity in the DIFFICULT condition than the females. At Fpz the negativity is significantly larger in the EASY than in the DIFFICULT condition, and negativity in the STANDARD condition is intermediate.

P300 RESULTS

P300 was measured as the peak amplitude at 423 milliseconds following S2, with respect to a baseline defined as the average of the activity in the 1000 millisecond interval preceding S1. This conforms to the peak aplitudes on the block averages. The single trial measurements were entered into ANOVAs.

(a) P300 RESULTS FOR THE FIRST BLOCK OF DAYS

A significant electrode effect ($F_{3,12} = 4.80$) occurs such that Pz activity is more positive than all other electrode sites and Cz activity significantly less positive than all others except Fz. A further sex by electrode interaction ($F_{3,12} = 6.03$) shows that this is due to a combination of the results for the male and female subjects (see Figure 20). For female subjects Pz is significantly greater than Fpz with a tendency for positivity to increase in a posterior direction. For males, significant increases in positivity at Fpz and decreases in positivity at Cz result in Fpz and Pz being significantly larger than Fz, which is itself significantly larger than Cz.

An incentive by order (of incentive) by electrode effect ($F_{3,12} = 3.99$) shows that day 2 subjects show the same patterns of activity regardless of incentive level while on day 1 all electrode sites except Pz are larger for the low incentive subjects such that activity at Fpz and PZ is not significantly different. The results for day 1 are in fact similar to the averaged results for the male subjects. Fpz significantly differs over days and incentive level with no consistent pattern. For Fz, the high incentive group on day 1 was significantly smaller than all others. Cz increases on day 2 over day 1 results, although low incentive subjects show larger P300 amplitudes at Cz on day 1 than high incentive subjects. At Pz significant differences occur, in descending order, between day 2 high incentive, day 2 low incentive, day 1 low incentive, and day 1 high incentive.

(b) P300 RESULTS FOR THE SECOND BLOCK OF DAYS

Only electrode ($F_{3,12} = 6.10$) and sex by information processing ($F_{3,12} = 3.60$) effects occur (see Figure 21). The

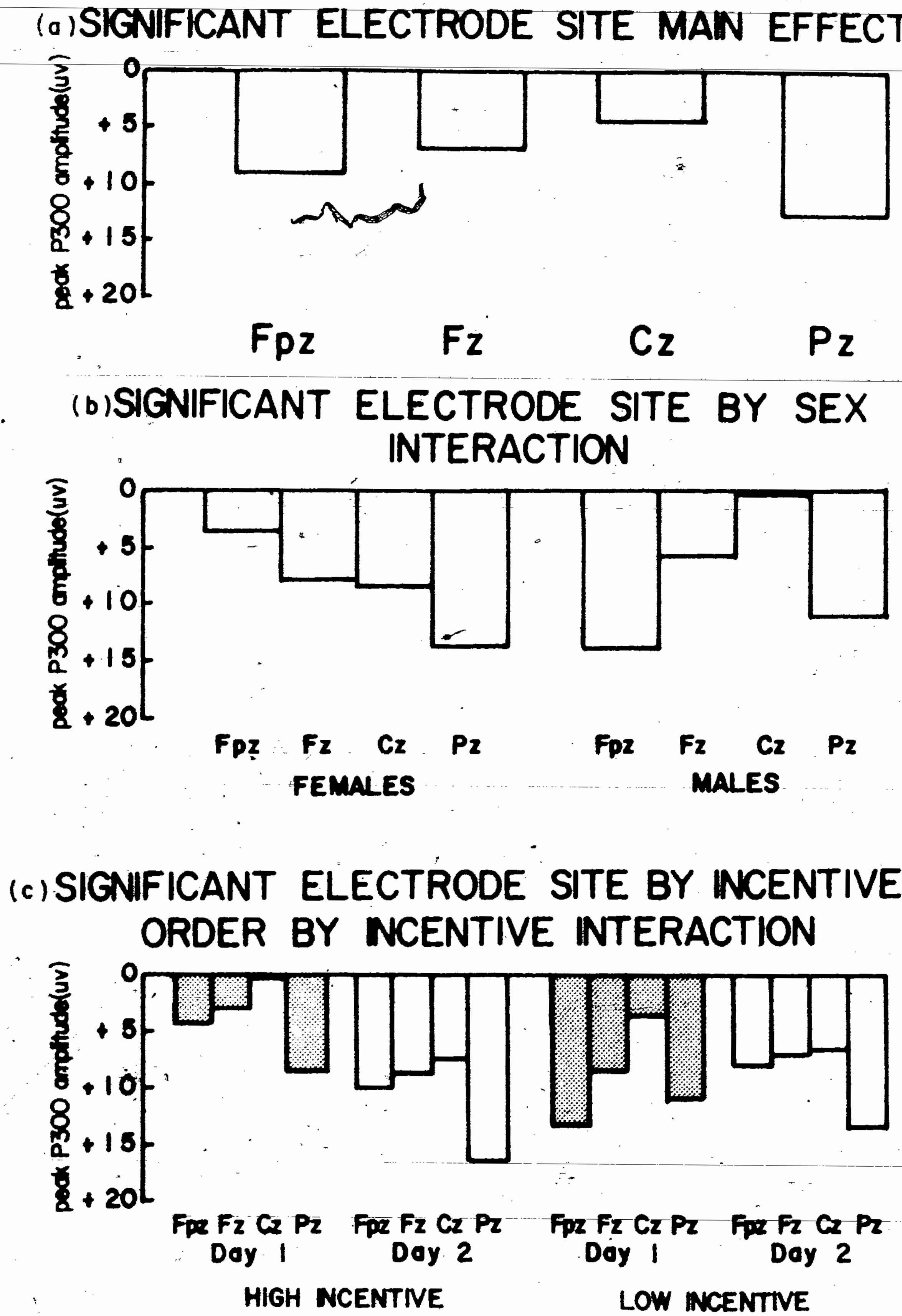
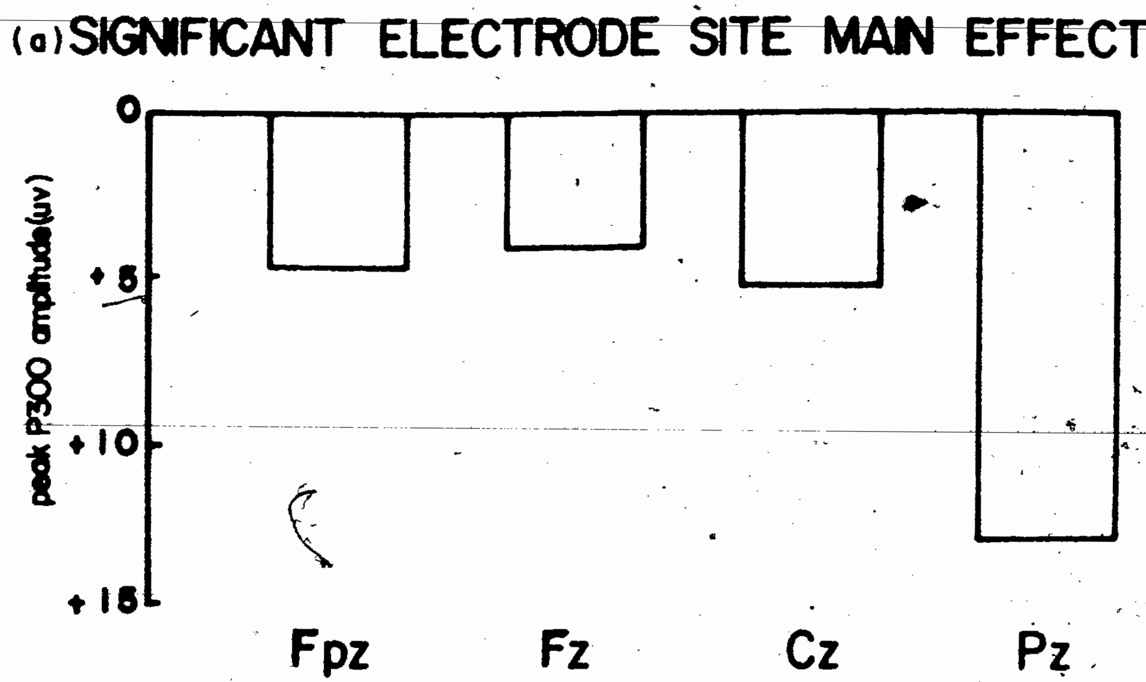


FIGURE 20 - P300 DAYS 1 & 2



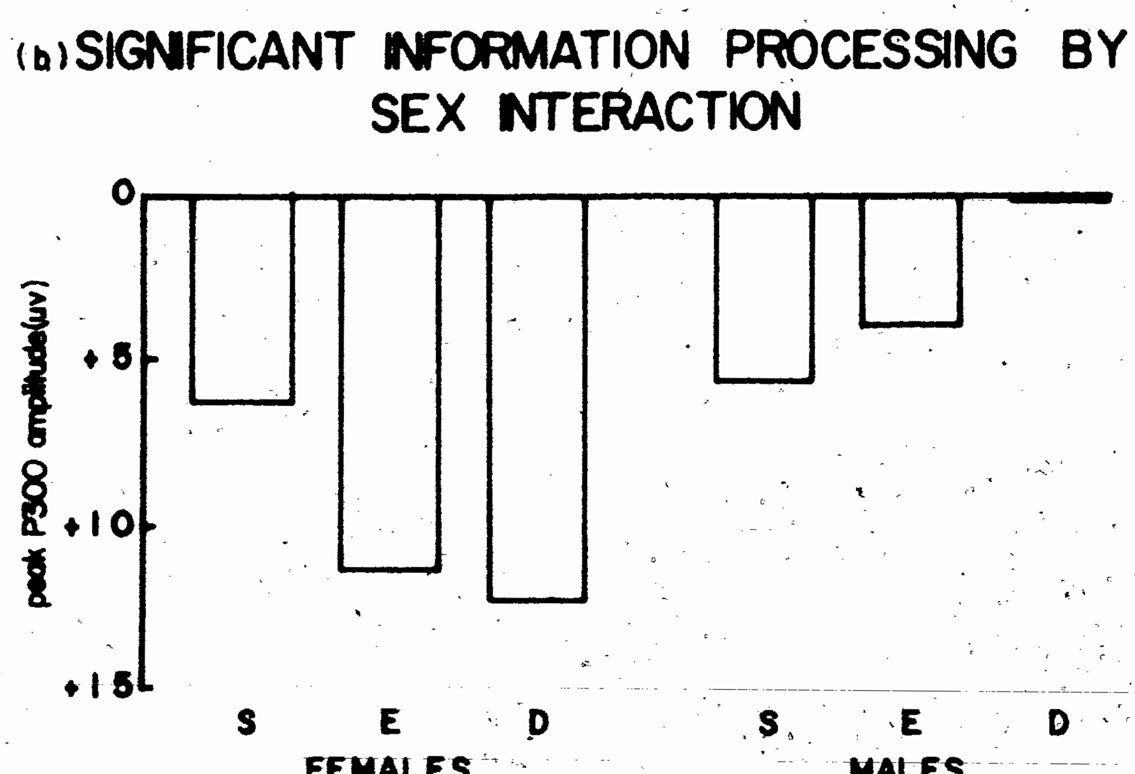


FIGURE 21 - P300 DAYS 3&4

electrode pattern shows that Pz is more positive than all other electrode sites. The sex by information processing effect shows that for females P300 positivity tends to increase as the difficulty of the condition increases, with no information processing effects for males. For females, the DIFFICULT condition is significantly larger than the STANDARD condition, with the EASY condition intermediate.

GALVANIC SKIN POTENTIAL RESULTS FOR ALL DAYS

The GSP was measured as the total area from S1 to 1000 milliseconds following S2, with respect to the average of the activity in the 1000 milliseconds preceding S1.

Only a block by information processing effect (F 2,16 = 4.33) and a block by incentive by order by trials interaction significant (F 15,120 = 2.00) were significant. (Days 1 and 2 comprise Block 1, and days 3 and 4 comprise Block 2.) As shown in Figure 22, the GSP during the EASY condition is significantly larger than during the DIFFICULT condition on the first block of days, with the STANDARD condition intermediate. On the second block of days, the STANDARD condition is significantly larger than both the EASY and DIFFICULT conditions. A significant decrease in the amplitude of the GSP in the EASY condition occurred between the first and second blocks. The second interaction appears to show variations between trials over days of a minor nature.

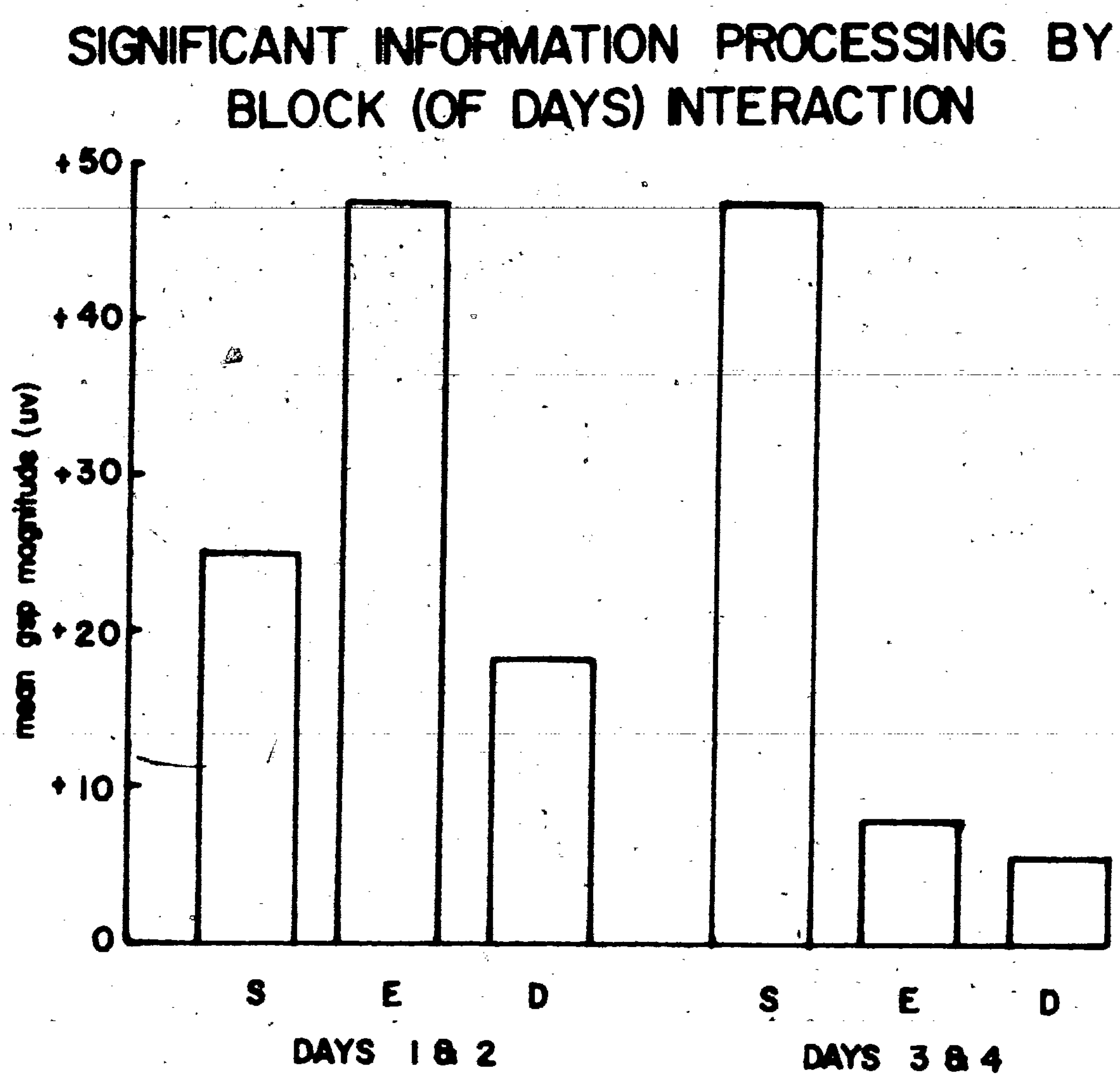


FIGURE 22 - GALVANIC SKIN POTENTIAL

EOG RESULTS FOR ALL DAYS

The EOG activity was measured from 100 milliseconds following S1 to 100 milliseconds preceding S2, with respect to a baseline defined as the average of the activity in the 1000 milliseconds preceding S1.

The ANOVA showed only a significant blocks by incentive by order (of incentive) by trials effect ($F_{15,60} = 1.89$). It is only just significant. It appears to show a decrease in trial variability over days.

HEART RATE RESULTS FOR ALL DAYS

On each four second trial, the average number of sample points (15.6 milliseconds per point) between peaks was entered into the ANOVA. For presentation, the necessary means from the data were converted into beats per minute.

A series of significant effects occurred which evolve into a five-way blocks by incentive by order by sex by information processing effect ($F_{2,16} = 5.78$, see Figure 23).

The main information processing effect ($F_{2,16} = 26.43$) shows heart rate to be significantly slower in the STANDARD than the EASY and DIFFICULT conditions. The sex by information processing effect ($F_{2,16} = 4.07$) shows the above to be true only for male subjects; the female subjects show no difference in heart rate over the three conditions. The heart rates of females

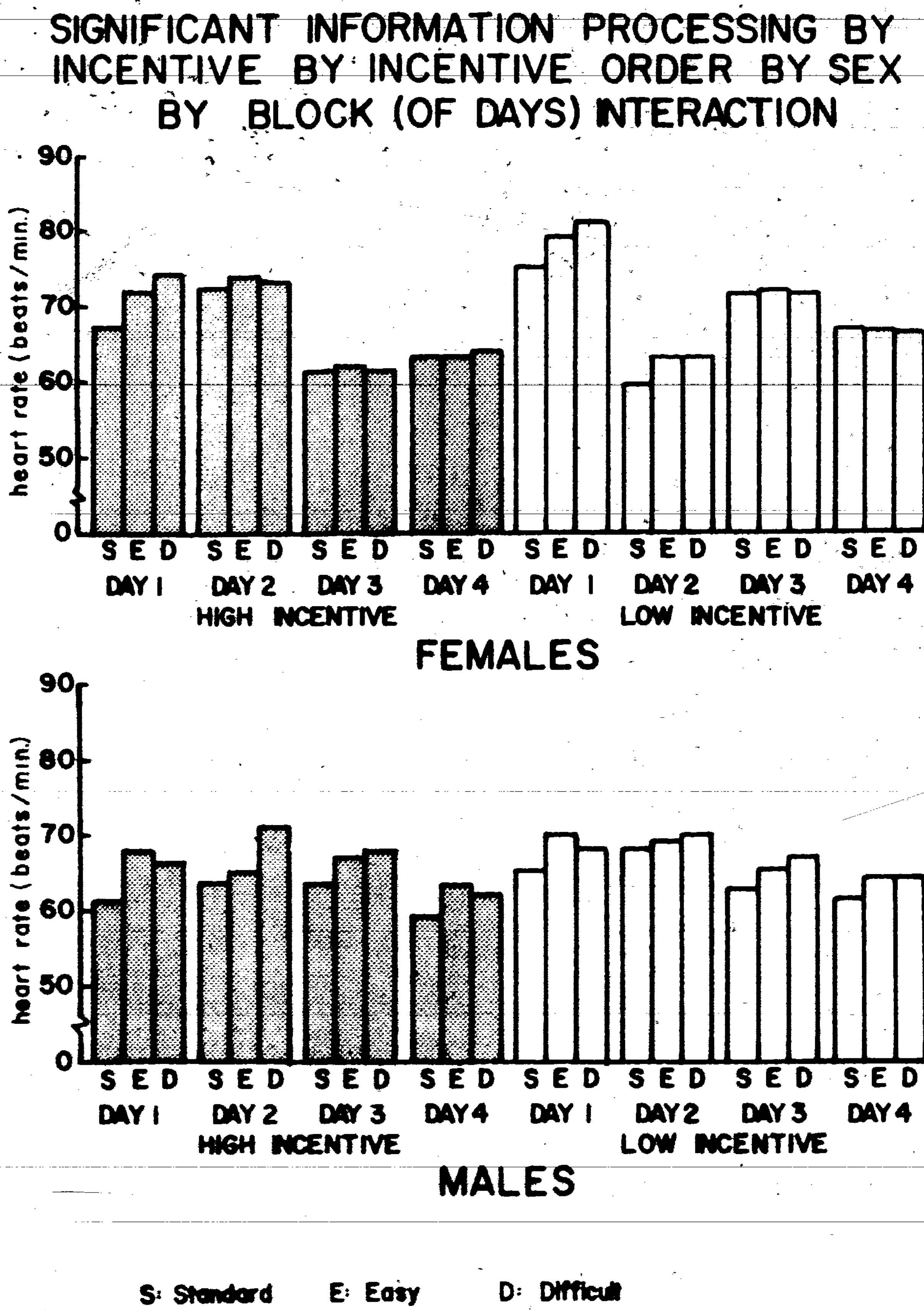


FIGURE 23-HEART RATE

are significantly faster than those of males in the EASY and STANDARD conditions.

The incentive by order (of incentive) by information processing effect ($F_{2,16} = 5.09$) shows the STANDARD condition to be significantly slower than both other conditions on the second day of each block. On the first day, only the difference between the STANDARD and DIFFICULT conditions is significant, with the EASY condition intermediate. In all three information processing conditions, heart rates for the low incentive groups on Day 2 are slower than for the low incentive groups on Day 1. Also, for the low-high group, heart rates in all three information processing conditions are significantly faster on Day 2 (in the high incentive condition) than on Day 1 (in the low incentive condition).

In the large five-way interaction the females showed strong incentive effects on days 1 and 2 in oppcsite directions, making it likely that while heart rates are faster on day 1 for low incentive subjects, it generally decreases over days for females. On days 3 and 4 low incentive subjects consistently show greater beats/minute than high incentive subjects. A decreasing effect of information processing lcad occurs such that while heart rate is fastest for the DIFFICULT conditions on day 1, decreasing significantly over the EASY and the STANDARD conditions, by day 3 no information processing effect is left.

Males, however, show generally slower heart rates, a tendency for the heart rate to increase as information processing increases in difficulty, and a tendency for heart rates to decrease over days.

REACTION TIME RESULTS FOR ALL DAYS

The reaction time was automatically computed during the experimental session and recorded by the experimenter.

Females had significantly slower reaction times than males (F 1,8 = 8.04), as shown in Figure 24a. An information processing effect (F 2,16 = 10.20) showed the reaction times were significantly faster in the STANDARD condition than in the EASY or DIFFICULT conditions (see Figure 24b). Analysis of the incentive by order interaction (F 1,8 = 9.84) showed that the first day of each block had significantly slower reaction times than the second day (see Figure 25a), but the incentive by order by blocks effect (F 1,8 = 6.52) reveals a sharp decrease between day 1 and later days reaction times for the high incentive subjects and a more gradual decrease for low incentive subjects, with the major decrease between days 2 and 3 (see Figure 25b). Therefore, the incentive by order interaction is only significant for the first block of days. In addition, on day 2 the low incentive subjects showed significantly slower reaction times than the high incentive subjects.

The incentive by order by sex by trials interaction (F 15,120 = 1.83) translates to a days by sex by trials interaction. No clear pattern is apparent.

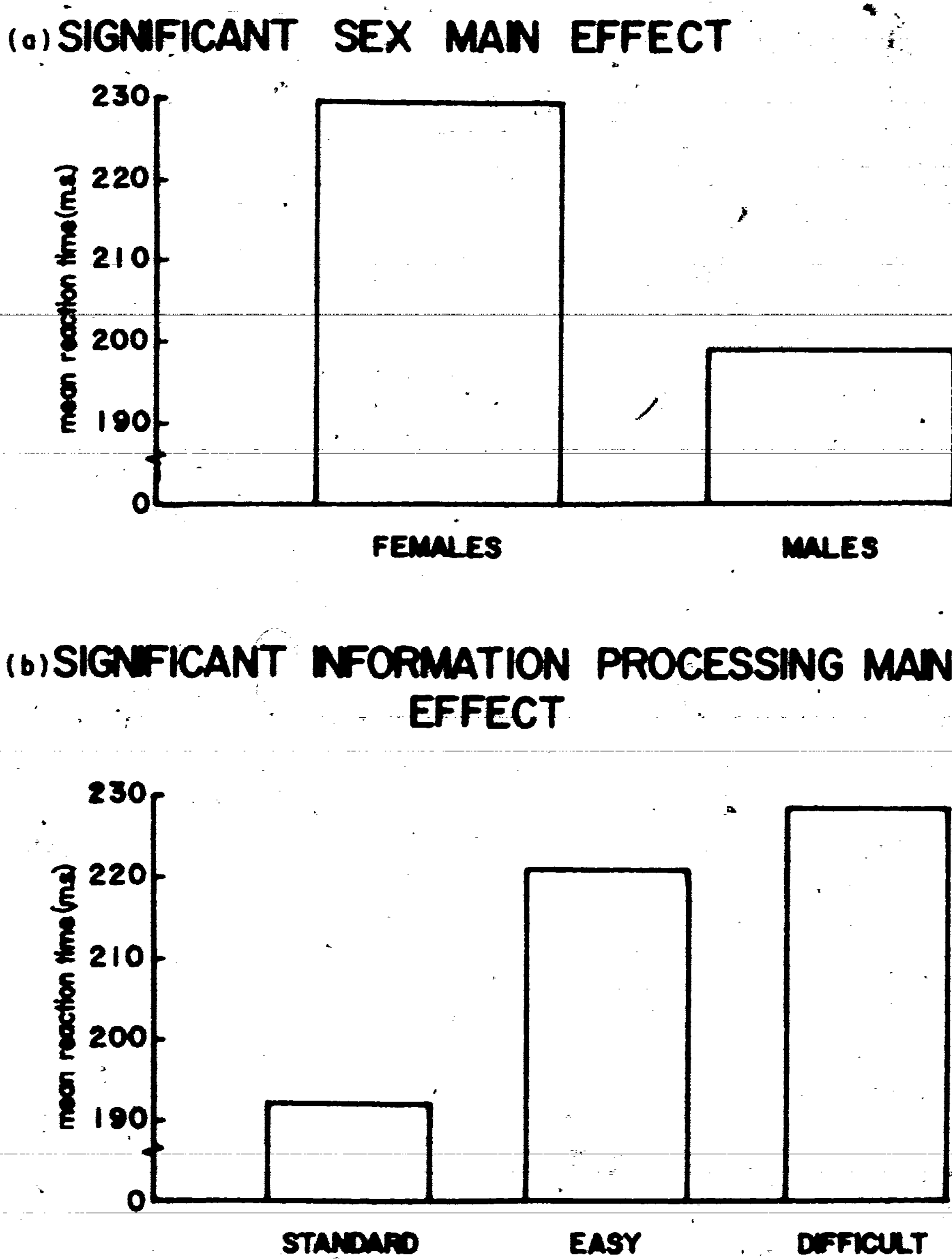
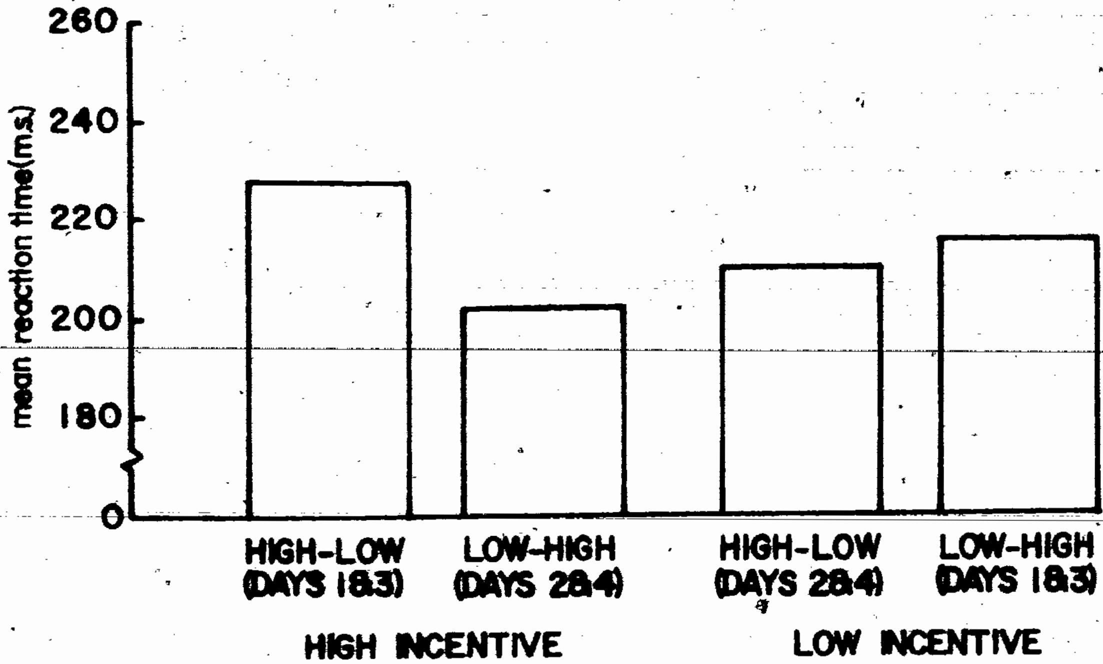


FIGURE 24 - REACTION TIME

(a) SIGNIFICANT INCENTIVE BY INCENTIVE ORDER INTERACTION



(b) SIGNIFICANT INCENTIVE BY INCENTIVE ORDER BY BLOCKS INTERACTION

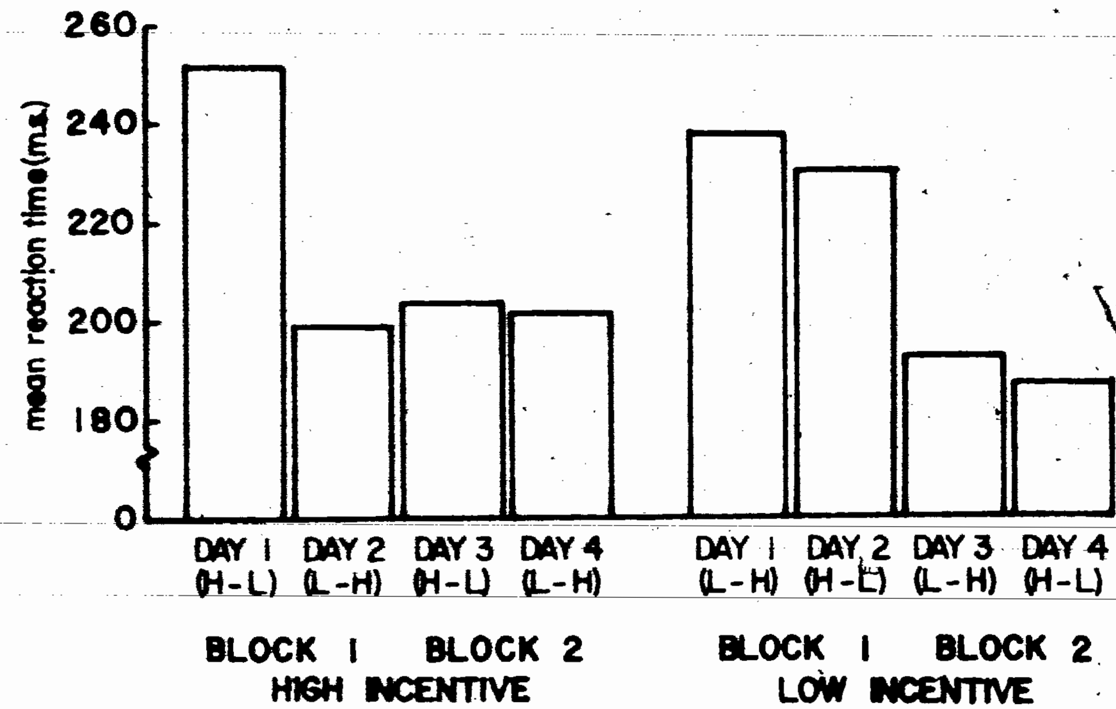
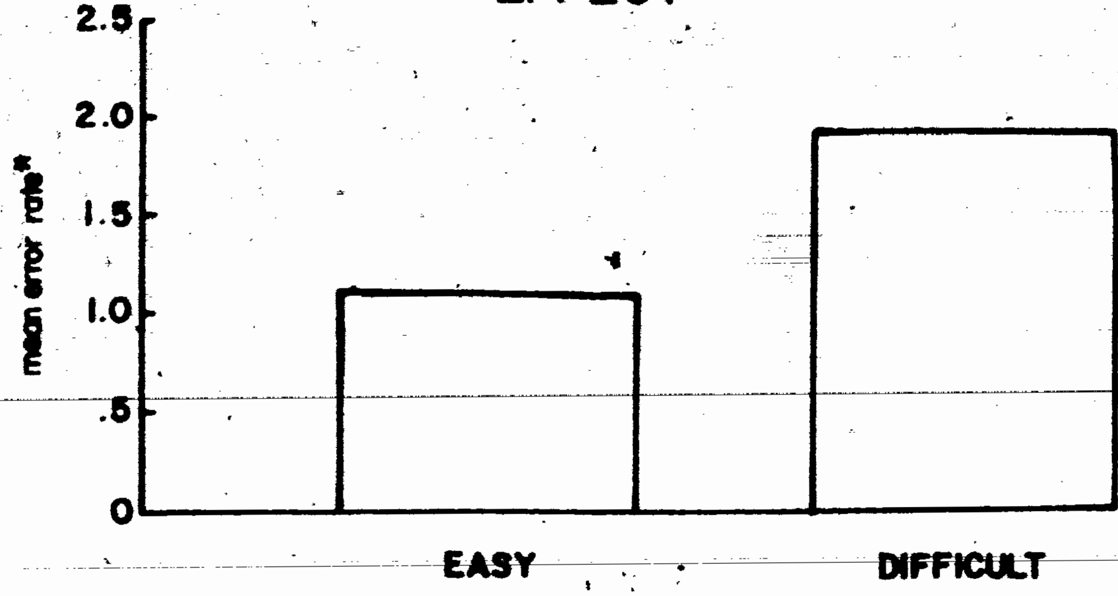


FIGURE 25-REACTION TIME

VERBAL RESPONSE ERROR RESULTS FOR ALL DAYS

Significant order (F 1,16 = 5.17) and information processing effects (F 1,16 = 7.02) occurred. Significantly more errors occurred in the DIFFICULT than the EASY condition. The order effect shows HIGH-LOW subjects made more errors than the LOW-HIGH subjects. On the basis of the conclusions suggested above, it is likely that this reflects a steadily decreasing error rate over days, coupled with an initial effect of incentive on the first day.

(a) SIGNIFICANT INFORMATION PROCESSING MAIN EFFECT



(b) SIGNIFICANT INCENTIVE ORDER MAIN EFFECT

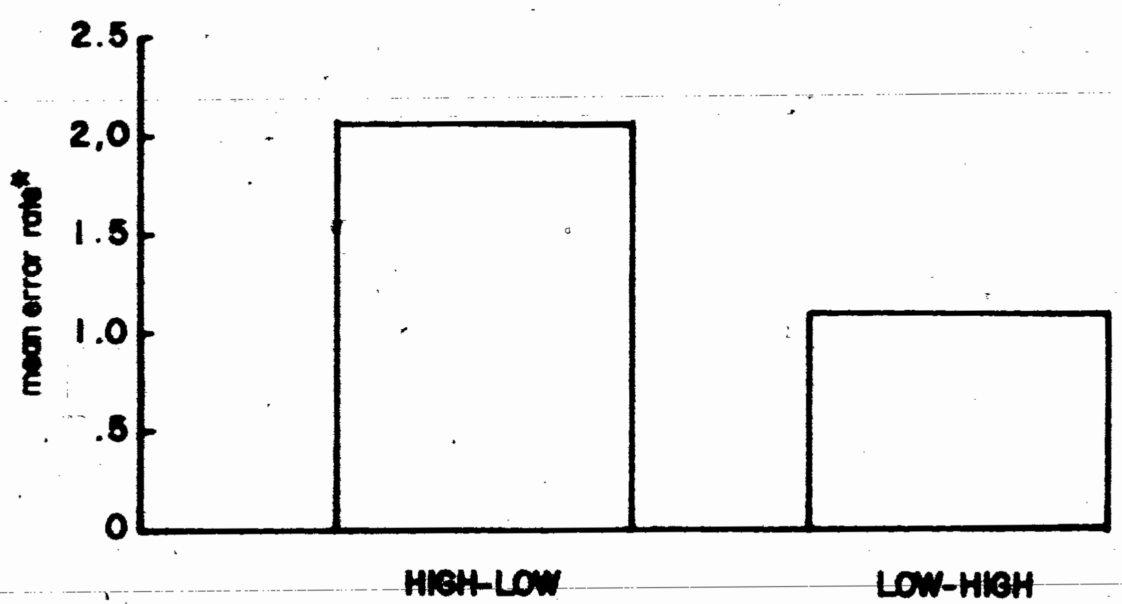


FIGURE 26-VERBAL RESPONSE ERROR RATE

(* MEAN VERBAL RESPONSE ERROR RATE / INFORMATION PROCESSING CONDITION / SUBJECT / DAY)

DISCUSSION

The results, considering the large number of ANOVAs run and the subsequent possibility of Type B errors, were relatively clean. In general, the hypotheses generated were supported by the female subjects.

The females showed significant differences in CNV magnitude between the STANDARD and the EASY and DIFFICULT conditions on the first block of days, and there were significant differences between all three information processing conditions, in the hypothesized direction, on the second block of days.

Although females (see Figure 17, page 71) do not show progressive decrements in CNV amplitude with increasing information processing load if results are examined separately by days or by level of incentive, males show only a slight tendency for CNV amplitudes to decrease with increases in information processing load.

In the first block of days a significant sex by incentive order by incentive by information processing interaction occurred for Measure 4 (overall CNV amplitude). Figure 11 (page 60) shows that the CNV amplitude of male subjects did tend to attenuate with increasing loads; the effect is, however, minor compared to the attenuation shown by the female subjects on day 2. The same interaction occurs on the second block of days, but no effect of information processing load is observed for the male subjects.

For the female subjects P300 showed no information processing effects on days 1 and 2, but for days 3 and 4 the magnitude in the STANDARD condition was significantly less than in the other two conditions. The male subjects showed a different pattern of electrode activity for P300 on the first block of days than the females. However, while the activity at the Pz electrode site of the male subjects showed high magnitude responses on the second block of days, no information processing effect was found.

The results for heart rate also differ between the male and the female subjects. Females in the high incentive condition had slower heart rates on the first day than low incentive females, with both these groups showing an increase in heart rate with increasing task difficulty. On the second day the female subjects showed a decrease in heart rate regardless of incentive level, and the relationship between high and low incentive subjects was reversed. While this decrease in heart rate continued over days 3 and 4, the information processing effects ceased. In the second block of days the low incentive females tended to have faster heart rates than high incentive females. These results suggest that the heart rate results of the females reflect phasic deceleration preceding the motor response as in experiments by Lacey and Lacey (1970) and Obrist (1968). Therefore, they seem to relate to attention rather than arousal levels.

The heart rates of male subjects were significantly affected by information processing conditions, with the rate increasing as task difficulty increased, overlaid by a general decrease over days. High incentive males tended to show slower heart rates than low incentive males.

No interactions with sex were found for the GSP, error rate, or reaction time results, although male subjects had significantly faster reaction times overall. More errors occurred in the DIFFICULT condition, which justified the treatment of the EASY and DIFFICULT tasks as two different levels of task difficulty, processing complexity, or levels of information processsing. Reaction times only distinguished between the STANDARD and the EASY and DIFFICULT conditions, being faster in the STANDARD condition as was expected. Reaction times decreased over days. The GSP showed an irregular pattern on the first block of days, the magnitude being maximal in the EASY condition. On the final days it was largest in the STANDARD condition and equally small in the EASY and DIFFICULT conditions.

Finally, no shift in the topography of the CNV or P300 of the male or female subjects occurred between information processing conditions. The three conditions tended to show centro-frontal distributions with maximal variations occurring at Cz.

THE EFFECTS OF AROUSAL

In similar experiments it has usually been concluded that the magnitude attenuations shown by the female subjects in the information processing conditions result from arousal or distraction. In these studies (Tecce and Scheff, 1969; Tecce et al., 1976) the heart rate increased when distracting tasks or stimuli were added to a reaction time paradigm (reflecting the subjects' increased level of arousal) and reaction time decreased (reflecting the subjects' distraction from the reaction time task). Clearly, the females showed marked CNV magnitude-information processing effects when there were no heart rate effects.

The heart rate measure in this study differed significantly from previous studies which recorded the CNV over long periods of time. Here the record spanned only four seconds, thus reflecting phasic heart rate changes overlaid upon a tonic level. Still, variations in heart rate occurred between conditions. The findings by Tecce and Scheff (1969) and Tecce et al. (1976) of a positive relationship between information processing load and the heart rate were replicated on the first day, but these effects were only transitory for the female subjects. The CNV amplitude did, however, show continued information processing effects for the female subjects.

Before rejecting the hypothesis that the inverse relationship between CNV amplitude and information processing levels is due to variations in arousal, it is possible that the heart rate is not a true measure of cortical arousal. Lacey (1967), Routtenberg (1968) and Warren and Harris (1975) have all suggested that cortical and autonomic indices of arousal actually reflect two separate arousal systems. Warren and Harris (1975) recorded EEG and skin potential activity during auditory stimulus presentation in a single trial free recall task. They found no obvious correlations between cortical and autonomic indicants of arousal.

Acceptance of the concept of a cortical "ceiling effect" would allow the integration of three findings from the literature. First, a "ceiling effect" could then be said to occur in conjunction with task difficulty. Knott and Irwin (1967) hypothesized that highly anxious subjects showed less CNV responsivity to a situation intended to increase CNV amplitude by increasing stress because of a "ceiling effect". In this experiment (as suggested by Poon et al., 1974 following an experiment concerned with information processing loads), in the more cognitively demanding tasks the average limit of dc activity may be closer to the physiological maximum for negativity. Negative-going components would be limited, and positive-going components would occur in an environment more easily driven in that direction. Here, the female subjects showed a positive relationship between CNV amplitude and information processing load, and a negative relationship between P300 and CNV magnitude for the three conditions.

Second, Knott and Peters (1973, 1974a) found that the CNV amplitude of the female subjects was attenuated more than those of males in the high stress conditions.

Knott and Peters first study, 1973, was a simple reaction time task with an electrical shock as S2. This is similar to the paradigm of Knott and Irwin (1967, 1968), but, instead of varying the intensity of the shock, differential warning stimuli preceded a light or shock at various ISI (800, 1600 or 4800 milliseconds). In the longest ISI condition, the female subjects showed an increased CNV in the low stress condition, while the males showed only a positive relationship between ISI and reaction time.

In the second study, Knott and Peters (1974a) had subjects respond to only one of two distinguishable S2s. Errors resulted in a noxious "squeal". For females, the maximum peak negativity decreased on response trials as stress increased (defined as progressively more difficult trials, resulting in a greater number of errors); there was no difference for males. For both males and females, the maximum peak negativity on non-response trials increased as stress increased; however this relationship did not reach significance for the males. In general, the pattern of results appearred to be clearest for females, and inconsistent or insignificant for males.

It is not always the case that only female subjects show CNV attenuation in similar situations. A third study showed CNV attenuation in high stress conditions for both female and male subjects. Knott and Peters (1974b) used three conditions: for two control groups the imperative stimulus was a light flash; in the second condition S2 was a shock; in the third condition a differential response to S2 (a flash) was required and an error was punished by a noxious sound. On response trials, CNV magnitude was decreased in the experimental conditions when compared with the control conditions, for subjects of both sexes. However, for no-response trials, the CNV magnitudes of males were decreased, and the that of females increased, over the control condition.

Therefore, a difference between the responses of male and female subjects, as found in this study, has been previously found in situations hypothesized to produce high levels of arousal within male and female subjects.

That the difference is apparent in this study, as in the above studies, may be due to some underlying similarity between the experimental paradigms, or may simply reflect the fact that these are among the few CNV experiments that have controlled for the sex of the subject. In this thesis, however, the sequencing of EASY and DIFFICULT trials was not exactly the same for the male and female subjects. The sequencing of the EASY and DIFFICULT conditions immediately following the first standard condition was identical for both male and female subjects, but the later order of EASY and DIFFICULT conditions differed between the two sexes. It is possible that this difference is responible for some of the differences between the results of the males and the females, but this possibility is felt to small.

A search of studies to tabulate results with respect to sex is limited by the typical lack of reference to the sex of the subjects. All or predominantly female subjects were used by Tecce and Scheff (1969) and Tecce and Hamilton (1973). Sexes were mixed, but not controlled for in the study by Tecce et al. (1976). Clearly, confounding could occur if there is no control for sex differences, since in this study such differences had opposite effects for P300 only. Finally, CNV attenuation occurred only for female subjects in the study by Delse et al. (1972, outlined above), in which the subjects were required to compare S1 to S2. In addition, in the study by Roth et al. (1975), in which P300 amplitude was not found to be positively related to information processing load, all the subjects were males.

The third point on which the results of this study and previous arousal studies overlap is in the amplitude variations of segments of the CNV waveform. Naatanen and Gaillard (1974) found that the early rather than late, components of the CNV were affected by conditions known to enhance the non-specific activating systems. The measure of the CNV in the 300 milliseconds preceding S2 (Measure 3) was the only measure on days 3 and 4 that did not show an information processing main effect (although this measure showed attenuation in the distraction condition of Tecce and Hamilton's 1973 study).

The results of this thesis show that both the heart rate and the GSP reflected phasic activity. On the last block of days both sexes showed slower heart rates for the high incentive subjects. This is possibly due to an increase in the decelerative component of the triphasic heart wave pattern, reflecting an increase in attention levels. The general decrease in heart rate over days could then reflect either a decrease in anxiety or arousal, or an increase in concentration. This is the distinguishing factor between incentive and arousal levels. An increase in incentive may be associated with variations in arousal levels, or variations in the level of attention (defined as concentration to the task). By habituating the subject to the situation, situational anxiety decreased, and variations in attention levels became more evident.

Likewise, the decrease in GSP positivity with information processing load could be viewed as an inhibition of autonomic activity to facilitate attentional processes. Obrist et al. (1973) viewed the decrease in somatic activity found in their study as representing inhibition of task irrelevant activities necessitated by efficient execution of the behavioral task. Phasic cardiac deceleration occurs during orienting behavior (Graham and Clifton, 1966) and attention to external signals (Obrist, 1968; Lacey, 1959). The measure of GSP in this study reflects only phasic, and not tonic GSP levels. Thus, phasic GSP activity could decrease with increases in attention.

THE EFFECTS OF TASK DIFFICULTY

If arousal is the cause of CNV attenuation in the trials which require the greatest amount of information processing, then this might be due to higher levels of arousal accompanying the more difficult tasks. However, there is no evidence that a more difficult task, in itself, actually produces increased levels of arousal in the subjects. The review of experiments above, which concluded that task difficulty was effective in altering CNV magnitude suggested that there were two divisions within the general category of task difficulty which were associated with opposite CNV results.

In the task difficulty section of the introduction, studies necessitating encoding (Delse et al., 1972; Roth et al., 1975), and analyses and response decisions (Poon et al., 1976) or continuous addition throughout the condition (Tecce and Hamilton, 1973) were associated with CNV attentuation. Yet, if a more difficult stimulus differentiation (Rebert et al., 1967) or a response decision is necessary at S2 (Donchin et al., 1972) then CNV amplitude is enhanced.

If task difficulty actually meant an increasingly more difficult perceptual discrimination at S2, with the S1-S2 interval being only a time of preparation for the subject, then the CNV magnitude increased as task difficulty increased. If the subject was not in such a context in the S1-S2 interval, but was actually immersed in progressively more difficult tasks, then the CNV amplitude decreased as task difficulty increased. If it is argued that anxiety or arousal, which is a concominant of the increasing task requirements, is the cause of the attenuation, then the argument must explain why perceptual discrimination tasks preclude such effects of arousal.

THE EFFECT OF SELECTIVE ATTENTION OR DISTRACTION

The second major hypothesis states that the attenuation of CNV amplitude reflects a decrease in selective attention to the expected signal or the reaction time task in general, due to the effect expended in attending to the distracting task.

The possibility that distraction has occurred in this study is tenable due to the significant differences in the reaction times between the STANDARD, and EASY and DIFFICULT conditions for both males and females. (Tecce and Hamilton, 1973, argued that there must be evidence of performance decrement on the central task, evidenced by an increase in reaction time, in addition to evidence that the distracting and experimental stimuli have been processed to justify the statement that distraction has occurred.)

Yet, what is actually meant by distraction? If the subject is performing a simple motor task (such as is required in the STANDARD CNV paradigm) and is distracted by random, inexplicable tones, then a decrease in the CNV preceding the imperative stimulus occurs. When Walter (1968) suggests that amplitude decrement varies directly with the similarity of distracting stimuli to experimental stimuli, does this not imply increased information processing to reject these similar stimuli and related response conflicts?

Furthermore, if attention is divided between two tasks, it is reasonable to assume that attending to two different parts of the environment must lead to a shifting of attention between the two and a less than optimum response to either. Therefore, if the recorded response to a reaction time task involves a slow negative cortical potential, and the response to the task is decreased due to the necessity of two processes occurring, then this is likely to imply attenuation of the CNV. However, this does not explain why not only a decrease in negativity occurs, but also an increase in positivity.

The possibility of parallel but independent occurences cannot be ruled out. Thus the CNV could be attenuated and P300 amplitude enhanced concurrently due to different processes. In a task involving selective attention, the amplitude of P300 is positively related to the degree of selective attention directed to the stimulus (Donchin and Cohen, 1967; Smith et al., 1970). Therefore, if distracting stimuli occurred in the CNV interval, attention to S2 would decrease. This should yield decreases in both the CNV and P300. However, if the distracting stimuli are contingent with S2, as in this experiment, then summation due to the attention directed to the two stimuli could lead to a larger P300 in the distraction condition, regardless of the level of information processing.

An analysis of previous studies from the literature does not resolve the issue. For example, in the studies by Poon et al. (1974, 1976) the stimuli which are relevant for information processing are presented at S2. The subject did not need to respond to more than one stimulus at S2, so it must be concluded that more attention was directed to these stimuli than to the comparable stimuli in the reaction time task. Researchers have found (Ritter and Vaughan, 1969; Chapman and Bragdon, 1964) P300 to show a positive relationship to the amount of information carried by a stimulus.

Therefore, no clear opposition to the possibility of parallel processes is available.

However, it is clear that the term "distraction" is an inadequate explanatory concept. Furthermore, this study found no difference in reaction times between EASY and DIFFICULT conditions, yet the female subjects showed significant differences in CNV amplitude. Therefore, according to the requirements outlined by Tecce and Hamilton (1973), no difference in the level of distraction occurred between the EASY and DIFFICULT conditions. A significant difference between verbal response error rates did occur, but this is a decrement in the response to the more difficult distraction task, and is not associated with improvements in performance in the reaction time task.

TOPOGRAPHICAL DISTRIBUTION OF P300 AND THE CNV

While it has been stated that a negative relationship exists between P300 and CNV amplitudes, the two potentials have a different topographical distribution. The CNV is largest at Cz, and P300 is largest at Pz. The decrease in negativity, however, occurs over a large area. The information processing by electrode site by incentive interaction for Measure 4 (the total CNV magnitude) on days 3 and 4 (Figure 4) shows CNV attenuation occurs at Fz, Cz and Pz. A general change in negativity may rely solely upon volume conduction associated with generally localized generators. If an increase in positivity occurs, it would affect CNV and P300 amplitudes regardless of their inception. Since the greatest effect is at Cz for the CNV, it is possible that the change in positivity is greatest here.

A number of recent studies have found either parietal or centro-parietal regions to show larger CNV activity during tasks involving cognitive processing. Pocn et al. (1974) found Pz significantly larger than Cz, which was significantly larger than Fz, in a pattern learning task without a motor response. The STANDARD reaction time task showed a significant decrease in activity from Cz to Pz to Fz. Poon et al. (1976), in a discriminative reaction to letter pair stimuli, found Cz > Pz > Fz. The difference between Pz and Fz was not significant for the reaction time task.

The general finding of larger Pz activity in the more difficult tasks was nct found in this experiment, or in that of Tecce et al. (1976) (although they found significant decreases at Pz and Cz in the letter-recall task versus the STANDARD reaction time task, but not at Fz).

This study found the CNV to have a centro-frontal localization, with increases in the level of information processing causing a general decrease in activity. It is possible that aspects of the experimental task are responsible for this localization. Specifically, this study required the subject to make a motor response to S2, as did the study by Tecce et al. (1976). However, in the studies where the largest CNV activity was found at Pz, no motor response was required. Thus, a motor potential originating from the primary motor region below the Cz electrode site may bias the topography of the CNV towards a more central localization, even in a task requiring what is, presumably, parietal activity.

THE EFFECTS OF INFORMATION PROCESSING LOAD

Only the P300 to S2 was measured in this study, due to variations in the latency of P300 between averages and because it was often unclear. If the averages in Appendix B are examined, it may be seen that a positive and monotonic relationship between information processing load and P300 amplitude to S1 does not exist.

Although the information in S1 and S2 was equal, and the same processes would occur in response to them, the P300 to S2 reflected the change from the STANDARD to the EASY and DIFFICULT conditions, and the P300 to S1 did not. This has also been found by Rohrbaugh et al. (1974), Donchin et al. (1973) and Hirsh (1971) in CNV tasks.

This reflects earlier suggestions that the increase in P300 positivity may actually be an increase in the positivity of CNV resolution. There is no way of distinguishing between the P300 to S2 and the resolution of the CNV, as they occur contiguously. The resolution of the CNV is more than just a return to baseline on the negative excursion, it often overshoots the baseline and resembles a positive potential. (See Figure 1. The return of the CNV to baseline after S2 includes a large positive wave. This is referred to as "CNV resolution".) The overlap of P300, if it is a separate entity, and this positive rebound would distort the measured amplitude due to summation. Donchin (1975) inexplicably found that the two did not summate, but this does not preclude the possibility of such an occurrence in a different situation.

Yet, it is possible that P300 would not occur to S1, not because it is one with CNV resolution, but due to it's own properties. Following S2 a final decision must be made before verbalizing the sums. A large number of papers (Rohrbaugh et al., 1974; Hirsh, 1971; Shelburne, 1972; Smith et al., 1970; Davis, 1964; Spong et al., 1965; Donchin and Cohen, 1967; Naatanen, 1967; Ritter and Vaughan, 1969) have suggested that P300 is an indication of decision-making, although Picton and Hillyard (1974) concluded that P300 actually followed the response and therefore could not be occurring at the same time as the decision.

However the issue is concluded, it must again be asked why the resolution of the CNV, or P300, varies significantly between information processing conditions. The plots suggest that CNV resolution is not in fact more positive (the change in amplitude appears to be the same in all of the conditions), but that this simply reflects the decreased negativity of the CNV with respect to the baseline (see Figure 27).

In a study by Weinberg et al. (1976), different CNV waveforms occurred, depending upon where in the trial the information was given as to which response must be made to S2. The information, in the form of two distinguishable stimuli, was given at either S1 or S2. In the STANDARD condition, the CNV rose early in the interval to its maximum and remained very flat until the occurrence of S2. If the information was at S1, the first part of the CNV was strongly positive and it rose with a positive slope to a maximum negativity at S2. If the information was at S2, maximum negativity occurred early in the interval, and decreased during the interval. The authors concluded that there was an inverse relationship between the amount of information being processed in a moment in time and the magnitude of negativity.

Furthermore, the P300 to S1 appears approximately equal in the two latter information processing conditions, athough it is larger than in the STANDARD condition. The P300 to S2 is more positive if the information is at S2. The plotted averages show that this is because it is riding on the positive slope of the CNV.

Two additional studies show slow potential shifts in

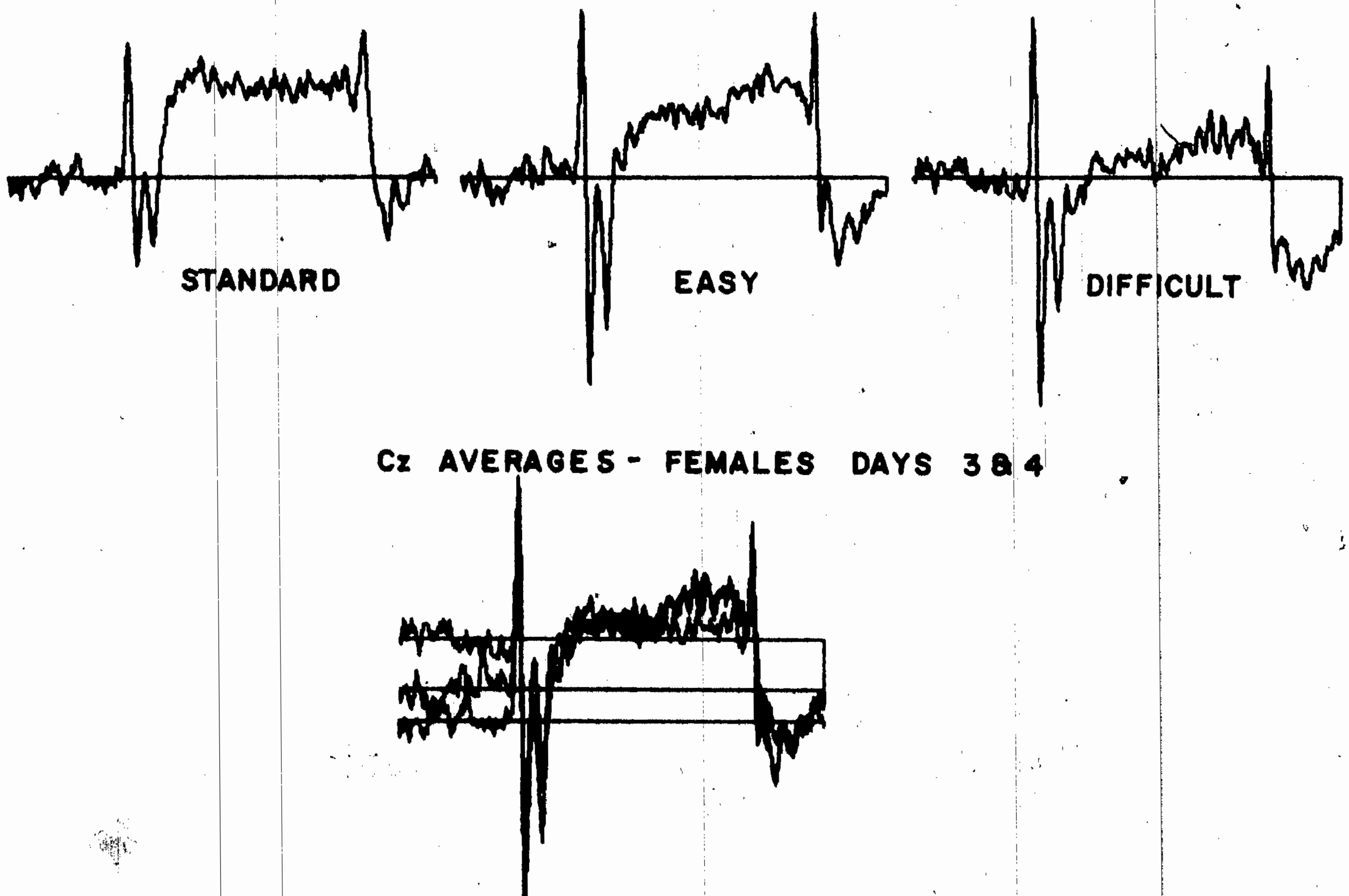


FIGURE 27 - OVERPLOTS OF CNV WAVEFORMS IN INFORMATION PROCESSING CONDITIONS

relationship to information processing load.

Wilson et al. (1973) examined both slow potential shifts (SPSs) and late positive components (LPCs) during trials involving a simple concept indentification. The LPC was generally larger when the evoking stimulus dimension was responded to than when it was not responded to. While the direction of SPS preceding the stimuli showed no general positive or negative tendencies, the SPS showed a positive shift between the hypothesized stimulus and the next stimulus, and this stimulus was followed by a negative shift, thus the LPC occurred overlaid upon a positive shift. The effect of this shift upon the vertex LPC was insignificant.

Tueting and Sutton (1973), discussing the data of Paul (1971), point out a clear SPS occurring during the stimulus detection task. Preceding the stimuli, recorded activity is similar. Following the stmulus, a positive and then negative swing of the SPS occurs. The amplitude of the SPS depends upon the subjects response to the stimulus. It is largest for hits and a clear LPC occurs. Correct rejection trials shows a smaller shift, and the variation is increasing diminished in the misses and false alarms conditions. The use of trial averages may possibly be a problem here, because, given that such a positive shift occurs, time-locking will only occur in the hit conditions.

In this study, the increase in CNV positivity is not a slow change. It may be seen in Figure 27 that the similarity between the three CNV waveforms starts very soon after the evoked potentials to S1. The positive aspects of the evoked potentials to S1 are not inconsistent with the suggestion that they too reflect a more general increase in positivity.

In conclusion, the attenuation of the CNV appears to be the result of a positive potential occurring in the cortex due to information processing which the CNV, including P300, rides upon.

In final conclusion, the best explanation of the CNV attenuation in the conditions requiring tasks in addition to the reaction time task appears to center around the level of information processing load required by the task after the habituation of arousal. The effect, however, seems to occur for female subjects only. The male subjects clearly show arousal and incentive effects, but do not show information processing effects upon CNV or P300 magnitudes.

APPENDIX A

SEQUENCING OF CONDITIONS

SEQUENCING OF CONDITIONS - DAYS 1 TO 4

MALES				FEMALES			
HIGH STANDARD EASY EASY DIFFICULT DIFFICULT STANDARD	HIGH STANDARD DIFFICULT DIFFICULT EASY EASY STANDARD	LOW STANDARD EASY DIFFICULT DIFFICULT EASY STANDARD	LOW STANDARD DIFFICULT EASY EASY DIFFICULT STANDARD	HIGH STANDARD DIFFICULT EASY EASY DIFFICULT STANDARD	HIGH STANDARD EASY DIFFICULT DIFFICULT EASY STANDARD	LOW STANDARD DIFFICULT EASY DIFFICULT EASY STANDARD	LOW STANDARD EASY DIFFICULT EASY DIFFICULT STANDARD
LOW STANDARD DIFFICULT EASY EASY DIFFICULT STANDARD	LOW STANDARD EASY DIFFICULT DIFFICULT EASY STANDARD	LOW STANDARD DIFFICULT DIFFICULT EASY EASY STANDARD	LOW STANDARD EASY EASY DIFFICULT DIFFICULT STANDARD	LOW STANDARD DIFFICULT DIFFICULT EASY EASY STANDARD	LOW STANDARD EASY DIFFICULT EASY DIFFICULT STANDARD	HIGH STANDARD DIFFICULT EASY EASY DIFFICULT STANDARD	HIGH STANDARD EASY DIFFICULT DIFFICULT EASY STANDARD
HIGH STANDARD DIFFICULT EASY DIFFICULT EASY STANDARD	LOW STANDARD EASY EASY DIFFICULT DIFFICULT STANDARD	HIGH STANDARD EASY DIFFICULT EASY DIFFICULT STANDARD	LOW STANDARD DIFFICULT DIFFICULT EASY EASY STANDARD	LOW STANDARD EASY DIFFICULT EASY DIFFICULT STANDARD	HIGH STANDARD DIFFICULT EASY DIFFICULT EASY STANDARD	HIGH STANDARD EASY EASY DIFFICULT DIFFICULT STANDARD	LOW STANDARD DIFFICULT DIFFICULT EASY EASY STANDARD
LOW STANDARD EASY DIFFICULT EASY DIFFICULT STANDARD	HIGH STANDARD DIFFICULT EASY DIFFICULT EASY STANDARD	LOW STANDARD DIFFICULT DIFFICULT EASY DIFFICULT STANDARD	HIGH STANDARD EASY EASY DIFFICULT EASY STANDARD	HIGH STANDARD EASY DIFFICULT DIFFICULT EASY STANDARD	LOW STANDARD DIFFICULT EASY EASY DIFFICULT STANDARD	HIGH STANDARD EASY DIFFICULT DIFFICULT EASY STANDARD	LOW STANDARD DIFFICULT EASY EASY DIFFICULT STANDARD

HIGH: HIGH INCENTIVE CONDITION

LOW: LOW INCENTIVE CONDITION

APPENDIX B

ANALYSES OF VARIANCE

ANALYSIS OF VARIANCE - CNV DAYS 1 & 2 - MEASURE 1

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S(XO)	310589.3	310589.3	4.5503
2 X (SEX)	1	S(XO)	7729.859	7729.859	0.1132
3 E (ELECTRODES)	3	ES(XO)	250252.2	83417.38	16.5537*
4 I (INCENTIVE)	1	IS(XO)	5507.383	5507.383	2.0771
5 O (ORDER)	1	S(XO)	12670.94	12670.94	0.1856
6 P (PROCESSING)	2	SP(XO)	[illegible]	[illegible]	11.5950*
7 T (TRIALS)	15	ST(XO)	44064.23	2937.615	1.2862
8 XE	3	ES(XO)	20804.75	6934.919	1.2094
9 XI	1	IS(XO)	1879.691	1879.691	0.6988
10 [illegible]	3	EIS(XO)	[illegible]	[illegible]	0.3287
11 XO	1	S(XO)	[illegible]	[illegible]	0.0346
12 EO	3	ES(XO)	[illegible]	[illegible]	2.8008
13 IO	1	IS(XO)	5231.701	5231.701	[illegible]
14 XP	2	SP(XO)	[illegible]	8234.750	1.9315
15 EP	6	ESP(XO)	[illegible]	[illegible]	[illegible]
16 IP	2	ISP(XO)	[illegible]	[illegible]	1.0702
17 OP	2	SP(XO)	[illegible]	[illegible]	[illegible]
18 [illegible]	15	ST(XO)	[illegible]	[illegible]	1.7939
19 [illegible]	45	EST(XO)	[illegible]	[illegible]	[illegible]
20 [illegible]	15	IST(XO)	[illegible]	1756.322	0.6543
21 OT	15	ST(XO)	[illegible]	[illegible]	1.6392
22 [illegible]	30	SPT(XO)	[illegible]	[illegible]	1.1443
23 [illegible](XO)	4		[illegible]	[illegible]	
24 [illegible]	3	EIS(XO)	[illegible]	[illegible]	0.2058
25 [illegible]	3	ES(XO)	[illegible]	[illegible]	0.3180
26 [illegible]	1	IS(XO)	9195.707	9195.707	3.4185
27 [illegible]	3	EIS(XO)	[illegible]	[illegible]	0.1597
28 [illegible]	6	ESP(XO)	[illegible]	660.0938	0.5236
29 [illegible]	2	ISP(XO)	[illegible]	711.3730	0.2895
30 [illegible]	6	EISP(XO)	[illegible]	[illegible]	1.2731
31 [illegible]	2	SP(XO)	[illegible]	[illegible]	1.1542
32 [illegible]	6	ESP(XO)	[illegible]	[illegible]	2.3777
33 [illegible]	2	ISP(XO)	[illegible]	[illegible]	0.6124
34 [illegible]	45	EST(XO)	[illegible]	[illegible]	1.0154
35 [illegible]	15	IST(XO)	[illegible]	[illegible]	0.9603
36 [illegible]	45	EIST(XO)	[illegible]	[illegible]	1.1513
37 [illegible]	15	ST(XO)	[illegible]	[illegible]	1.0158
38 [illegible]	45	EST(XO)	[illegible]	451.6604	0.9552
39 [illegible]	15	IST(XO)	[illegible]	[illegible]	0.5248
40 [illegible]	30	SPT(XO)	[illegible]	[illegible]	0.5691
41 [illegible]	90	ESPT(XO)	[illegible]	[illegible]	0.9341
42 [illegible]	30	ISPT(XO)	[illegible]	[illegible]	1.2456
43 [illegible]	[illegible]	SPT(XO)	[illegible]	[illegible]	0.7056
44 [illegible](XO)	[illegible]		[illegible]	[illegible]	
45 [illegible](XO)	[illegible]		[illegible]	[illegible]	
46 [illegible](XO)	[illegible]		[illegible]	[illegible]	
47 [illegible](XO)	60		[illegible]	[illegible]	
48 [illegible]	3	EIS(XO)	[illegible]	[illegible]	0.5693
49 [illegible]	6	EISP(XO)	[illegible]	[illegible]	0.2200
50 [illegible]	6	ESP(XO)	[illegible]	[illegible]	0.5729
51 [illegible]	2	ISP(XO)	[illegible]	[illegible]	1.0774
52 [illegible]	6	EISP(XO)	[illegible]	[illegible]	0.4740
53 [illegible]	45	EIST(XO)	[illegible]	[illegible]	0.8551
54 [illegible]	45	EST(XO)	[illegible]	[illegible]	0.9710
55 [illegible]	15	IST(XO)	[illegible]	[illegible]	0.8008
56 [illegible]	45	EIST(XO)	[illegible]	[illegible]	1.3433
57 [illegible]	90	ESPT(XO)	[illegible]	[illegible]	1.0712
58 [illegible]	[illegible]	ISPT(XO)	[illegible]	[illegible]	0.5669
59 [illegible]	90	EISPT(XO)	[illegible]	[illegible]	1.2828
60 [illegible]	[illegible]	SPT(XO)	[illegible]	[illegible]	0.9169
61 [illegible]	[illegible]	ESPT(XO)	[illegible]	[illegible]	0.7745
62 [illegible]	30	ISPT(XO)	[illegible]	[illegible]	0.5976
63 [illegible](XO)	12		[illegible]	[illegible]	
64 [illegible](XO)	24		[illegible]	[illegible]	
65 [illegible](XO)	[illegible]		[illegible]	[illegible]	
66 [illegible](XO)	180		[illegible]	[illegible]	
67 [illegible](XO)	120		[illegible]	[illegible]	
68 [illegible]	[illegible]	EISP(XO)	[illegible]	[illegible]	0.9886
69 [illegible]	[illegible]	EIST(XO)	[illegible]	[illegible]	[illegible]
70 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.7220
71 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
73 [illegible]	[illegible]	EISPT(XO)	[illegible]	[illegible]	1.1986
74 [illegible]	[illegible]		[illegible]	[illegible]	
75 [illegible](XO)	[illegible]		[illegible]	[illegible]	
76 [illegible](XO)	180		[illegible]	[illegible]	
77 [illegible](XO)	360		[illegible]	[illegible]	
78 [illegible](XO)	120		[illegible]	[illegible]	
79 [illegible]	90	EISPT(XO)	[illegible]	[illegible]	1.2075
80 EISPT(XO)	360		[illegible]	[illegible]	

* p < .05

ANALYSIS OF VARIANCE - CNV DAYS 1 & 2 - MEASURE 2

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S(XO)	333083.3	333083.3	22.4557
2 X (SEX)	1	S(XO)	30.08333	30.08333	0.0020
3 E (ELECTRODES)	3	ES(XO)	210708.3	70236.06	35.4886*
4 I (INCENTIVE)	1	IS(XO)	4695.574	4695.574	18.0782*
5 O (ORDER)	1	S(XO)	18213.02	18213.02	1.2279
6 P (PROCESSING)	2	SP(XO)	87487.69	43743.85	4.0940
7 T (TRIALS)	15	ST(XO)	56726.50	3781.767	1.0426
8 XE	3	ES(XO)	31125.50	10375.16	5.2423*
9 XI	1	IS(XO)	15579.01	15579.01	59.9799*
10 EI	3	EIS(XO)	1639.551	546.5168	0.4093
11 XO	1	S(XO)	221.0195	221.0195	0.0149
12 EO	3	ES(XO)	50450.29	16816.76	8.4971*
13 IO	1	IS(XO)	12088.80	12088.80	46.5424*
14 XP	2	SP(XO)	2686.125	1343.063	0.1257
15 EP	6	ESP(XO)	27472.25	4578.707	3.3438*
16 IP	2	ISP(XO)	4159.688	2079.844	1.3485
17 OP	2	SP(XO)	3437.813	1718.906	0.1609
18 XT	15	ST(XO)	65355.50	4357.035	1.2012
19 ET	45	EST(XO)	19364.75	430.3276	0.6652
20 IT	15	IST(XO)	47221.25	3148.083	1.1406
21 OT	15	ST(XO)	93505.63	6233.707	1.7186
22 PT	30	SPT(XO)	92606.25	3086.875	1.0207
23 S(XO)	4		59331.56	14832.89	
24 XEI	3	EIS(XO)	5096.117	1698.706	1.2722
25 XEO	3	ES(XO)	2078.375	692.7915	0.3501
26 XIO	1	IS(XO)	33853.78	33853.78	130.3385*
27 EIO	3	EIS(XO)	7942.219	2647.406	1.9827
28 XEP	6	ESP(XO)	5480.313	913.3853	0.6670
29 XIP	2	ISP(XO)	2104.992	1052.496	0.6824
30 EIP	6	EISP(XO)	1992.824	332.1372	0.4011
31 XOP	2	SP(XO)	10856.54	5428.270	0.5080
32 EOP	6	ESP(XO)	8190.020	1365.003	0.9968
33 IOP	2	ISP(XO)	1985.074	992.5371	0.6435
34 XET	45	EST(XO)	22067.19	490.3818	0.7580
35 XIT	15	IST(XO)	43811.69	2920.779	1.0583
36 EIT	45	EIST(XO)	25003.06	555.6235	1.0920
37 XOT	15	ST(XO)	25266.00	1684.400	0.4644
38 EOT	45	EST(XO)	30206.44	671.2542	1.0376
39 IOT	15	IST(XO)	48454.06	3230.271	1.1704
40 XPT	30	SPT(XO)	102268.1	3408.935	1.1272
41 EPT	90	ESPT(XO)	63621.68	706.9076	1.1970
42 IPT	30	ISPT(XO)	120739.3	4024.644	1.1182
43 OPT	30	SPT(XO)	122687.7	4089.589	1.3258
44 ES(XO)	12		23749.35	1979.113	
45 IS(XO)	4		1038.949	259.7373	
46 SP(XO)	8		85478.56	10684.82	
47 ST(XO)	60		217634.3	3627.239	
48 [illegible]	3	EIS(XO)	3523.293	1174.431	0.8796
49 [illegible]	6	EISP(XO)	1021.195	170.1992	0.2055
50 [illegible]	6	ESP(XO)	2817.082	469.5137	0.3429
51 [illegible]	2	ISP(XO)	13818.93	6909.461	4.4473
52 [illegible]	6	EISP(XO)	[illegible]	772.2603	0.9326
53 [illegible]	6	EISP(XO)	[illegible]	614.7207	1.2081
54 [illegible]	45	EST(XO)	[illegible]	[illegible]	0.9030
55 [illegible]	15	IST(XO)	[illegible]	2492.217	0.9030
56 [illegible]	45	EIST(XO)	[illegible]	[illegible]	1.1790
57 [illegible]	90	ESPT(XO)	[illegible]	[illegible]	1.0145
58 [illegible]	30	ISPT(XO)	[illegible]	3632.323	1.0092
59 [illegible]	90	EISPT(XO)	[illegible]	[illegible]	1.0727
60 [illegible]	[illegible]	SPT(XO)	[illegible]	[illegible]	0.7016
61 [illegible]	90	ESPT(XO)	[illegible]	[illegible]	0.8070
62 [illegible]	30	ISPT(XO)	[illegible]	[illegible]	0.5119
63 [illegible]	12		[illegible]	[illegible]	
64 [illegible]	24		[illegible]	[illegible]	
65 [illegible]	8		[illegible]	[illegible]	
66 [illegible]	180		[illegible]	[illegible]	
67 [illegible]	[illegible]		[illegible]	[illegible]	
68 [illegible]	120		[illegible]	[illegible]	
69 [illegible]	[illegible]	EISP(XO)	[illegible]	[illegible]	0.5641
70 [illegible]	45	EIST(XO)	[illegible]	[illegible]	1.1335
71 [illegible]	[illegible]	EISPT(XO)	[illegible]	[illegible]	0.9304
72 [illegible]	[illegible]	ESPT(XO)	[illegible]	[illegible]	1.0324
73 [illegible]	30	ISPT(XO)	[illegible]	[illegible]	1.1972
74 [illegible]	90	EISPT(XO)	[illegible]	[illegible]	1.1210
75 [illegible]	24		[illegible]	[illegible]	
76 [illegible]	180		[illegible]	[illegible]	
77 [illegible]	180		[illegible]	[illegible]	
78 [illegible]	120		[illegible]	[illegible]	
79 [illegible]	90	EISPT(XO)	[illegible]	[illegible]	0.7855
80 EISPT(XO)	360		202255.1	561.8196	

* p < .05

ANALYSIS OF VARIANCE - CNV DAYS 1 & 2 - MEASURE 3

SOURCE		DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1	MEAN	1	S(XO)	611613.1	611613.1	20.1842
2	X (SEX)	1	S(XO)	14430.00	14430.00	0.4762
3	E (ELECTRODES)	3	ES(XO)	611197.6	203732.5	26.9950*
4	I (INCENTIVE)	1	IS(XO)	23852.08	23852.08	6.3355
5	O (ORDER)	1	S(XO)	26449.27	26449.27	0.8729
6	P (PROCESSING)	2	SP(XO)	34442.31	17221.16	1.0585
7	T (TRIALS)	15	ST(XO)	65895.63	4393.039	1.0461
8	XE	3	ES(XO)	45826.06	15275.35	2.0240
9	XI	1	IS(XO)	40070.48	40070.48	10.6454*
10	EI	3	EIS(XO)	1462.855	487.6184	0.7933
11	XO	1	S(XO)	62.45703	62.45703	0.0021
12	EO	3	ES(XO)	39683.61	13227.87	1.7527
13	IO	1	IS(XO)	14076.73	14076.73	3.7390
14	XP	2	SP(XO)	578.6563	289.3281	0.0178
15	EP	6	ESP(XO)	48274.75	8045.789	3.4626*
16	IP	2	ISP(XO)	8225.730	4112.863	1.0538
17	OP	2	SP(XO)	4660.293	2330.146	0.1432
18	XT	15	ST(XO)	59424.50	3961.633	0.9434
19	ET	45	EST(XO)	20950.38	465.5637	0.6038
20	IT	15	IST(XO)	30470.94	2031.396	0.6986
21	OT	15	ST(XO)	90610.69	6040.711	1.4385
22	PT	30	SPT(XO)	127491.6	4249.719	1.2712
23	S(XO)	4		121206.6	30301.64	
24	XEI	3	EIS(XO)	1253.102	417.7004	0.6795
25	XEO	3	ES(XO)	9607.063	3202.354	0.4243
26	XIO	1	IS(XO)	40251.96	40251.96	10.6915*
27	EIO	3	EIS(XO)	3813.102	1271.034	2.0677
28	XEP	6	ESP(XO)	7302.594	1217.099	0.5238
29	XIP	2	ISP(XO)	5169.508	2584.754	0.6623
30	EIP	6	EISP(XO)	1970.227	328.3711	0.2522
31	XOP	2	SP(XO)	846.2617	423.1309	0.0260
32	EOP	6	ESP(XO)	9922.852	1653.809	0.7117
33	IOP	2	ISP(XO)	1001.977	500.9883	0.1284
34	XET	45	EST(XO)	37231.13	827.3582	1.0731
35	XIT	15	IST(XO)	50005.13	3333.675	1.1464
36	EIT	45	EIST(XO)	35516.44	789.2542	0.8737
37	XOT	15	ST(XO)	24525.81	1635.054	0.3894
38	EOT	45	EST(XO)	42613.38	946.9639	1.2282
39	IOT	15	IST(XO)	51014.63	3400.975	1.1695
40	XPT	30	SPT(XO)	107724.6	3590.821	1.0741
41	EPT	90	ESPT(XO)	81655.19	907.2799	1.2484
42	IPT	30	ISPT(XO)	142388.5	4746.281	1.2173
43	OPT	30	SPT(XO)	153087.7	5102.923	1.5376
44	ES(XO)	12		90564.56	7547.047	
45	IS(XO)	4		15059.42	3764.854	
46	SP(XO)	8		130158.8	16269.84	
47	ST(XO)	60		251966.3	4199.438	
48	XEIO	3	EIS(XO)	5050.422	1683.474	2.7387
49	XEIP	6	EISP(XO)	1806.152	301.0254	0.2312
50	XEOP	6	ESP(XO)	6614.813	1102.469	0.4745
51	XIOP	2	ISP(XO)	15018.07	7509.031	1.9239
52	EIOP	6	EISP(XO)	12140.45	2023.407	1.5542
53	XEIT	45	EIST(XO)	28414.88	631.4417	0.6990
54	XEOT	45	EST(XO)	23821.94	529.3762	1.6866
55	XIOT	15	IST(XO)	79424.36	5294.957	1.8201
56	EIOT	45	EIST(XO)	35033.50	778.5222	0.8618
57	XEPT	90	ESPT(XO)	56273.19	625.2576	0.8603
58	XIPT	30	ISPT(XO)	144094.1	4803.133	1.2319
59	EIPT	90	EISPT(XO)	70270.63	780.7847	1.0587
60	XOPT	30	SPT(XO)	51765.25	1725.508	0.5161
61	EOPT	90	ESPT(XO)	57222.63	635.8069	0.8748
62	IOPT	30	ISPT(XO)	92759.19	3091.973	0.7930
63	EIS(XO)	12		7376.348	614.6956	
64	ESP(XO)	24		55767.25	2323.635	
65	ISP(XO)	8		31223.81	3902.976	
66	EST(XO)	180		138782.9	771.0161	
67	IST(XO)	60		174480.0	2908.000	
68	SPT(XO)	120		401181.4	3310.708	
69	XEIOP	6	EISP(XO)	3501.684	583.6138	0.4483
70	XEIOT	45	EIST(XO)	30639.19	680.8706	0.7537
71	XEIPT	90	EISPT(XO)	62081.38	689.9061	0.9354
72	XEOPT	90	ESPT(XO)	52536.88	583.7429	0.8032
73	XIOPT	30	ISPT(XO)	104050.8	3468.360	0.8895
74	EIOPT	90	EISPT(XO)	50918.19	565.7576	0.7671
75	EISP(XO)	24		31246.38	1301.933	
76	EIST(XO)	180		162596.8	903.3154	
77	ESPT(XO)	360		261640.8	726.7800	
78	ISPT(XO)	120		467881.8	3899.014	
79	XEIOPT	90	EISPT(XO)	55829.81	620.3311	0.8411
80	EISPT(XO)	360		265505.6	737.5156	

* P < .05

ANALYSIS OF VARIANCE - CNV DAYS 1 & 2 - MEASURE 4

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S (XO)	.1030245E 08	.1030245E 083	14.5929
2 X (SEX)	1	S (XO)	163595.9	163595.9	0.2317
3 E (ELECTRODES)	3	ES (XO)	5380987.	1793662.	24.8989*
4 I (INCENTIVE)	1	IS (XO)	158470.1	158470.1	15.2098*
5 O (ORDER)	1	S (XO)	74045.13	74045.13	0.1049
6 P (PROCESSING)	2	SP (XO)	1902051.	951025.5	4.9197*
7 T (TRIALS)	15	ST (XO)	1031220.	68748.00	1.0775
8 XE	3	ES (XO)	797363.0	265787.6	3.6896
9 XI	1	IS (XO)	446794.6	446794.6	42.8830*
10 EI	3	EIS (XO)	22072.94	7357.645	0.2922
11 XO	1	S (XO)	18811.94	18811.94	0.0266
12 EO	3	ES (XO)	1188986.	396328.6	5.5017*
13 IO	1	IS (XO)	288067.1	288067.1	27.6405*
14 XP	2	SP (XO)	32138.00	16069.00	0.0831
15 EP	6	ESP (XO)	754049.0	125674.8	4.1539*
16 IP	2	ISP (XO)	103864.0	51932.00	1.7648
17 OP	2	SP (XO)	157429.0	78714.50	0.4072
18 XT	15	ST (XO)	1213562.	80904.13	1.2681
19 ET	45	EST (XO)	326512.9	7255.840	0.6135
20 IT	15	IST (XO)	724195.9	48279.39	1.0465
21 OT	15	ST (XO)	1736703.	115780.2	1.8147
22 PT	30	SPT (XO)	1924892.	64163.07	1.1184
23 S (XO)	4		2823959.	705989.8	
24 [illegible]	3	EIS (XO)	53784.44	17928.14	0.7121
25 [illegible]	3	ES (XO)	62558.00	20852.66	0.2895
26 [illegible]	1	IS (XO)	535621.3	535621.3	51.4085*
27 [illegible]	3	EIS (XO)	115706.9	38568.96	1.5319
28 [illegible]	6	ESP (XO)	122376.0	20396.00	0.6741
29 [illegible]	2	ISP (XO)	13389.38	6694.688	0.2275
30 [illegible]	6	EISP (XO)	49777.06	8296.176	0.3722
31 [illegible]	2	SP (XO)	79451.06	39725.53	0.2055
32 [illegible]	6	ESP (XO)	223048.0	37174.66	1.2287
33 [illegible]	2	ISP (XO)	7236.875	3618.438	0.1230
34 [illegible]	45	EST (XO)	547393.1	12164.29	1.0285
35 [illegible]	15	IST (XO)	695541.1	46369.40	1.0052
36 [illegible]	45	EIST (XO)	479181.1	10648.46	0.9526
37 [illegible]	15	ST (XO)	418449.0	27896.60	0.4372
38 [illegible]	45	EST (XO)	621937.0	13820.82	1.1685
39 [illegible]	15	IST (XO)	641784.0	42785.60	0.9275
40 [illegible]	30	SPT (XO)	1670262.	55675.40	0.9740
41 [illegible]	90	ESPT (XO)	1079397.	11993.30	1.0031
42 [illegible]	30	ISPT (XO)	2471215.	82373.81	1.1621
43 [illegible]	30	SPT (XO)	2069858.	68995.25	1.1974
44 [illegible] (XO)	12		864453.0	72037.75	
45 [illegible] (XO)	4		413675.69	103418.92	
46 [illegible] (XO)	8		1541743.	192717.9	
47 [illegible] (XO)	60		[illegible]	[illegible]	
48 [illegible]	3	EIS (XO)	[illegible]	17436.41	0.6925
49 [illegible]	6	EISP (XO)	[illegible]	[illegible]	0.2291
50 [illegible]	6	ESP (XO)	[illegible]	[illegible]	0.4552
51 [illegible]	2	ISP (XO)	[illegible]	[illegible]	5.1760*
52 [illegible]	6	EISP (XO)	[illegible]	[illegible]	0.8210
53 [illegible]	45	EIST (XO)	[illegible]	[illegible]	0.9838
54 [illegible]	45	EST (XO)	[illegible]	[illegible]	0.8158
55 [illegible]	15	IST (XO)	[illegible]	67776.00	1.3607
56 [illegible]	45	[illegible]	[illegible]	[illegible]	1.0732
57 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.9280
58 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.8537
59 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.0970
60 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.5955
61 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.7423
62 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.5228
63 [illegible] (XO)	12		[illegible]	[illegible]	
64 [illegible] (XO)	24		[illegible]	[illegible]	
65 [illegible] (XO)	8		[illegible]	[illegible]	
66 [illegible] (XO)	180		[illegible]	[illegible]	
67 [illegible] (XO)	60		[illegible]	[illegible]	
68 [illegible] (XO)	120		[illegible]	[illegible]	
69 [illegible]	[illegible]	EISP (XO)	[illegible]	[illegible]	0.5660
70 [illegible]	[illegible]	EIST (XO)	[illegible]	[illegible]	1.0898
71 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.8169
72 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.9735
73 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.9717
74 [illegible]	[illegible]	EISPT (XO)	[illegible]	[illegible]	0.8968
75 [illegible] (XO)	[illegible]		[illegible]	[illegible]	
76 [illegible] (XO)	180		[illegible]	[illegible]	
77 [illegible] (XO)	[illegible]		[illegible]	[illegible]	
78 [illegible] (XO)	120		[illegible]	[illegible]	
79 [illegible]	90	EISPT (XO)	[illegible]	8654.603	0.7749
80 EISPT (XO)	360		4020725.	11168.69	

* P < .05

ANALYSIS OF VARIANCE - CNV DAYS 3 & 4 - MEASURE 1

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S(XO)	361769.3	361769.3	11.9122
2 X (SEX)	1	S(XO)	5799.750	5799.750	0.1910
3 E (ELECTRODES)	3	ES(XO)	213923.8	71307.88	8.5654*
4 I (INCENTIVE)	1	IS(XO)	1393.477	1393.477	0.5519
5 O (ORDER)	1	S(XO)	9341.617	9341.617	0.3076
6 P (PROCESSING)	2	SP(XO)	92327.19	46163.59	7.1184*
7 T (TRIALS)	15	ST(XO)	62193.07	4146.203	1.7583
8 XE	3	ES(XO)	11217.50	3739.167	0.4491
9 XI	1	IS(XO)	5164.156	5164.156	2.0452
10 EI	3	EIS(XO)	4993.148	1664.383	1.7536
11 XO	1	S(XO)	1369.336	1369.336	0.0451
12 EO	3	ES(XO)	34699.13	11566.38	1.3893
13 IO	1	IS(XO)	2679.410	2679.410	1.0611
14 XP	2	SP(XO)	60738.38	30369.19	4.6829*
15 EP	6	ESP(XO)	25034.75	4172.457	5.8594*
16 IP	2	ISP(XO)	4006.125	2003.063	1.8976
17 OP	2	SP(XO)	8538.375	4269.188	0.6583
18 XT	15	ST(XO)	59042.43	3936.162	1.6692
19 ET	45	EST(XO)	20254.18	450.0928	0.9769
20 IT	15	IST(XO)	20609.68	1373.979	0.5864
21 OT	15	ST(XO)	34882.30	2325.487	0.9862
22 PT	30	SPT(XO)	75195.44	2506.514	1.1584
23 S(XO)	4		121478.6	30369.64	
24 XEI	3	EIS(XO)	676.7813	225.5938	0.2377
25 XEO	3	ES(XO)	33911.43	11303.81	1.3578
26 XIO	1	IS(XO)	1907.957	1907.957	0.7556
27 EIO	3	EIS(XO)	7368.777	2456.259	2.5879
28 XEP	6	ESP(XO)	2506.813	417.8020	0.5867
29 XIP	2	ISP(XO)	5685.000	2842.500	2.6928
30 EIP	6	EISP(XO)	8382.039	1397.006	1.3365
31 XOP	2	SP(XO)	4029.938	2014.969	0.3107
32 EOP	6	ESP(XO)	7929.930	1321.655	1.8560
33 IOP	2	ISP(XO)	1922.152	961.0762	0.9105
34 XET	45	EST(XO)	22233.14	494.0696	1.0723
35 XIT	15	IST(XO)	20788.52	1385.901	0.5915
36 EIT	45	EIST(XO)	17045.48	378.7883	0.7414
37 XOT	15	ST(XO)	21194.45	1412.963	0.5992
38 EOT	45	EST(XO)	21919.17	487.1057	1.0572
39 IOT	15	IST(XO)	46872.13	3124.809	1.3336
40 XPT	30	SPT(XO)	85493.00	2849.767	1.3170
41 EPT	90	ESPT(XO)	52961.30	588.4591	1.2689
42 IPT	30	ISPT(XO)	45364.31	1512.144	0.6168
43 OPT	30	SPT(XO)	80501.81	2683.394	1.2401
44 ES(XO)	12		99900.81	8325.066	
45 IS(XO)	4		10100.23	2525.058	
46 SP(XO)	8		51880.94	6485.117	
47 ST(XO)	60		141486.2	2358.103	
48 XEIO	3	EIS(XO)	2227.637	742.5454	0.7823
49 XEIP	6	EISP(XO)	1593.055	265.5090	0.2540
50 XEOP	6	ESP(XO)	6286.516	1047.752	1.4714
51 XIOP	2	ISP(XO)	2183.516	1091.758	1.0343
52 EIOP	6	EISP(XO)	5433.477	905.5793	0.8664
53 XEIT	45	EIST(XO)	13275.86	295.0190	0.5774
54 XEOT	45	EST(XO)	25905.72	575.6826	1.2494
55 XIOT	15	IST(XO)	45653.49	3043.566	1.2989
56 EIOT	45	EIST(XO)	27650.12	614.4470	1.2026
57 XEPT	90	ESPT(XO)	47816.25	531.2915	1.1456
58 XIPT	30	ISPT(XO)	59830.69	1994.356	0.8135
59 EIPT	90	EISPT(XO)	52652.56	585.0283	1.1022
60 XOPT	30	SPT(XO)	79384.31	2646.144	1.2229
61 EOPT	90	ESPT(XO)	52456.38	582.8484	1.2568
62 IOPT	30	ISPT(XO)	87136.06	2904.535	1.1847
63 EIS(XO)	12		11389.51	949.1255	
64 ESP(XO)	24		17090.17	712.0903	
65 ISP(XO)	8		8444.691	1055.586	
66 EST(XO)	180		82936.63	460.7588	
67 IST(XO)	60		140589.1	2343.152	
68 SPT(XO)	120		259657.8	2163.815	
69 XEIOP	6	EISP(XO)	1616.141	269.3567	0.2577
70 XEIOT	45	EIST(XO)	20605.45	457.8989	0.8962
71 XEIPT	90	EISPT(XO)	41229.25	458.1025	0.8631
72 XEOPT	90	ESPT(XO)	51351.50	570.5774	1.2303
73 XIOPT	30	ISPT(XO)	67774.31	2259.144	0.9215
74 EIOPT	90	EISPT(XO)	38892.50	432.1387	0.8141
75 EISP(XO)	24		25086.38	1045.266	
76 EIST(XO)	180		91966.38	510.9241	
77 ESPT(XO)	360		166951.9	463.7553	
78 ISPT(XO)	120		294199.7	2451.664	
79 XEIOPT	90	EISPT(XO)	36756.31	408.4033	0.7694
80 EISPT(XO)	360		191083.2	530.7866	

* $p < .05$

ANALYSIS OF VARIANCE - CNV DAYS 3 & 4 - MEASURE 2

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S(XO)	567049.8	567049.8	61.8750
2 X (SEX)	1	S(XO)	12164.31	12164.31	1.3273
3 E (ELECTRODES)	3	ES(XO)	184596.8	61532.25	20.2672*
4 I (INCENTIVE)	1	IS(XO)	1151.745	1151.745	0.1437
5 O (ORDER)	1	S(XO)	1356.016	1356.016	0.1480
6 P (PROCESSING)	2	SP(XO)	53887.53	26943.77	7.5741*
7 T (TRIALS)	15	ST(XO)	51849.43	3456.628	0.9751
8 XE	3	ES(XO)	14788.19	4929.395	1.6236
9 XI	1	IS(XO)	12533.19	12533.19	1.5634
10 EI	3	EIS(XO)	5150.691	1716.897	5.2741*
11 XO	1	S(XO)	3364.656	3364.656	0.3671
12 EO	3	ES(XO)	17984.11	5994.703	1.9745
13 IO	1	IS(XO)	8516.672	8516.672	1.0624
14 XP	2	SP(XO)	44778.22	22389.11	6.2938*
15 EP	6	ESP(XO)	29100.16	4916.693	5.6729*
16 IP	2	ISP(XO)	7551.410	3775.705	0.5842
17 OP	2	SP(XO)	11309.64	5654.820	1.5896
18 XT	15	ST(XO)	40225.57	2681.705	0.7565
19 ET	45	EST(XO)	31365.70	697.0154	1.1548
20 IT	15	IST(XO)	40774.95	2718.330	0.6839
21 OT	15	ST(XO)	54996.95	3666.463	1.0343
22 PT	30	SPT(XO)	75250.56	2508.352	0.7955
23 S(XO)	4		36657.77	9164.441	
24 XEI	3	EIS(XO)	2066.621	688.8735	2.1161
25 XEO	3	ES(XO)	13319.22	4439.738	1.4623
26 XIO	1	IS(XO)	759.0430	759.0430	0.0947
27 EIO	3	EIS(XO)	2753.141	917.7134	2.8191
28 XEP	6	ESP(XO)	6750.688	1125.115	1.5890
29 XIP	2	ISP(XO)	894.4297	447.2148	0.0692
30 EIP	6	EISP(XO)	6174.586	1029.098	1.3719
31 XOP	2	SP(XO)	897.8906	448.9453	0.1262
32 EOP	6	ESP(XO)	7791.375	1298.563	1.8340
33 IOP	2	ISP(XO)	6740.184	3370.092	0.5214
34 XET	45	EST(XO)	28533.16	634.0703	1.0505
35 XIT	15	IST(XO)	32952.49	2196.833	0.5527
36 EIT	45	EIST(XO)	23477.41	521.7202	0.8117
37 XOT	15	ST(XO)	54095.30	3606.353	1.0173
38 EOT	45	EST(XO)	24400.99	542.2441	0.8984
39 IOT	15	IST(XO)	83173.00	5544.863	1.3951
40 XPT	30	SPT(XO)	117223.9	3907.464	1.2393
41 EPT	90	ESPT(XO)	58905.88	654.5095	1.0840
42 IPT	30	ISPT(XO)	82428.00	2747.600	0.7982
43 OPT	30	SPT(XO)	78737.44	2624.581	0.8324
44 ES(XO)	12		36432.52	3036.043	
45 IS(XO)	4		32066.19	8016.547	
46 SP(XO)	8		28458.64	3557.332	
47 ST(XO)	60		212699.6	3544.994	
48 XEIO	3	EIS(XO)	1418.719	472.9063	1.4527
49 XEIP	6	EISP(XO)	2318.328	386.3879	0.5151
50 XEOP	6	ESP(XO)	3698.344	616.3906	0.8705
51 XIOP	2	ISP(XO)	14804.00	7401.996	1.1452
52 EIOP	6	EISP(XO)	1804.570	300.7617	0.4010
53 XEIT	45	EIST(XO)	20715.97	460.3547	0.7162
54 XEOT	45	EST(XO)	25938.27	576.4060	0.9550
55 XIOT	15	IST(XO)	43852.69	2923.512	0.7356
56 EIOT	45	EIST(XO)	37065.63	823.6807	1.2815
57 XEPT	90	ESPT(XO)	58975.56	655.2839	1.0852
58 XIPT	30	ISPT(XO)	99156.81	3305.227	0.9602
59 EIPT	90	EISPT(XO)	53536.13	594.8457	0.9577
60 XOPT	30	SPT(XO)	74374.50	2479.150	0.7863
61 EOPT	90	ESPT(XO)	69952.45	777.2439	1.2874
62 IOPT	30	ISPT(XO)	131987.6	4399.586	1.2782
63 EIS(XO)	12		[illegible]	[illegible]	
64 ESP(XO)	24		16993.30	708.0540	
65 ISP(XO)	8		51706.69	6463.336	
66 EST(XO)	180		108642.3	603.5684	
67 IST(XO)	60		238470.8	3974.512	
68 SPT(XO)	120		[illegible]	3153.035	
69 XEIOP	6	EISP(XO)	3637.988	606.3313	0.8117
70 XEIOT	45	EIST(XO)	24749.75	550.0021	0.8567
71 XEIPT	90	EISPT(XO)	63277.75	703.0859	1.1320
72 XEOPT	90	ESPT(XO)	66363.31	737.3921	1.2577
73 XIOPT	30	ISPT(XO)	77181.06	2572.702	0.7474
74 EIOPT	90	EISPT(XO)	[illegible]	606.5474	0.9766
75 EISP(XO)	24		18002.45	750.1019	
76 EIST(XO)	180		115698.8	642.7711	
77 ESPT(XO)	360		217372.2	603.8094	
78 ISPT(XO)	120		413050.0	3442.083	
79 XEIOPT	90	EISPT(XO)	51136.06	568.1785	0.9148
80 EISPT(XO)	360		223593.6	621.0938	

* P < .05

ANALYSIS OF VARIANCE - CNV DAYS 1 & 4 - MEASURE 3

SOURCE		DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1	MEAN	1	S(XO)	960608.1	960608.1	57.3587
2	X (SEX)	1	S(XO)	41735.13	41735.13	2.4920
3	E (ELECTRODES)	3	ES(XO)	594859.3	198286.4	21.9806*
4	I (INCENTIVE)	1	IS(XO)	7812.563	7812.563	2.3031
5	O (ORDER)	1	S(XO)	7230.586	7230.586	0.4317
6	P (PROCESSING)	2	SP(XO)	23967.92	11983.96	2.2857
7	T (TRIALS)	15	ST(XO)	81698.94	5446.594	1.2897
8	XE	3	ES(XO)	31958.75	10652.91	1.1809
9	XI	1	IS(XO)	1952.332	1952.332	0.5755
10	EI	3	EIS(XO)	1799.250	599.7500	0.6356
11	XO	1	S(XO)	5949.102	5949.102	0.3552
12	EO	3	ES(XO)	17134.85	5711.617	0.6331
13	IO	1	IS(XO)	9580.266	9580.266	2.8243
14	XP	2	SP(XO)	28516.14	14258.07	2.7194
15	EP	6	ESP(XO)	26622.20	4437.031	3.8983*
16	IP	2	ISP(XO)	17799.20	8899.602	8.2540*
17	OP	2	SP(XO)	15079.65	7539.824	1.4381
18	XT	15	ST(XO)	83411.44	5560.762	1.3168
19	ET	45	EST(XO)	24853.06	552.2900	0.8545
20	IT	15	IST(XO)	36462.25	2430.817	0.7228
21	OT	15	ST(XO)	45703.94	3046.929	0.7215
22	PT	30	SPT(XO)	89188.63	2972.954	0.8530
23	S(XO)	4		66989.50	16747.38	
24	XEI	3	EIS(XO)	645.4805	215.1602	0.2280
25	XEO	3	ES(XO)	66804.19	22268.06	2.4685
26	XIO	1	IS(XO)	1885.902	1885.902	0.5560
27	EIO	3	EIS(XO)	711.5469	237.1823	0.2514
28	XEP	6	ESP(XO)	10938.03	1823.005	1.6017
29	XIP	2	ISP(XO)	1650.527	825.2637	0.7654
30	EIP	6	EISP(XO)	5123.547	853.9243	1.0427
31	XOP	2	SP(XO)	2763.063	1381.531	0.2635
32	EOP	6	ESP(XO)	6217.563	1036.260	C.9104
33	IOP	2	ISP(XO)	18041.90	9020.949	8.3665*
34	XET	45	EST(XO)	40244.94	894.3321	1.3838
35	XIT	15	IST(XO)	27525.44	1835.029	0.5457
36	EIT	45	EIST(XO)	31271.94	694.9319	1.0284
37	XOT	15	ST(XO)	37771.81	2518.121	0.5963
38	EOT	45	EST(XO)	27809.25	617.9832	0.9562
39	IOT	15	IST(XO)	79392.25	5292.816	1.5739
40	XPT	30	SPT(XO)	145917.4	4863.914	1.3956
41	EPT	90	ESPT(XO)	67779.75	753.1082	1.0493
42	IPT	30	ISPT(XO)	108358.8	3611.960	1.0900
43	OPT	30	SPT(XO)	172655.7	5755.188	1.6513
44	ES(XO)	12		108251.5	9020.957	
45	IS(XO)	4		13568.54	3392.134	
46	SP(XO)	8		41944.13	5243.016	
47	ST(XO)	60		253381.2	4223.020	
48	XEIO	3	EIS(XO)	2373.551	791.1836	0.8385
49	XEIP	6	EISP(XO)	904.5547	150.7591	0.1841
50	XEOP	6	ESP(XO)	3831.781	638.6301	0.5611
51	XIOP	2	ISP(XO)	12976.13	6488.066	6.0174*
52	EIOP	6	EISP(XO)	2980.469	496.7446	0.6066
53	XEIT	45	EIST(XO)	20342.56	452.0569	0.6690
54	XEOT	45	EST(XO)	40764.63	905.8807	1.4017
55	XIOT	15	IST(XO)	65398.38	4359.891	1.2965
56	EIOT	45	EIST(XO)	37804.13	840.0916	1.2432
57	XEPT	90	ESPT(XO)	60186.25	668.7361	0.9318
58	XIPT	30	ISPT(XO)	113817.4	3793.912	1.1449
59	EIPT	90	EISPT(XO)	61925.50	688.0610	0.8580
60	XOPT	30	SPT(XO)	101580.1	3386.004	0.9698
61	EOPT	90	ESPT(XO)	82473.50	916.3721	1.2768
62	IOPT	30	ISPT(XO)	139820.1	4660.669	1.4064
63	EIS(XO)	12		11922.73	993.5605	
64	ESP(XO)	24		27316.47	1138.186	
65	ISP(XO)	8		8625.770	1078.221	
66	EST(XO)	180		116332.90	646.2939	
67	IST(XO)	60		201775.3	3362.921	
68	SPT(XO)	120		418230.8	3485.257	
69	XEIOP	6	EISP(XO)	700.5703	116.7617	0.1426
70	XEIOT	45	EIST(XO)	32901.00	731.1333	1.0819
71	XEIPT	90	EISPT(XO)	85779.88	953.1098	1.1884
72	XEOPT	90	ESPT(XO)	77628.75	862.5417	1.2049
73	XIOPT	30	ISPT(XO)	96475.88	3215.862	0.9704
74	EIOPT	90	EISPT(XO)	80709.94	896.7771	1.1182
75	EISP(XO)	24		19653.71	818.9046	
76	EIST(XO)	180		121638.4	675.7690	
77	ESPT(XO)	360		258376.4	717.7122	
78	ISPT(XO)	120		397568.4	3313.070	
79	XEIOPT	90	EISPT(XO)	64052.63	711.6958	0.8874
80	EISPT(XO)	360		288713.1	801.9807	

* $p < .05$

ANALYSIS OF VARIANCE - CNV DAYS 3 & 4 - MEASURE 4

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S(XO)	.1533311E 08	.1533311E 08	39.2569
2 X (SEX)	1	S(XO)	373716.6	373716.6	0.9568
3 E (ELECTRODES)	3	ES(XO)	5056442.	1685480.	15.9834*
4 I (INCENTIVE)	1	IS(XO)	29347.33	29347.33	0.3460
5 O (ORDER)	1	S(XO)	175314.0	175314.0	0.4489
6 P (PROCESSING)	2	SP(XO)	1291970.	645985.0	8.4805*
7 T (TRIALS)	15	ST(XO)	917654.8	61176.98	0.9152
8 XE	3	ES(XO)	350950.0	116983.3	1.1094
9 XI	1	IS(XO)	160704.3	160704.3	1.8946
10 EI	3	EIS(XO)	33372.67	11124.22	0.9187
11 XO	1	S(XO)	50173.00	50173.00	0.1285
12 EO	3	ES(XO)	450725.0	150241.6	1.4247
13 IO	1	IS(XO)	151495.3	151495.3	1.7860
14 XP	2	SP(XO)	1041221.	520610.5	6.8346*
15 EP	6	ESP(XO)	603044.0	100507.3	6.0624*
16 IP	2	ISP(XO)	121461.0	60730.50	1.7530
17 OP	2	SP(XO)	234838.0	117419.0	1.5415
18 XT	15	ST(XO)	1260870.	84058.00	1.2575
19 ET	45	EST(XO)	522852.2	11618.94	1.1433
20 IT	15	IST(XO)	551661.2	36777.41	0.5692
21 OT	15	ST(XO)	1001239.	66749.25	0.9985
22 PT	30	SPT(XO)	1669288.	55642.93	1.1356
23 S(XO)	4		1562336.	390584.0	
24 XEI	3	EIS(XO)	9374.645	3124.881	0.2581
25 XEO	3	ES(XO)	633720.0	211240.0	2.0032
26 XIO	1	IS(XO)	232.0625	232.0625	0.0027
27 EIO	3	EIS(XO)	68365.69	22788.56	1.8821
28 XEP	6	ESP(XO)	111842.0	18640.33	1.1244
29 XIP	2	ISP(XO)	31658.00	15829.00	0.4569
30 EIP	6	EISP(XO)	170854.3	28475.72	1.9764
31 XOP	2	SP(XO)	4882.000	2441.000	0.0320
32 EOP	6	ESP(XO)	129627.0	21604.50	1.3031
33 IOP	2	ISP(XO)	170673.8	85336.88	2.4633
34 XET	45	EST(XO)	582974.8	12954.99	1.2748
35 XIT	15	IST(XO)	554647.8	36976.52	0.5723
36 EIT	45	EIST(XO)	419787.6	9328.613	0.8732
37 XOT	15	ST(XO)	543042.8	36202.85	0.5416
38 EOT	45	EST(XO)	492536.8	10945.26	1.0770
39 IOT	15	IST(XO)	1324112.	88274.13	1.3661
40 XPT	30	SPT(XO)	2263823.	75460.77	1.5401
41 EPT	90	ESPT(XO)	1130510.	12561.22	1.2327
42 IPT	30	ISPT(XO)	1509124.	50304.13	0.8671
43 OPT	30	SPT(XO)	2098746.	69958.19	1.4278
44 ES(XO)	12		1265420.	105451.6	
45 IS(XO)	4		339294.9	84823.69	
46 SP(XO)	[illegible]		609383.0	76172.88	
47 ST(XO)	60		4010849.	66847.44	
48 XEIO	3	EIS(XO)	5347.313	1782.438	0.1472
49 XEIP	6	EISP(XO)	29636.00	4939.332	0.3428
50 XEOP	6	ESP(XO)	82211.00	13701.83	0.8265
51 XIOP	2	ISP(XO)	88911.19	44455.59	1.2832
52 EIOP	6	EISP(XO)	87700.25	14616.71	1.0145
53 XEIT	45	EIST(XO)	275215.6	6115.898	0.5725
54 XEOT	45	EST(XO)	576280.2	12806.22	1.2601
55 XIOT	15	IST(XO)	1003201.	66880.06	1.0350
56 EIOT	45	EIST(XO)	680806.0	15129.02	1.1462
57 XEPT	90	ESPT(XO)	998245.0	11091.61	1.0100
58 XIPT	30	ISPT(XO)	1788927.	59630.90	1.0279
59 EIPT	90	EISPT(XO)	913511.0	10150.12	0.8249
60 XOPT	30	SPT(XO)	1474028.	49134.27	1.0028
61 EOPT	90	ESPT(XO)	1146763.	12741.81	1.1603
62 IOPT	30	ISPT(XO)	2351173.	78372.38	1.3509
63 EIS(XO)	12		145296.8	12108.06	
64 ESP(XO)	24		397889.0	16578.71	
65 ISP(XO)	8		277158.9	34643.61	
66 EST(XO)	180		1829257.	10162.54	
67 IST(XO)	60		[illegible]	[illegible]	
68 SPT(XO)	120		5879809.	48998.41	
69 XEIOP	6	EISP(XO)	39963.44	6660.570	0.4623
70 XEIOT	45	EIST(XO)	473983.0	10532.95	0.9859
71 XEIPT	90	EISPT(XO)	1167108.	12967.86	1.0539
72 XEOPT	90	ESPT(XO)	1127449.	12527.21	1.1408
73 XIOPT	30	ISPT(XO)	1470520.	49017.33	0.8449
74 EIOPT	90	EISPT(XO)	935622.0	10395.80	0.8448
75 EISP(XO)	24		345782.7	14407.61	
76 EIST(XO)	180		1924264.	10690.13	
77 ESPT(XO)	360		3953368.	10981.58	
78 ISPT(XO)	120		6961732.	58014.43	
79 XEIOPT	90	EISPT(XO)	919266.0	10214.07	0.8301
80 EISPT(XO)	360		4429862.	12305.17	

* p < .05

ANALYSIS OF VARIANCE - P300 DAYS 1 & 2

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S (XO)	208824.1	208824.1	6.5266
2 X (SEX)	1	S (XO)	208.3333	208.3333	0.0065
3 I (INCENTIVE)	1	IS (XO)	2106.750	2106.750	0.4804
4 O (ORDER)	1	S (XO)	10048.55	10048.55	0.3141
5 P (PROCESSING)	2	SP (XO)	1.180338	.5901690	0.0001
6 T (TRIALS)	15	ST (XO)	25107.09	1673.806	1.0576
7 E (ELECTRODES)	3	SE (XO)	26504.58	8834.859	4.7993*
8 XI	1	IS (XO)	7154.055	7154.055	1.6313
9 XO	1	S (XO)	5918.516	5918.516	0.1850
10 IO	1	IS (XO)	8021.254	8021.254	1.8290
11 XP	2	SP (XO)	3309.123	1654.561	0.3105
12 IP	2	ISP (XO)	2140.695	1070.347	0.6416
13 OP	2	SP (XO)	133.3431	66.67154	0.0125
14 XT	15	ST (XO)	26334.53	1755.635	1.1094
15 IT	15	IST (XO)	9774.563	651.6375	0.6479
16 OT	15	ST (XO)	12033.55	802.2368	0.5069
17 PT	30	SPT (XO)	35043.75	1168.125	1.0954
18 XE	3	SE (XO)	33325.66	11108.55	6.0344*
19 IE	3	ISE (XO)	1432.941	477.6470	1.6548
20 OE	3	SE (XO)	1067.137	355.7122	0.1932
21 PE	6	SPE (XO)	1425.172	237.5286	0.4547
22 TE	45	STE (XO)	6277.301	139.4956	0.7095
23 S (XO)	4		127982.6	31995.64	
24 XIO	1	IS (XO)	3727.715	3727.715	0.8500
25 XIP	2	ISP (XO)	3768.903	1884.451	1.1296
26 XOP	2	SP (XO)	974.9128	487.4563	0.0915
27 IOP	2	ISP (XO)	5440.680	2720.340	1.6306
28 XIT	15	IST (XO)	20809.01	1387.267	1.3792
29 XOT	15	ST (XO)	14919.81	994.6538	0.6285
30 IOT	15	IST (XO)	18097.72	1206.515	1.1995
31 XPT	30	SPT (XO)	26849.59	894.9863	0.8393
32 IPT	30	ISPT (XO)	38797.81	1293.260	1.3712
33 OPT	30	SPT (XO)	33684.31	1122.810	1.0529
34 XIE	3	ISE (XO)	239.1953	79.73177	0.2762
35 XOE	3	SE (XO)	2178.977	726.3254	0.3946
36 IOE	3	ISE (XO)	3458.859	1152.953	3.9945*
37 XPE	6	SPE (XO)	1455.082	242.5137	0.4643
38 IPE	6	ISPE (XO)	563.5593	93.92654	0.4388
39 OPE	6	SPE (XO)	2015.840	335.9731	0.6432
40 XTE	45	STE (XO)	9266.320	205.9182	1.0473
41 ITE	45	ISTE (XO)	7464.582	165.8796	1.0487
42 OTE	45	STE (XO)	9186.707	204.1490	1.0384
43 PTE	90	SPTE (XO)	20126.13	223.6236	1.2170
44 IS (XO)	4		17542.16	4385.539	
45 SP (XO)	8		42636.34	5329.539	
46 ST (XO)	60		94954.75	1582.579	
47 SE (XO)	12		22090.27	1840.856	
48 XIOP	2	ISP (XO)	2798.152	1399.076	0.8386
49 XIOT	15	IST (XO)	10700.87	713.3911	0.7093
50 XIPT	30	ISPT (XO)	29942.94	998.0979	1.0583
51 XOPT	30	SPT (XO)	39160.32	1305.344	1.2241
52 IOPT	30	ISPT (XO)	25047.76	834.9250	0.8853
53 XIOE	3	ISE (XO)	1004.875	334.9583	1.1605
54 XIPE	6	ISPE (XO)	1145.026	190.8376	0.8915
55 XOPE	6	SPE (XO)	3959.148	659.8579	1.2632
56 IOPE	6	ISPE (XO)	596.7844	99.46407	0.4647
57 XITE	45	ISTE (XO)	6807.547	151.2788	0.9564
58 XOTE	45	STE (XO)	6327.461	140.6102	0.7152
59 IOTE	45	ISTE (XO)	6987.133	155.2696	0.9816
60 XPTE	90	SPTE (XO)	14329.88	159.2208	0.8665
61 IPTE	90	ISPTE (XO)	13142.86	146.0317	0.7428
62 OPTE	90	SPTE (XO)	13547.70	150.5300	0.8192
63 ISP (XO)	8		13346.35	1668.294	
64 IST (XO)	60		60348.95	1005.816	
65 SPT (XO)	120		127963.8	1066.365	
66 ISE (XO)	12		3463.633	288.6360	
67 SPE (XO)	24		12536.93	522.3721	
68 STE (XO)	180		35389.58	196.6088	
69 XIOPT	30	ISPT (XO)	32823.36	1094.112	1.1601
70 XIOPE	6	ISPE (XO)	628.0554	104.6759	0.4890
71 XIOTE	45	ISTE (XO)	9013.383	200.2974	1.2663
72 XIPTE	90	ISPTE (XO)	13426.82	149.1868	0.7589
73 XOPTE	90	SPTE (XO)	20595.00	228.8333	1.2453
74 IOPTE	90	ISPTE (XO)	10034.27	111.4918	0.5671
75 ISPT (XO)	120		113178.2	943.1518	
76 ISPE (XO)	24		5137.391	214.0579	
77 ISTE (XO)	180		28472.04	158.1780	
78 SPTE (XO)	360		66150.75	183.7521	
79 XIOPTE	90	ISPTE (XO)	13228.66	146.9852	0.7477
80 ISPTE (XO)	360		70774.00	196.5944	

* $P < .05$

ANALYSIS OF VARIANCE - P300 DAYS 3 & 4

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S (XO)	141144.9	141144.9	5.2859
2 X (SEX)	1	S (XO)	36210.66	36210.66	1.3561
3 I (INCENTIVE)	1	IS (XO)	2974.781	2974.781	0.5950
4 O (ORDER)	1	S (XO)	162125.1	162125.1	6.0716
5 P (PROCESSING)	2	SP (XO)	1394.954	697.4771	0.2193
6 T (TRIALS)	15	ST (XO)	29154.15	1943.610	1.7990
7 E (ELECTRODES)	3	SE (XO)	41758.35	13919.45	6.1049*
8 XI	1	IS (XO)	2141.555	2141.555	0.4283
9 XO	1	S (XO)	29236.13	29236.13	1.0949
10 IO	1	IS (XO)	1901.625	1901.625	0.3804
11 XP	2	SP (XO)	22898.20	11449.10	3.6003*
12 IP	2	ISP (XO)	1639.749	819.8745	0.9601
13 OP	2	SP (XO)	4790.293	2395.146	0.7532
14 XT	15	ST (XO)	8224.063	548.2708	0.5075
15 IT	15	IST (XO)	9463.797	630.9197	0.6811
16 OT	15	ST (XO)	9943.852	662.9233	0.6136
17 PT	30	SPT (XO)	16219.69	540.6563	0.5449
18 XE	3	SE (XO)	12371.11	4123.703	1.8086
19 IE	3	ISE (XO)	333.5313	111.1771	0.3666
20 OE	3	SE (XO)	23178.63	7726.211	3.3886
21 PE	6	SPE (XO)	1327.484	221.2474	0.2789
22 TE	45	STE (XO)	9153.374	203.4083	1.3555
23 S (XO)	4		106809.2	26702.30	
24 XIO	1	IS (XO)	3431.945	3431.945	0.6864
25 XIP	2	ISP (XO)	463.0361	231.5181	0.2711
26 XOP	2	SP (XO)	33.99609	16.99805	0.0053
27 IOP	2	ISP (XO)	1749.625	874.8125	1.0245
28 XIT	15	IST (XO)	10409.87	693.9910	0.7491
29 XOT	15	ST (XO)	19552.59	1303.506	1.2065
30 IOT	15	IST (XO)	16800.33	1120.022	1.2090
31 XPT	30	SPT (XO)	41771.93	1392.398	1.4033
32 IPT	30	ISPT (XO)	36942.74	1231.425	1.3627
33 OPT	30	SPT (XO)	42756.94	1425.231	1.4364
34 XIE	3	ISE (XO)	218.5703	72.85677	0.2403
35 XOE	3	SE (XO)	2908.555	969.5181	0.4252
36 IOE	3	ISE (XO)	773.2813	257.7603	0.8500
37 XPE	6	SPE (XO)	2647.863	441.3105	0.5563
38 IPE	6	ISPE (XO)	444.9268	74.15445	0.3820
39 OPE	6	SPE (XO)	1672.473	278.7454	0.3514
40 XTE	45	STE (XO)	8466.852	188.1523	1.2538
41 ITE	45	ISTE (XO)	9000.445	200.0099	1.1094
42 OTE	45	STE (XO)	4204.648	93.43663	0.6226
43 PTE	90	SPTE (XO)	8345.473	92.72746	0.6785
44 IS (XO)	4		19998.43	4999.605	
45 SP (XO)	8		25440.32	3180.040	
46 ST (XO)	60		64824.35	1080.406	
47 SE (XO)	12		27360.76	2280.063	
48 XIOP	2	ISP (XO)	6319.223	3159.611	3.7001
49 XIOT	15	IST (XO)	12002.92	800.1946	0.8638
50 XIPT	30	ISPT (XO)	41362.26	1378.742	1.5257
51 XOPT	30	SPT (XO)	45662.00	1522.067	1.5340
52 IOPT	30	ISPT (XO)	27689.38	922.9792	1.2247
53 XIOE	3	ISE (XO)	1187.672	395.8906	1.3055
54 XIPE	6	ISPE (XO)	370.3809	61.73013	0.3180
55 XOPE	6	SPE (XO)	1246.449	207.7415	0.2619
56 IOPE	6	ISPE (XO)	646.3857	107.7310	0.5549
57 XITE	45	ISTE (XO)	4383.078	97.40173	0.5403
58 XOTE	45	STE (XO)	9453.587	210.0797	1.3999
59 IOTE	45	ISTE (XO)	11359.77	252.4394	1.4002
60 XPTE	90	SPTE (XO)	13844.94	153.8327	1.1256
61 IPTE	90	ISPTE (XO)	18778.41	208.6490	1.2345
62 OPTE	90	SPTE (XO)	14607.97	162.3108	1.1876
63 ISP (XO)	8		6831.363	853.9204	
64 IST (XO)	60		55582.45	926.3740	
65 SPT (XO)	120		119066.2	992.2183	
66 ISE (XO)	12		3638.914	303.2427	
67 SPE (XO)	24		19040.29	793.3454	
68 STE (XO)	180		27011.87	150.0659	
69 XIOPT	30	ISPT (XO)	30112.93	1003.764	1.3318
70 XIOPE	6	ISPE (XO)	577.7139	96.28564	0.4960
71 XIOTE	45	ISTE (XO)	5727.961	127.2880	0.7060
72 XIPTE	90	ISPTE (XO)	14921.80	165.7977	0.9810
73 XOPTE	90	SPTE (XO)	13431.42	149.2380	1.0920
74 IOPTE	90	ISPTE (XO)	17969.89	199.6654	1.1814
75 ISPT (XO)	120		108440.0	903.6670	
76 ISPE (XO)	24		4659.285	194.1369	
77 ISTE (XO)	180		32451.95	180.2886	
78 SPTE (XO)	360		49200.09	136.6669	
79 XIOPTE	90	ISPTE (XO)	12560.66	139.5629	0.8258
80 ISPTE (XO)	360	-	60843.21	169.0089	

* $p < .05$

ANALYSIS OF VARIANCE - GALVANIC SKIN POTENTIAL

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S (BXO)	1000059.	1000039.	2.6845
2 B (BLOCKS)	1	S (BXO)	40477.35	40477.35	0.1087
3 X (SEX)	1	S (BXO)	641614.6	641614.6	1.7223
4 I (INCENTIVE)	1	IS (BXO)	58768.88	58768.88	0.5204
5 O (ORDER)	1	S (BXO)	378037.3	378037.3	1.0148
6 P (PROCESSING)	2	SP (BXO)	138345.6	69172.81	2.2641
7 T (TRIALS)	15	ST (BXO)	163792.0	10919.46	0.6647
8 BX	1	S (BXO)	168568.0	168568.0	0.4525
9 BI	1	IS (BXO)	62232.75	62232.75	0.5511
10 XI	1	IS (BXO)	13650.50	13650.50	0.1209
11 BO	1	S (BXO)	52301.63	52301.63	0.1404
12 XO	1	S (BXO)	269212.1	269212.1	0.7227
13 IO	1	IS (BXO)	82910.94	82910.94	0.7342
14 BP	2	SP (BXO)	264405.6	132202.8	4.3270*
15 XP	2	SP (BXO)	33305.50	16652.75	0.5451
16 IP	2	ISP (BXO)	58014.50	29007.25	1.6602
17 OP	2	SP (BXO)	35707.13	17853.56	0.5844
18 BT	15	ST (BXO)	199970.6	13331.38	0.8115
19 XT	15	ST (BXO)	205255.4	13683.69	0.8330
20 IT	15	IST (BXO)	488972.8	32598.18	1.6061
21 OT	15	ST (BXO)	207203.3	13813.55	0.8409
22 PT	30	SPT (BXO)	418595.9	13953.20	1.0071
23 BXI	1	IS (BXO)	154259.3	154259.3	1.3659
24 BXO	1	S (BXO)	49197.38	49197.38	0.1321
25 BIO	1	IS (BXO)	23995.38	23995.38	0.2125
26 XIO	1	IS (BXO)	44667.69	44667.69	0.3955
27 BXP	2	SP (BXO)	82202.63	41101.31	1.3453
28 BIP	2	ISP (BXO)	39279.25	19639.63	1.1241
29 XIP	2	ISP (BXO)	32626.75	16313.38	0.9337
30 BOP	2	SP (BXO)	81712.19	40856.09	1.3372
31 XOP	2	SP (BXO)	71724.75	35862.38	1.1738
32 IOP	2	ISP (BXO)	46205.13	23102.56	1.3223
33 BXT	15	ST (BXO)	174793.4	11652.89	0.7094
34 BIT	15	IST (BXO)	301171.9	20078.12	0.9892
35 XIT	15	IST (BXO)	312511.4	20834.09	1.0265
36 BOT	15	ST (BXO)	320735.1	21382.34	1.3016
37 XOT	15	ST (BXO)	270579.3	18038.61	1.0981
38 IOT	15	IST (BXO)	283670.0	18911.33	0.9317
39 BPT	30	SPT (BXO)	427412.9	14247.09	1.0284
40 XPT	30	SPT (BXO)	604408.2	20146.94	1.4542
41 IPT	30	ISPT (BXO)	499333.4	16644.45	0.9858
42 OPT	30	SPT (BXO)	274647.7	9154.922	0.6608
43 S (BXO)	8		2980198.	372524.8	
44 BXIO	1	IS (BXO)	15701.13	15701.13	0.1390
45 BXIP	2	ISP (BXO)	36715.63	18357.81	1.0507
46 BXOP	2	SP (BXO)	86731.13	43365.5[illegible]	1.4194
47 BIOP	2	ISP (BXO)	8380.563	4190.281	0.2398
48 XIOP	2	ISP (BXO)	62029.13	31014.56	1.7751
49 BXIT	15	IST (BXO)	155650.4	10376.69	0.5112
50 BXOT	15	ST (BXO)	349829.3	23321.95	1.4197
51 BIOT	15	IST (BXO)	607455.9	40497.05	1.9952*
52 XIOT	15	IST (BXO)	127767.4	8517.824	0.4197
53 BXPT	30	SPT (BXO)	302708.0	10090.27	0.7283
54 BIPT	30	ISPT (BXO)	515872.8	17195.76	1.0185
55 XIPT	30	ISPT (BXO)	746483.6	24882.79	1.4738
56 BOPT	30	SPT (BXO)	467175.4	15572.51	1.1240
57 XOPT	30	SPT (BXO)	377807.2	12593.57	0.9090
58 IOPT	30	ISPT (BXO)	781306.3	26043.54	1.5425
59 IS (BXO)	8		903474.9	112934.3	
60 SP (BXO)	16		488842.9	30552.68	
61 ST (BXO)	120		1971264.	16427.20	
62 BXIOP	2	ISP (BXO)	16612.31	8306.156	0.4754
63 BXIOT	15	IST (BXO)	344513.8	22967.58	1.1316
64 BXIPT	30	ISPT (BXO)	364377.4	12145.91	0.7194
65 BXOPT	30	SPT (BXO)	460261.4	15342.04	1.1074
66 BIOPT	30	ISPT (BXO)	415653.7	13855.12	0.8206
67 XIOPT	30	ISPT (BXO)	613519.7	20450.66	1.2113
68 ISP (BXO)	16		279547.9	17471.75	
69 IST (BXO)	120		2435624.	20296.86	
70 SPT (BXO)	240		3325017.	13854.24	
71 BXIOPT	30	ISPT (BXO)	443430.3	14781.01	0.8755
72 ISPT (BXO)	240		4052055.	16883.56	

* P < .05

ANALYSIS OF VARIANCE - EYE MOVEMENTS

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S(XO)	846.0938	846.0938	0.0222
2 B (BLOCKS)	1	BS(XO)	12398.76	12398.76	0.5657
3 X (SEX)	1	S(XO)	51221.91	51221.91	1.3430
4 I (INCENTIVE)	1	IS(XO)	12195.04	12195.04	0.3759
5 O (ORDER)	1	S(XO)	38100.50	38100.50	0.9990
6 P (PROCESSING)	2	SP(XO)	23938.93	11969.46	0.6692
7 T (TRIALS)	15	ST(XO)	124726.9	8315.127	1.2432
8 BX	1	BS(XO)	85711.25	85711.25	3.9105
9 BI	1	BIS(XO)	47837.85	47837.85	2.2050
10 XI	1	IS(XO)	77896.45	77896.45	2.4007
11 BO	1	BS(XO)	53133.42	53133.42	2.4242
12 XO	1	S(XO)	8531.504	8531.504	0.2237
13 IO	1	IS(XO)	32248.23	32248.23	0.9939
14 BP	2	BSP(XO)	14691.77	7345.887	0.7537
15 XP	2	SP(XO)	79521.94	39760.97	1.5598
16 IP	2	ISP(XO)	39991.01	19995.51	2.5975
17 OP	2	SP(XO)	155325.0	77662.50	3.0446
18 BT	15	BST(XO)	155408.0	9693.863	0.9543
19 XT	15	ST(XO)	120209.9	8013.959	1.1363
20 IT	15	IST(XO)	260045.3	17336.35	1.5001
21 OT	15	ST(XO)	163020.8	10868.05	1.3249
22 PT	30	SPT(XO)	311233.0	10374.43	1.2619
23 S(XO)	4		152554.7	38138.67	
24 BXI	1	BIS(XO)	5111.063	5111.063	0.2356
25 BXO	1	BS(XO)	5828.016	5828.016	0.2659
26 BIO	1	BIS(XO)	1437.477	1437.477	0.0663
27 XIO	1	IS(XO)	19751.27	19751.27	0.6088
28 BXP	2	BSP(XO)	39977.81	19988.91	2.0420
29 BIP	2	BISP(XO)	3844.934	1922.467	0.0946
30 XIP	2	ISP(XO)	28505.29	14252.64	1.8514
31 BOP	2	BSP(XO)	70094.63	35047.31	3.6155
32 XOP	2	SP(XO)	21512.88	10756.44	0.4217
33 IOP	2	ISP(XO)	1141.438	570.7188	0.0741
34 BXT	15	BST(XO)	216050.8	14403.39	1.4179
35 BIT	15	BIST(XO)	188472.5	12564.83	0.9986
36 XIT	15	IST(XO)	175300.1	11686.67	1.0112
37 BOT	15	BST(XO)	173054.8	11536.98	1.1358
38 XOT	15	ST(XO)	137651.0	9176.730	1.3720
39 IOT	15	IST(XO)	140064.8	9337.625	0.8080
40 BPT	30	BSPT(XO)	344915.5	11497.18	1.0641
41 XPT	30	SPT(XO)	329265.7	8975.408	1.0918
42 IPT	30	ISPT(XO)	340023.7	11334.19	1.0762
43 OPT	30	SPT(XO)	353876.3	11799.01	1.4352
44 [illegible]	4		[illegible]	[illegible]	
45 [illegible]	4		[illegible]	[illegible]	
46 [illegible]	8		[illegible]	[illegible]	
47 [illegible]	60		[illegible]	[illegible]	
48 [illegible]	1	BIS(XO)	18279.30	18279.30	1.7644
49 [illegible]	2	BISP(XO)	[illegible]	[illegible]	0.4041
50 [illegible]	2	BSP(XO)	[illegible]	[illegible]	0.0494
51 [illegible]	2	BISP(XO)	[illegible]	[illegible]	0.9058
52 [illegible]	2	ISP(XO)	[illegible]	[illegible]	0.6757
53 [illegible]	15	BIST(XO)	[illegible]	[illegible]	0.5176
54 [illegible]	15	BST(XO)	[illegible]	[illegible]	0.7330
55 [illegible]	15	BIST(XO)	[illegible]	[illegible]	1.8908*
56 [illegible]	15	IST(XO)	[illegible]	[illegible]	0.7803
57 [illegible]	30	BSPT(XO)	[illegible]	7314.930	0.6770
58 [illegible]	30	BISPT(XO)	[illegible]	[illegible]	1.0703
59 [illegible]	30	BSPT(XO)	[illegible]	[illegible]	1.1646
60 [illegible]	30	BISPT(XO)	[illegible]	[illegible]	0.8592
61 [illegible]	30	SPT(XO)	[illegible]	[illegible]	1.1508
62 [illegible]	30	ISPT(XO)	[illegible]	[illegible]	0.6286
63 [illegible]	4		[illegible]	[illegible]	
64 [illegible]	8		[illegible]	[illegible]	
65 [illegible]	8		[illegible]	[illegible]	
66 [illegible]	60		[illegible]	[illegible]	
67 [illegible]	60		[illegible]	[illegible]	
68 [illegible]	120		[illegible]	[illegible]	
69 [illegible]	2	BISP(XO)	[illegible]	[illegible]	1.8266
70 [illegible]	15	BIST(XO)	[illegible]	[illegible]	0.8815
71 [illegible]	30	BISPT(XO)	[illegible]	[illegible]	1.1259
72 [illegible]	30	BISPT(XO)	[illegible]	[illegible]	0.8790
73 [illegible]	30	BISPT(XO)	[illegible]	9176.367	0.3921
74 [illegible]	30	ISPT(XO)	[illegible]	[illegible]	0.9403
75 [illegible]	8		[illegible]	[illegible]	
76 [illegible]	60		[illegible]	[illegible]	
77 [illegible]	120		[illegible]	10604.79	
78 [illegible]	120		1263757.	10531.22	
79 BXIOPT	30	BISPT(XO)	217922.6	7264.418	0.7835
80 BISPT(XO)	120		1109858.	9249.148	

* p < .05

ANALYSIS OF VARIANCE - HEART RATE

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S(BXO)	4997192.	4997192.	********
2 B (BLOCKS)	1	S(BXO)	4973.926	4973.926	2.0041
3 X (SEX)	1	S(BXO)	2823.982	2823.982	1.1378
4 I (INCENTIVE)	1	IS(BXO)	992.2996	992.2996	1.5181
5 O (ORDER)	1	S(BXO)	1553.538	1553.538	0.6260
6 P (PROCESSING)	2	SP(BXO)	2290.229	1145.114	26.4294*
7 T (TRIALS)	15	ST(BXO)	317.6101	21.17400	1.7082
8 BX	1	S(BXO)	40.24878	40.24878	0.0162
9 BI	1	IS(BXO)	1008.200	1008.200	1.5424
10 XI	1	IS(BXO)	35.71875	35.71875	0.0546
11 BO	1	S(BXO)	1126.208	1126.208	0.4538
12 XO	1	S(BXO)	3290.427	3290.427	1.3258
13 IO	1	IS(BXO)	1868.210	1868.210	2.8582
14 BP	2	SP(BXO)	207.0566	103.5283	2.3895
15 XP	2	SP(BXO)	352.9968	176.4984	4.0736*
16 IP	2	ISP(BXO)	43.56396	21.78198	1.2094
17 OP	2	SP(BXO)	80.31934	40.15967	0.9269
18 BT	15	ST(BXO)	152.6594	10.17729	0.8210
19 XT	15	ST(BXO)	173.6047	11.57365	0.9337
20 IT	15	IST(BXO)	134.7490	8.983268	0.8377
21 OT	15	ST(BXO)	95.31958	6.354638	0.5127
22 PT	30	SPT(BXO)	408.2747	13.60915	1.4873
23 BXI	1	IS(BXO)	2241.435	2241.435	3.4292
24 BXO	1	S(BXO)	167.4463	167.4463	0.0675
25 BIO	1	IS(BXO)	19.55859	19.55859	0.0299
26 XIO	1	IS(BXO)	421.8083	421.8083	0.6453
27 BXP	2	SP(BXO)	91.59302	45.79651	1.0570
28 BIP	2	ISP(BXO)	25.13916	12.56958	0.6979
29 XIP	2	ISP(BXO)	27.86694	13.93347	0.7736
30 [illegible]	2	SP(BXO)	11.07520	5.537598	0.1278
31 XOP	2	SP(BXO)	60.42651	30.21326	0.6973
32 IOP	2	ISP(BXO)	183.2410	91.62048	5.0870*
33 BXT	15	ST(BXO)	267.0007	17.80047	1.4360
34 BIT	15	IST(BXO)	136.7588	9.117252	0.8502
35 XIT	15	IST(BXO)	211.3682	14.09121	1.3140
36 BOT	15	ST(BXO)	125.6375	8.375830	0.6757
37 XOT	15	ST(BXO)	204.4250	13.62834	1.0994
38 IOT	15	IST(BXO)	57.74585	3.849723	0.3590
39 BPT	30	SPT(BXO)	191.5222	6.384073	0.6977
40 XPT	30	SPT(BXO)	404.8933	13.49644	1.4750
41 IPT	30	ISPT(BXO	346.5906	11.55302	1.1299
42 OPT	30	SPT(BXO)	391.2844	13.04281	1.4254
43 S(BXO)	8		19854.89	2481.861	
44 BXIO	1	IS(BXO)	2061.385	2061.385	3.1537
45 BXIP	2	ISP(BXO)	89.19116	44.59558	2.4761
46 BXOP	2	SP(BXO)	53.59644	26.79822	0.6185
47 BIOP	2	ISP(BXO)	37.43140	18.71570	1.0391
48 XIOP	2	ISP(BXO)	48.13623	24.06812	1.3363
49 BXIT	15	IST(BXO)	205.9973	13.73315	1.2806
50 BXOT	15	ST(BXO)	248.8818	16.59212	1.3385
51 BIOT	15	IST(BXO)	126.2144	8.414289	0.7846
52 XIOT	15	IST(BXO)	229.8618	15.32412	1.4290
53 BXPT	30	SPT(BXO)	378.3071	12.61024	1.3782
54 BIPT	30	ISPT(BXO	299.4277	9.980924	0.9761
55 XIPT	30	ISPT(BXO	259.3040	8.643465	0.8453
56 BOPT	30	SPT(BXO)	210.0657	7.002189	0.7653
57 XOPT	30	SPT(BXO)	399.1299	13.30433	1.4540
58 IOPT	30	ISPT(BXO	306.3027	10.21009	0.9985
59 IS(BXO)	8		5229.094	653.6367	
60 SP(BXO)	16		693.2356	43.32722	
61 ST(BXO)	120		1487.474	12.39561	
62 BXIOP	2	ISP(BXO)	208.2366	104.1183	5.7809*
63 BXIOT	15	IST(BXO)	163.5679	10.90452	1.0168
64 BXIPT	30	ISPT(BXO	382.8667	12.76222	1.2481
65 BXOPT	30	SPT(BXO)	259.4502	8.648339	0.9452
66 BIOPT	30	ISPT(BXO	174.6104	5.820345	0.5692
67 XIOPT	30	ISPT(BXO	254.0945	8.469815	0.8283
68 ISP(BXO)	16		288.1724	18.01077	
69 IST(BXO)	120		1286.869	10.72390	
70 SPT(BXO)	240		2195.997	9.149986	
71 BXIOPT	30	ISPT(BXO)	131.4392	4.381307	0.4285
72 ISPT(BXO)	240		2454.013	10.22505	

* P < .05

ANALYSIS OF VARIANCE - REACTION TIME

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S (BXO)	.7021986E 08	.7021986E 081	********
2 B (BLOCKS)	1	S (BXO)	449258.0	449258.0	10.5463
3 X (SEX)	1	S (BXO)	342636.4	342636.4	8.0434*
4 I (INCENTIVE)	1	IS (BXO)	478.1567	478.1567	0.0427
5 O (ORDER)	1	S (BXO)	42367.50	42367.50	0.9946
6 P (PROCESSING)	2	SP (BXO)	377312.2	188656.1	10.2021*
7 T (TRIALS)	15	ST (BXO)	59364.79	3957.653	0.6674
8 BX	1	S (BXO)	4968.938	4968.938	0.1166
9 BI	1	IS (BXO)	40088.09	40088.09	3.5817
10 XI	1	IS (BXO)	6.593262	6.593262	0.0006
11 BO	1	S (BXO)	57220.38	57220.38	1.3432
12 XO	1	S (BXO)	36241.13	36241.13	0.8508
13 IO	1	IS (BXO)	110144.4	110144.4	9.8408*
14 BP	2	SP (BXO)	44399.69	22199.84	1.2005
15 XP	2	SP (BXO)	95390.31	47695.16	2.5792
16 IP	2	ISP (BXO)	12580.88	6290.438	0.4675
17 OP	2	SP (BXO)	88821.25	44410.63	2.4016
18 BT	15	ST (BXO)	152506.2	10167.08	1.7145
19 XT	15	ST (BXO)	26031.46	1735.431	0.2927
20 IT	15	IST (BXO)	64595.84	4306.387	1.1056
21 OT	15	ST (BXO)	78056.19	5203.742	0.8775
22 PT	30	SPT (BXO)	107346.0	3578.200	0.9015
23 BXI	1	IS (BXO)	6147.906	6147.906	0.5493
24 BXO	1	S (BXO)	179681.7	179681.7	4.2180
25 BIO	1	IS (BXO)	73026.88	73026.88	6.5246*
26 XIO	1	IS (BXO)	38710.56	38710.56	3.4586
27 BXP	2	SP (BXO)	25722.50	12861.25	0.6955
28 BIP	2	ISP (BXO)	332.5977	166.2988	0.0124
29 XIP	2	ISP (BXO)	1107.063	553.5313	0.0411
30 BOP	2	SP (BXO)	117242.0	58621.00	3.1701
31 XOP	2	SP (BXO)	872.6250	436.3125	0.0236
32 IOP	2	ISP (BXO)	43547.19	21773.59	1.6182
33 BXT	15	ST (BXO)	54186.23	3612.415	0.6092
34 BIT	15	IST (BXO)	33204.16	2213.611	0.5683
35 XIT	15	IST (BXO)	70757.63	4717.172	1.2111
36 BOT	15	ST (BXO)	80090.94	5339.395	0.9004
37 XOT	15	ST (BXO)	35434.25	2362.283	0.3984
38 IOT	15	IST (BXO)	102087.4	6805.824	1.7473
39 BPT	30	SPT (BXO)	146459.1	4881.969	1.2300
40 XPT	30	SPT (BXO)	171258.8	5708.625	1.4382
41 IPT	30	ISPT (BXO)	124886.5	4162.883	1.0181
42 OPT	30	SPT (BXO)	108308.1	3610.271	0.9096
43 S (BXO)	8		340789.0	42598.63	
44 BXIO	1	IS (BXO)	541.2500	541.2500	0.0484
45 BXIP	2	ISP (BXO)	3172.621	1586.311	0.1179
46 BXOP	2	SP (BXO)	28595.31	14297.66	0.7732
47 BIOP	2	ISP (BXO)	20704.69	10352.34	0.7694
48 XIOP	2	ISP (BXO)	5026.688	2513.344	0.1868
49 BXIT	15	IST (BXO)	55805.38	3720.358	0.9552
50 BXOT	15	ST (BXO)	41251.88	2750.125	0.4638
51 BIOT	15	IST (BXO)	76079.94	5071.992	1.3022
52 XIOT	15	IST (BXO)	106731.6	7115.438	1.8268*
53 BXPT	30	SPT (BXO)	78872.69	2629.089	0.6624
54 BIPT	30	ISPT (BXO)	121081.8	4036.060	0.9871
55 XIPT	30	ISPT (BXO)	113873.8	3795.794	0.9283
56 BOPT	30	SPT (BXO)	156397.5	5213.250	1.3134
57 XOPT	30	SPT (BXO)	96598.81	3219.960	0.8112
58 IOPT	30	ISPT (BXO)	111413.2	3713.773	0.9083
59 IS (BXO)	8		89541.00	11192.63	
60 SP (BXO)	16		295870.6	18491.91	
61 ST (BXO)	120		711600.1	5930.000	
62 BXIOP	2	ISP (BXO)	9309.441	4654.719	0.3459
63 BXIOT	15	IST (BXO)	64745.13	4316.340	1.4082
64 BXIPT	30	ISPT (BXO)	95048.25	3168.275	0.7749
65 BXOPT	30	SPT (BXO)	111166.6	3705.552	0.9336
66 BIOPT	30	ISPT (BXO)	124668.8	4155.625	1.0164
67 XIOPT	30	ISPT (BXO)	114262.1	3808.737	0.9315
68 ISP (BXO)	16		215286.1	13455.38	
69 IST (BXO)	120		467395.8	3894.964	
70 SPT (BXO)	240		952608.4	3969.202	
71 BXIOPT	30	ISPT (BXO)	112068.4	3735.612	0.9136
72 ISPT (BXO)	240		981301.6	4088.757	

* $p < .05$

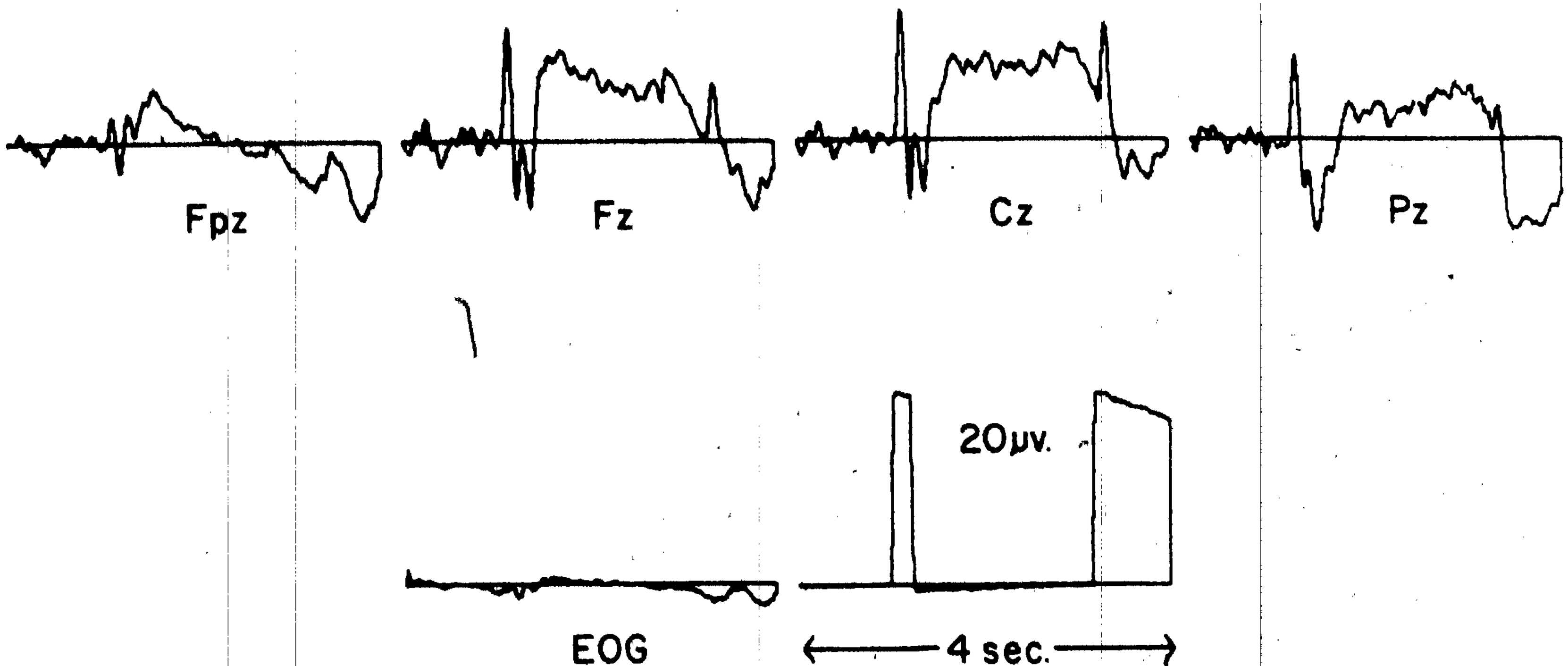
ANALYSIS OF VARIANCE - VERBAL ERROR RESPONSES

SOURCE	DF	ERROR TERM	SUM OF SQUARES	MEAN SQUARE	F
1 MEAN	1	S(BXIO)	162.5625	162.5625	59.7933
2 B (BLOCKS)	1	S(BXIO)	5.062500	5.062500	1.8621
3 X (SEX)	1	S(BXIO)	9.000000	9.000000	3.3104
4 I (INCENTIVE)	1	S(BXIO)	4.000000	4.000000	1.4713
5 O (ORDER)	1	S(BXIO)	14.06250	14.06250	5.1724*
6 P (PROCESSING)	1	SP(BXIO)	9.000000	9.000000	7.0246*
7 BX	1	S(BXIO)	.2499895	.2499895	0.0920
8 BI	1	S(BXIO)	1.000000	1.000000	0.3678
9 XI	1	S(BXIO)	.6250000E-01	.6250000E-01	0.0230
10 BO	1	S(BXIO)	.6250000E-01	.6250000E-01	0.0230
11 XO	1	S(BXIO)	2.250000	2.250000	0.8276
12 IO	1	S(BXIO)	.0	.0	0.0
13 BP	1	SP(BXIO)	.2500000	.2500000	0.1951
14 XP	1	SP(BXIO)	1.562500	1.562500	1.2195
15 IP	1	SP(BXIO)	.6250000E-01	.6250000E-01	0.0488
16 OP	1	SP(BXIO)	1.000000	1.000000	0.7805
17 BXI	1	S(BXIO)	.5624952	.5624952	0.2069
18 BXO	1	S(BXIO)	.9999952	.9999952	0.3678
19 BIO	1	S(BXIO)	.0	.0	0.0
20 XIO	1	S(BXIO)	5.062500	5.062500	1.8621
21 BXP	1	SP(BXIO)	1.562495	1.562495	1.2195
22 BIP	1	SP(BXIO)	.6250000E-01	.6250000E-01	0.0488
23 XIP	1	SP(BXIO)	.2500000	.2500000	0.1951
24 BOP	1	SP(BXIO)	2.250000	2.250000	1.7561
25 XOP	1	SP(BXIO)	.5625000	.5625000	0.4390
26 IOP	1	SP(BXIO)	1.562500	1.562500	1.2195
27 BXIO	1	S(BXIO)	1.562459	1.562459	0.5747
28 BXIP	1	SP(BXIO)	.2499743	.2499743	0.1951
29 BXOP	1	SP(BXIO)	.5624895	.5624895	0.4390
30 BIOP	1	SP(BXIO)	1.562500	1.562500	1.2195
31 XIOP	1	SP(BXIO)	4.000000	4.000000	3.1220
32 S(BXIO)	16		43.49983	2.718740	
33 BXIOP	1	SP(BXIO)	.9999752	.9999752	0.7805
34 SP(BXIO)	16		20.49951	1.281219	

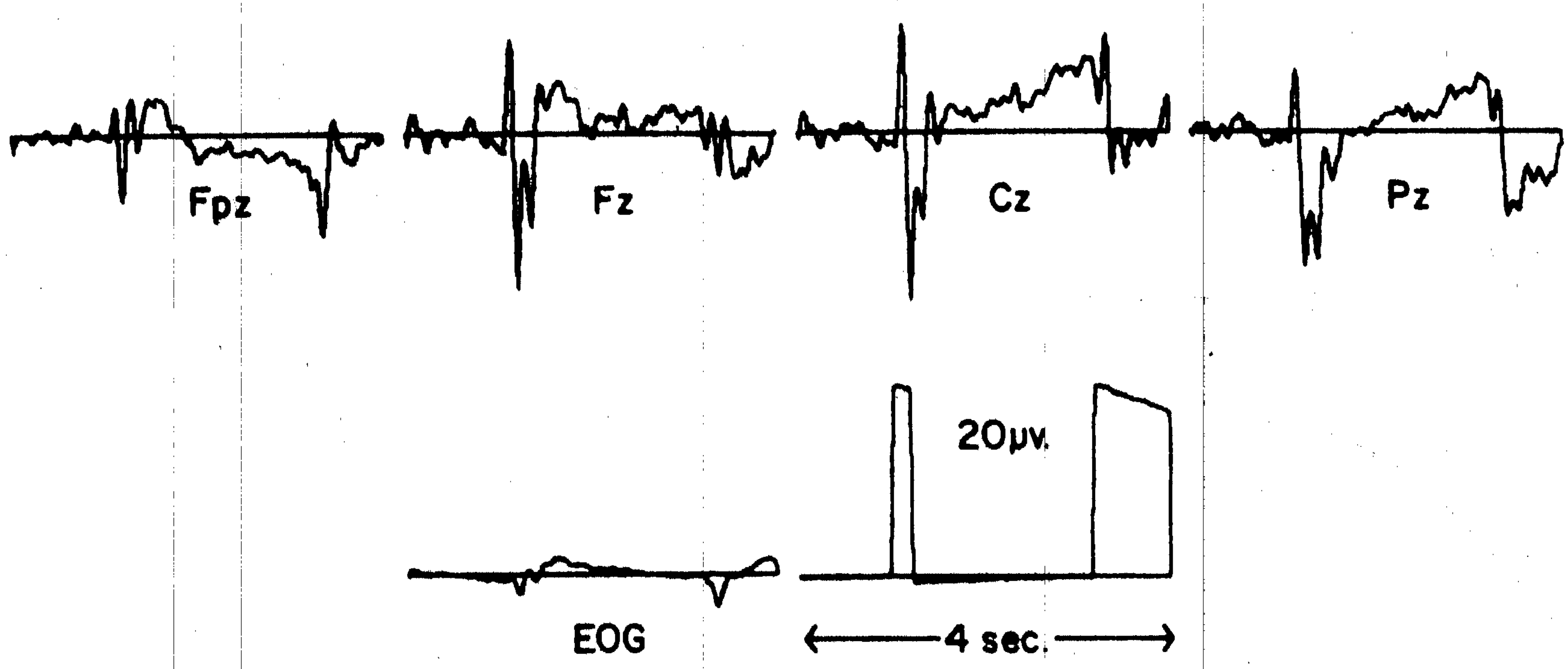
* $p < .05$

APPENDIX C

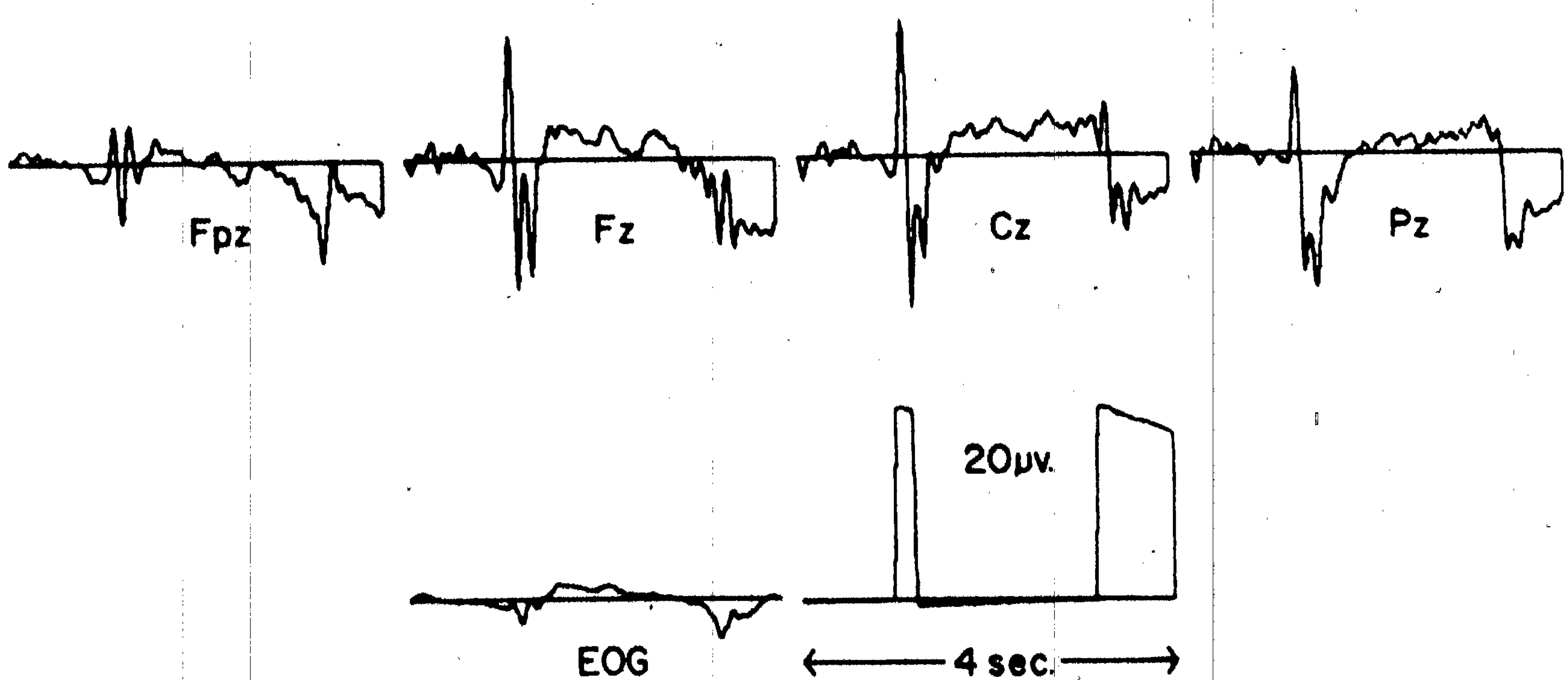
AVERAGED CNV WAVEFORMS



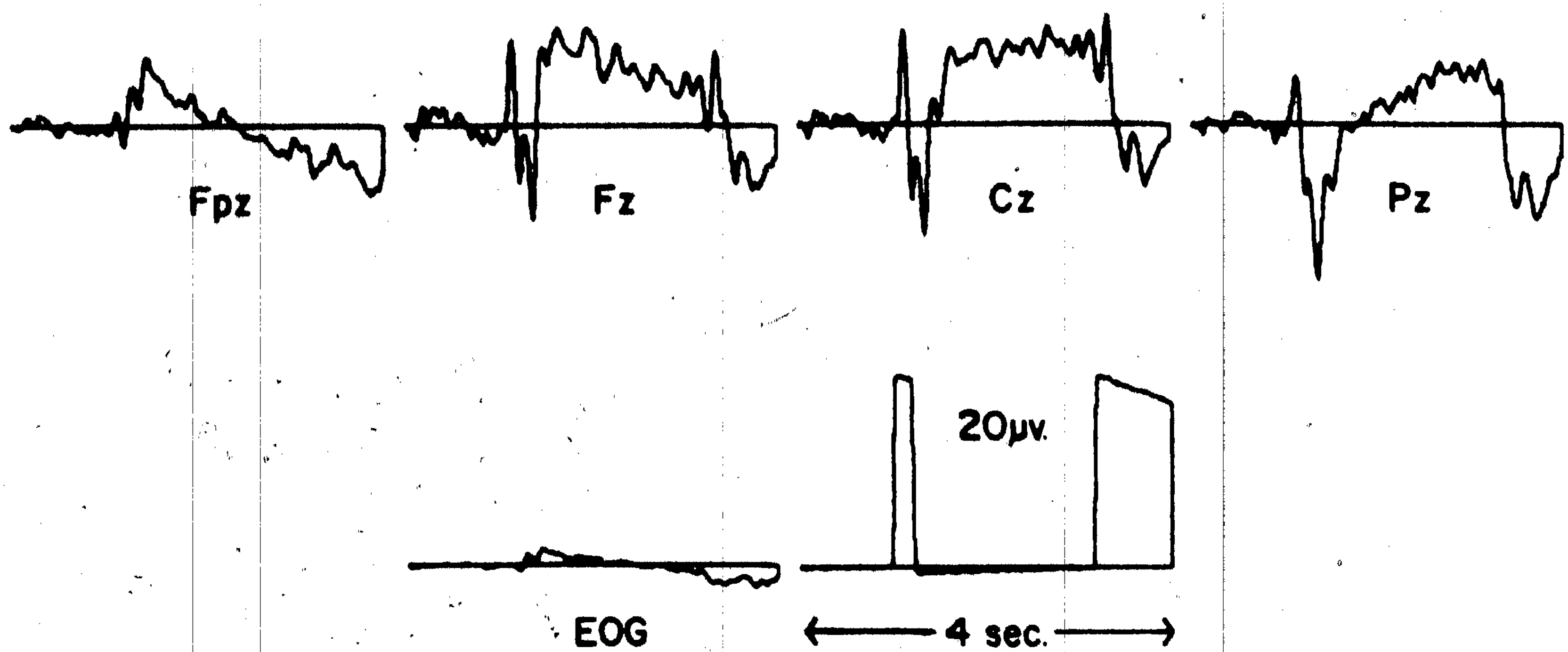
FEMALES - DAYS 1&2 - HIGH INCENTIVE - STANDARD



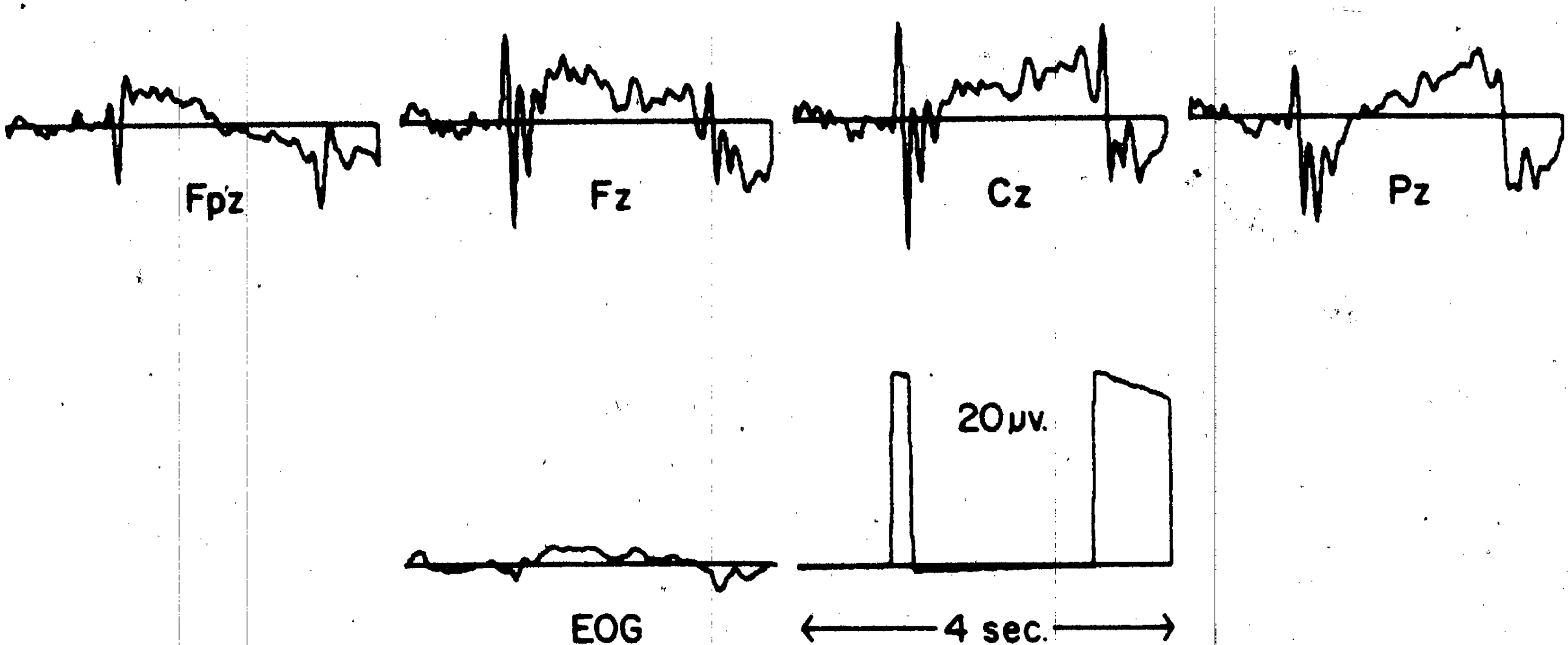
FEMALES - DAYS 1 & 2 - HIGH INCENTIVE - EASY



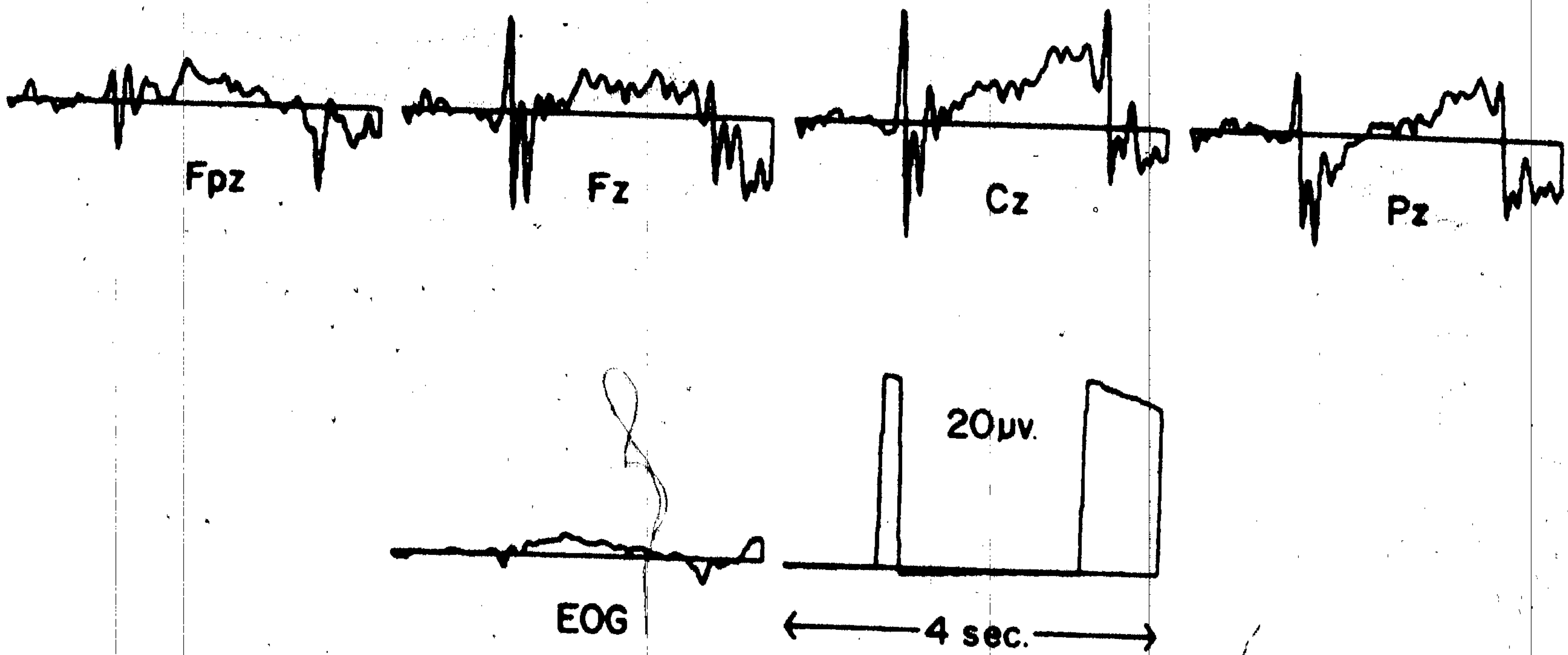
FEMALES - DAYS 1&2 - HIGH INCENTIVE - DIFFICULT



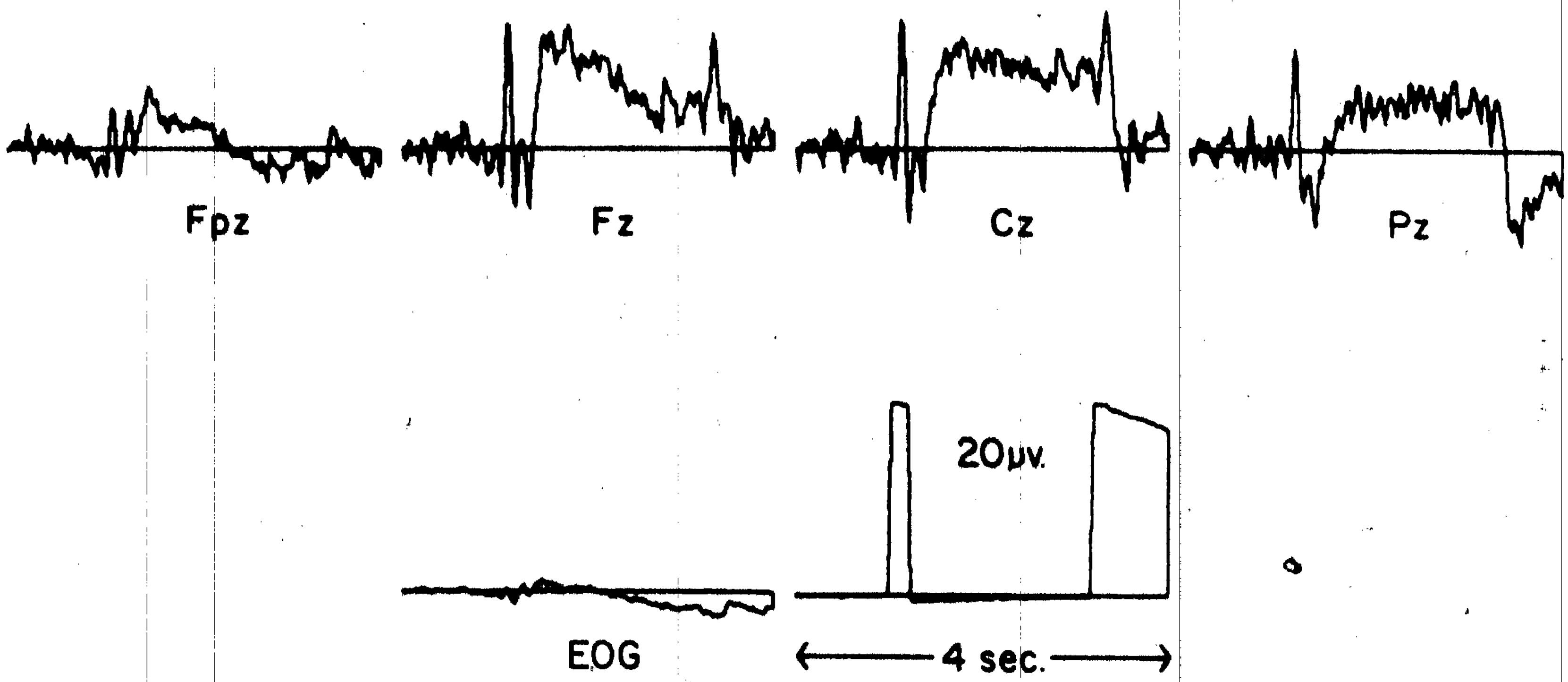
FEMALES - DAYS 1&2 - LOW INCENTIVE - STANDARD



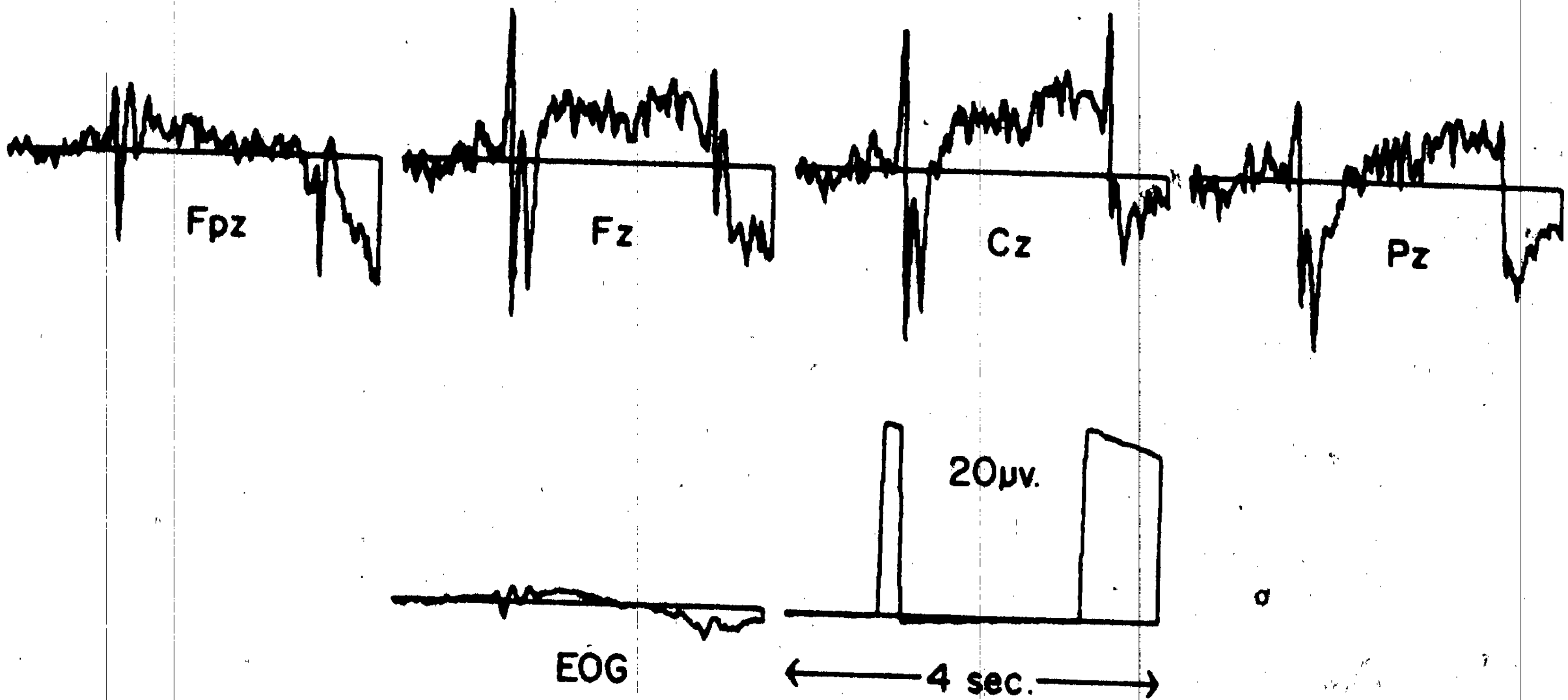
FEMALES - DAYS 1&2 - LOW INCENTIVE - EASY



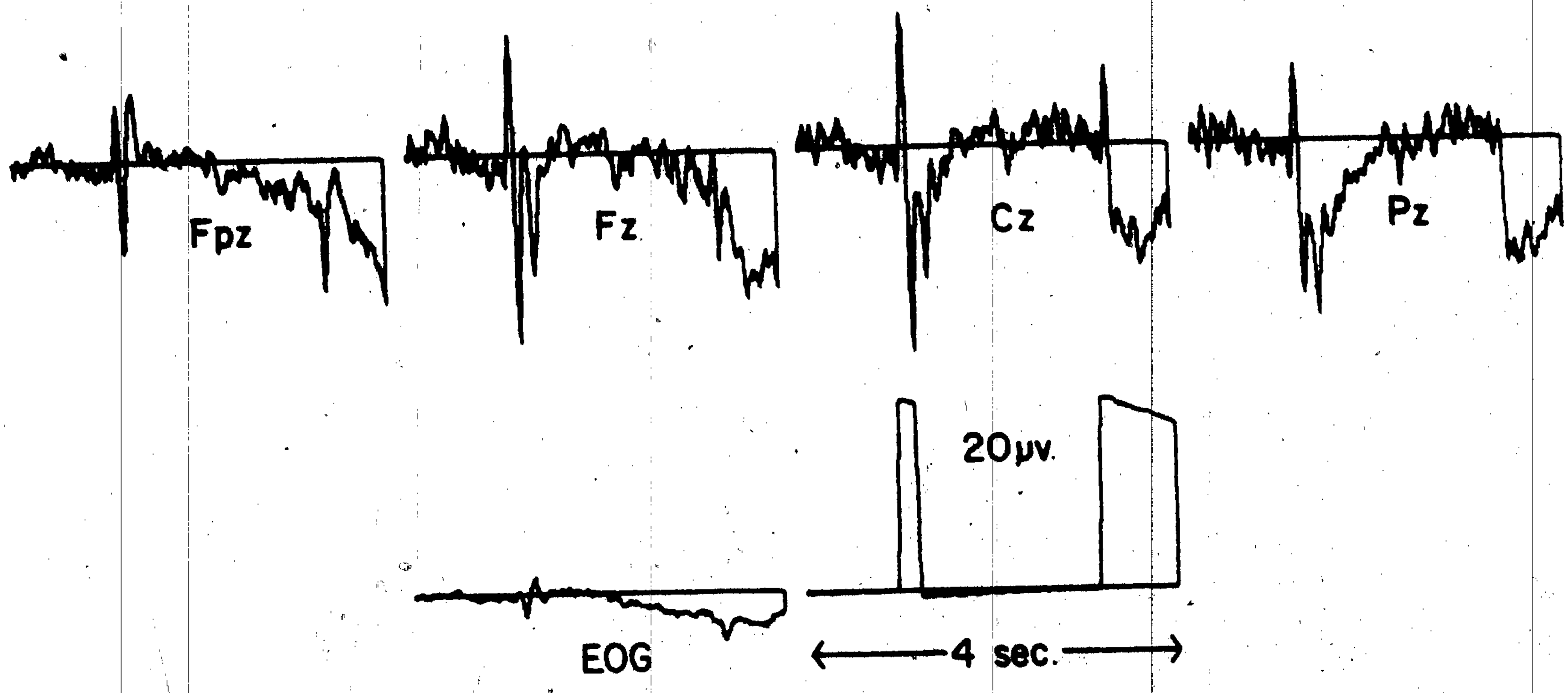
FEMALES - DAYS 1&2 - LOW INCENTIVE - DIFFICULT



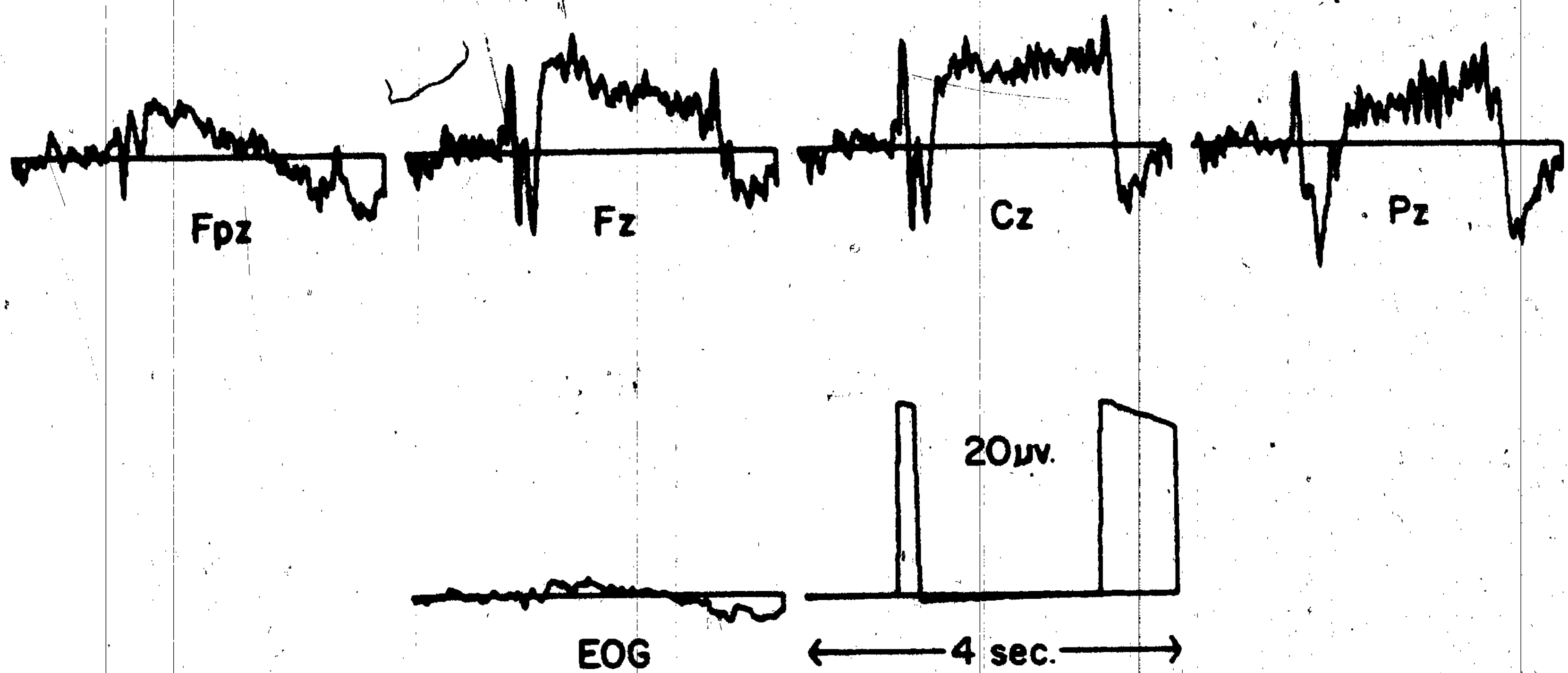
FEMALES - DAYS 3&4 - HIGH INCENTIVE - STANDARD



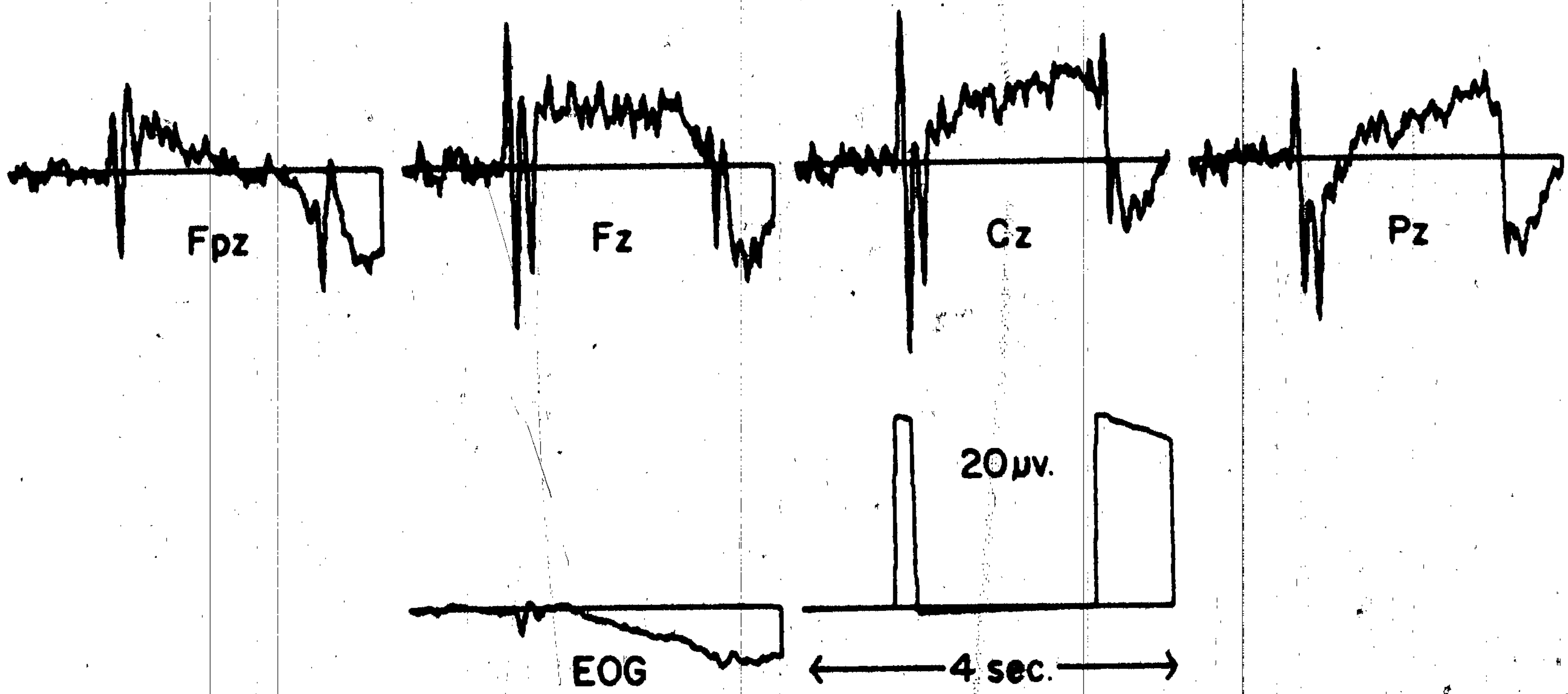
FEMALES - DAYS 3 & 4 - HIGH INCENTIVE - EASY



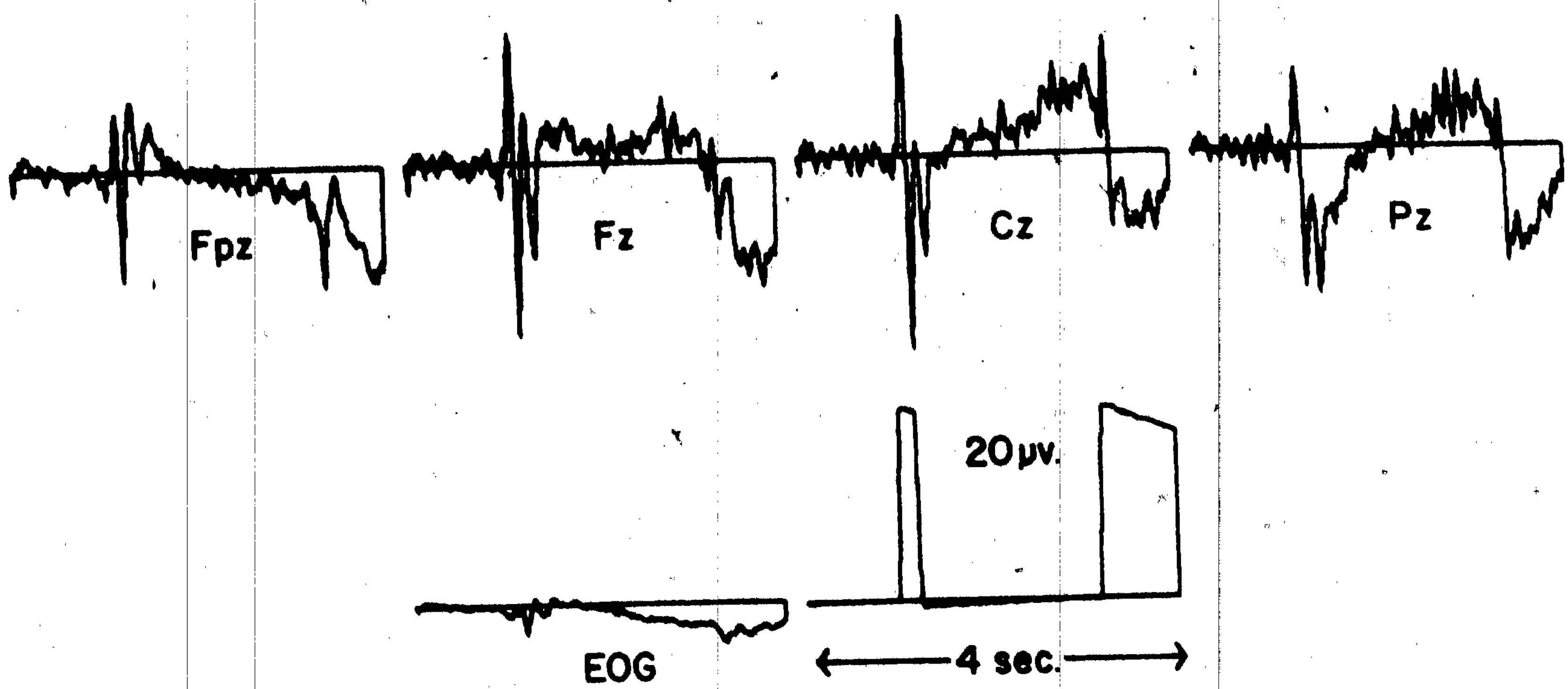
FEMALES - DAYS 3 & 4 - HIGH INCENTIVE - DIFFICULT



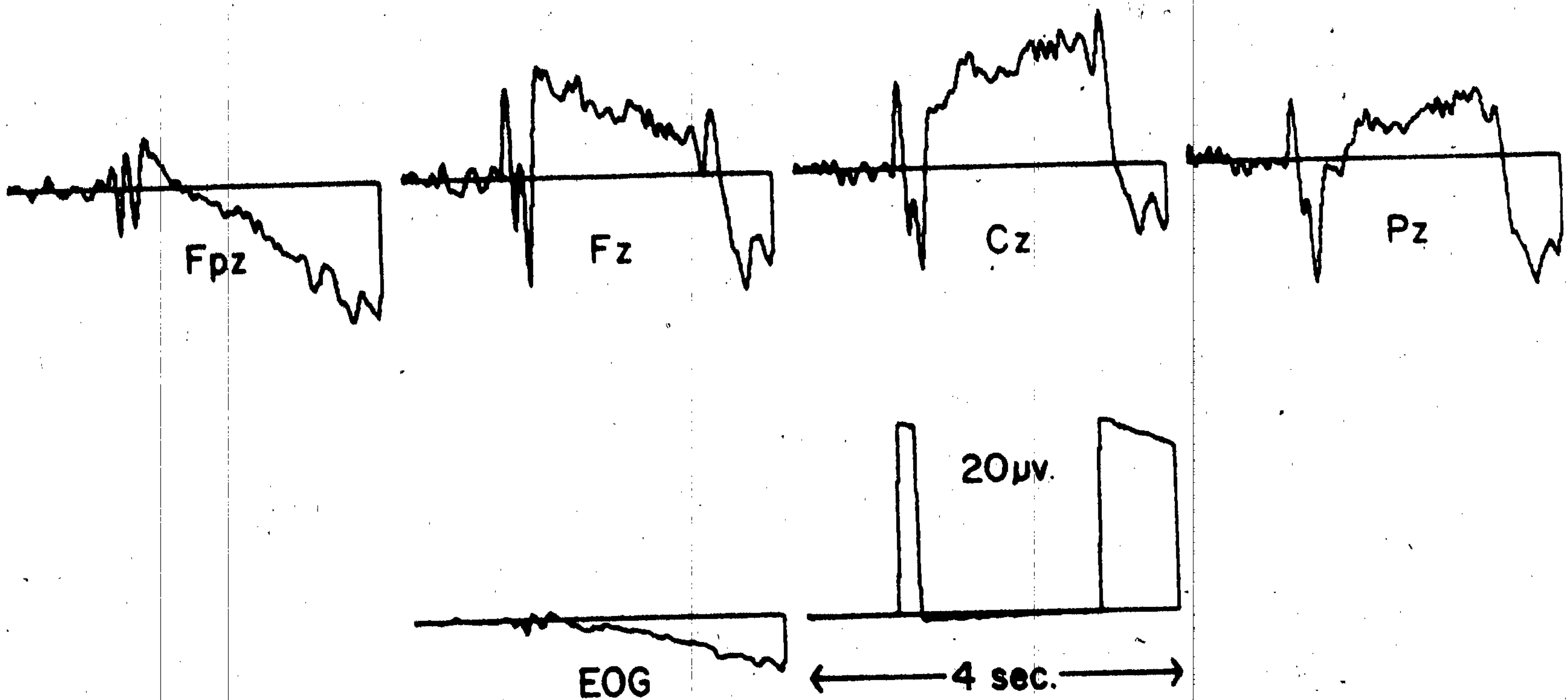
FEMALES - DAYS 3&4 - LOW INCENTIVE - STANDARD



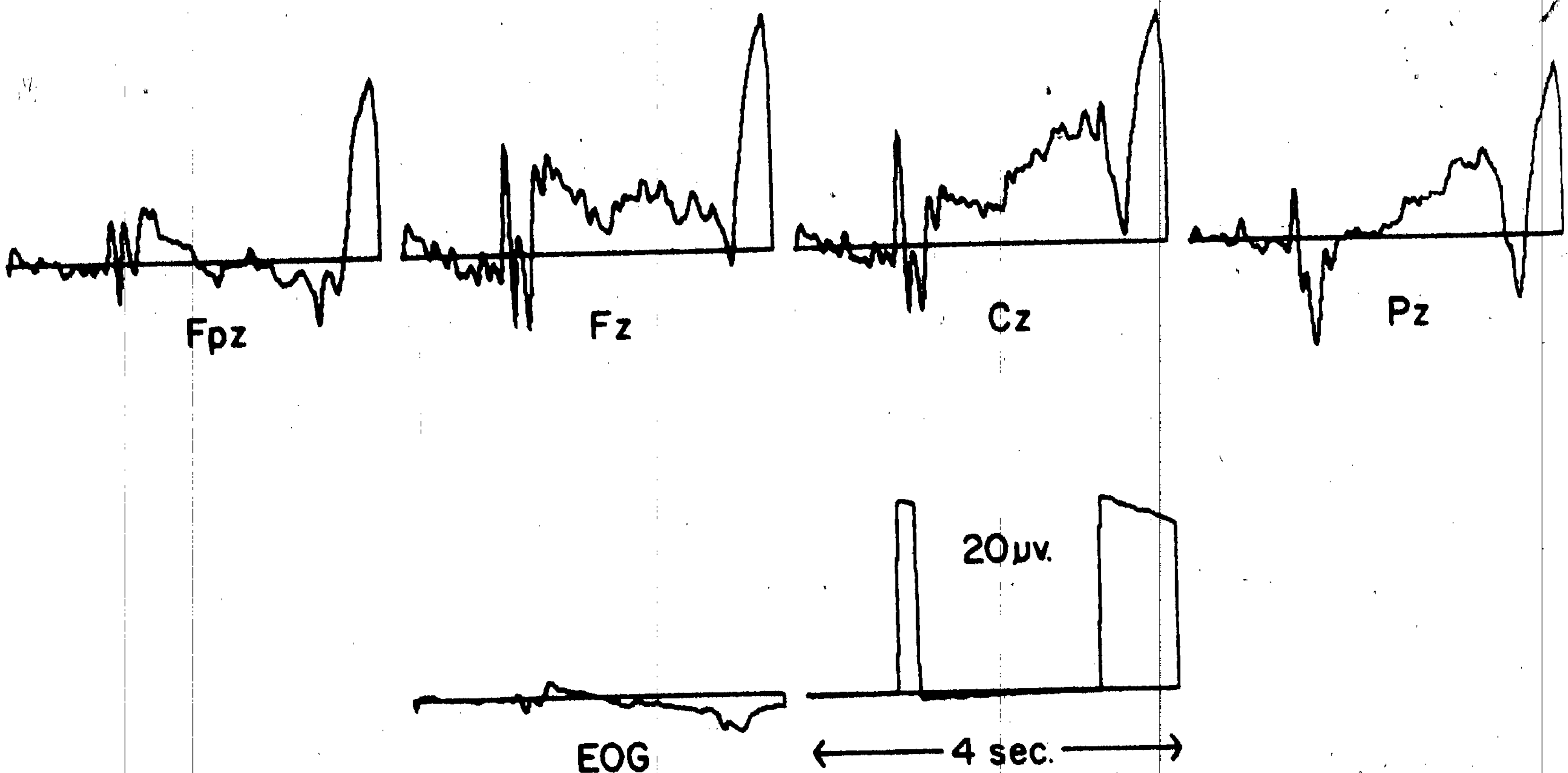
FEMALES - DAYS 3 & 4 - LOW INCENTIVE - EASY



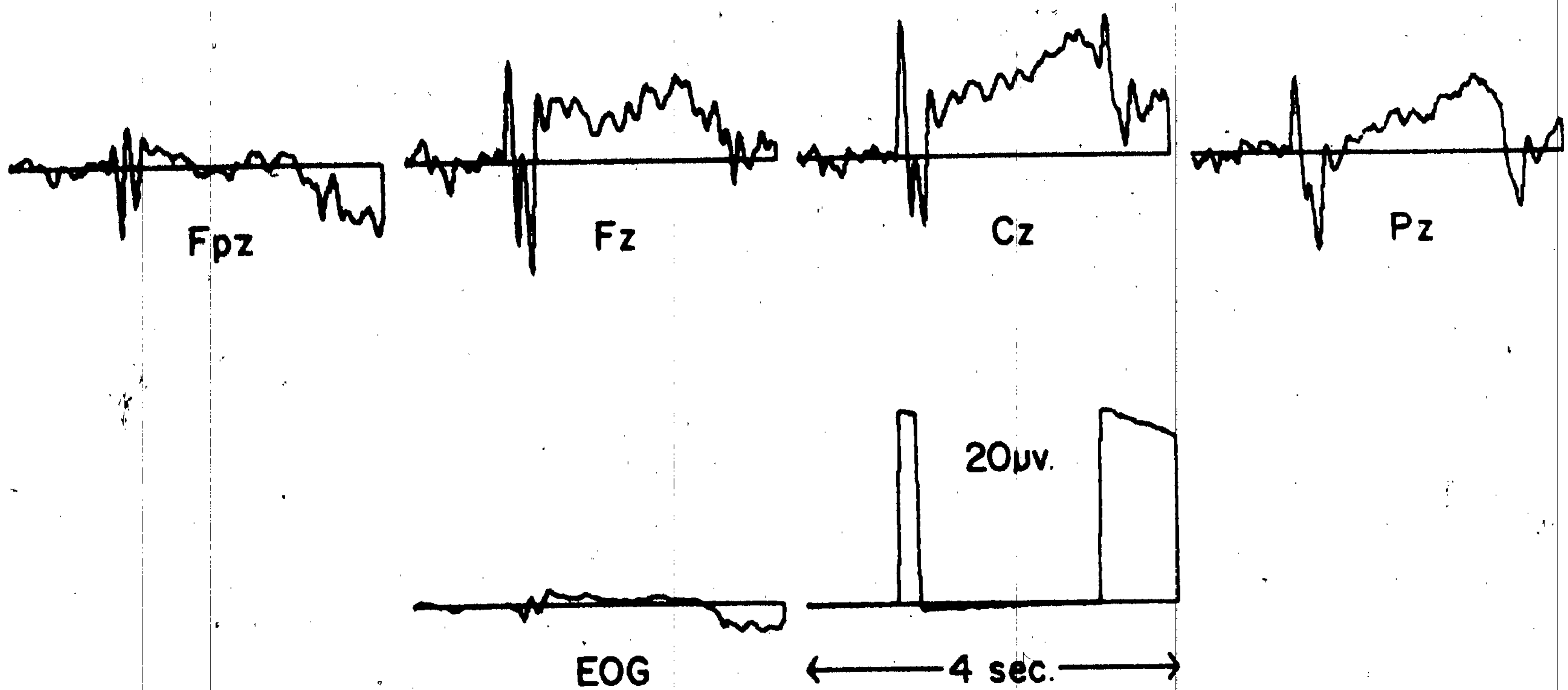
FEMALES - DAYS 3 & 4 - LOW INCENTIVE - DIFFICULT



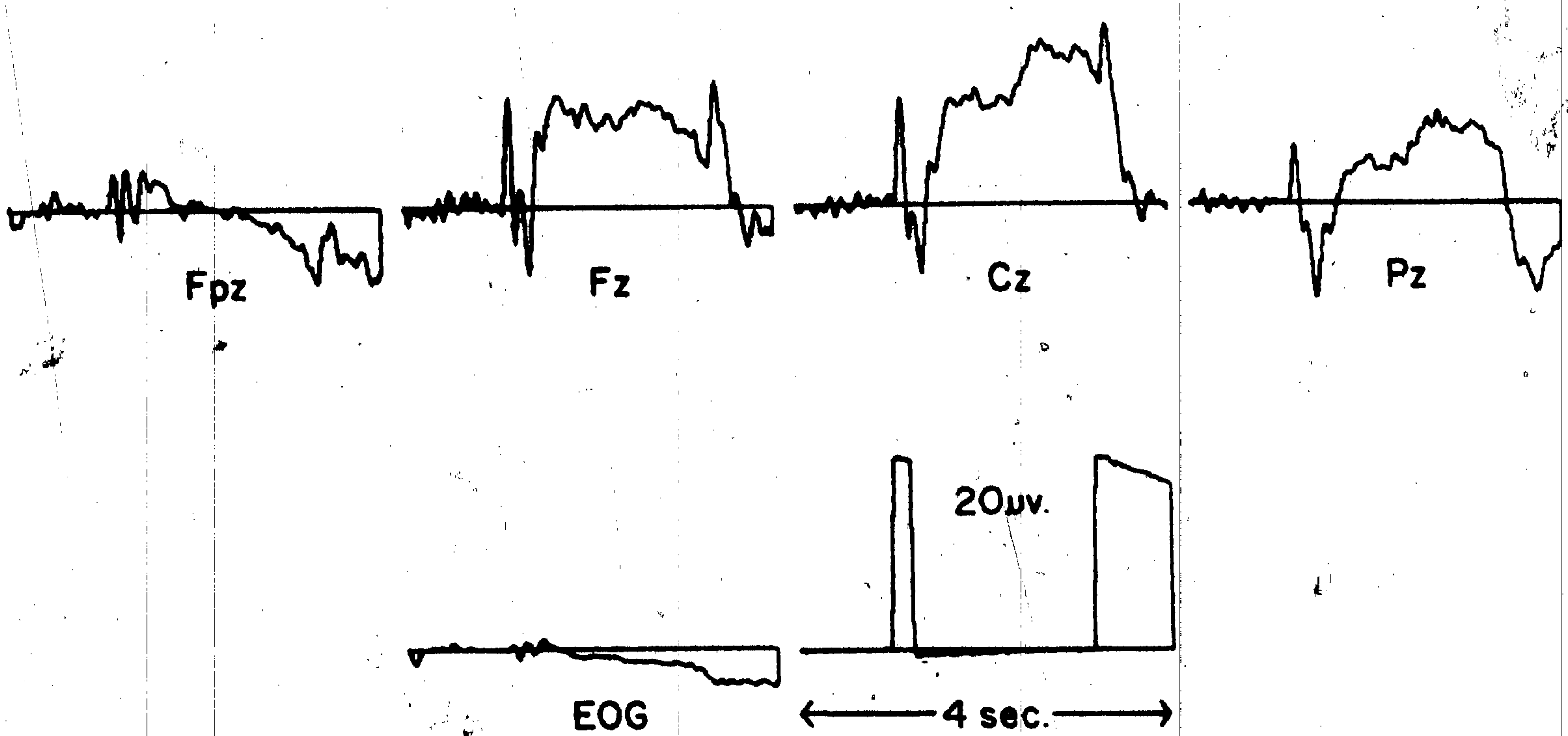
MALES - DAYS 1&2 - LOW INCENTIVE - STANDARD



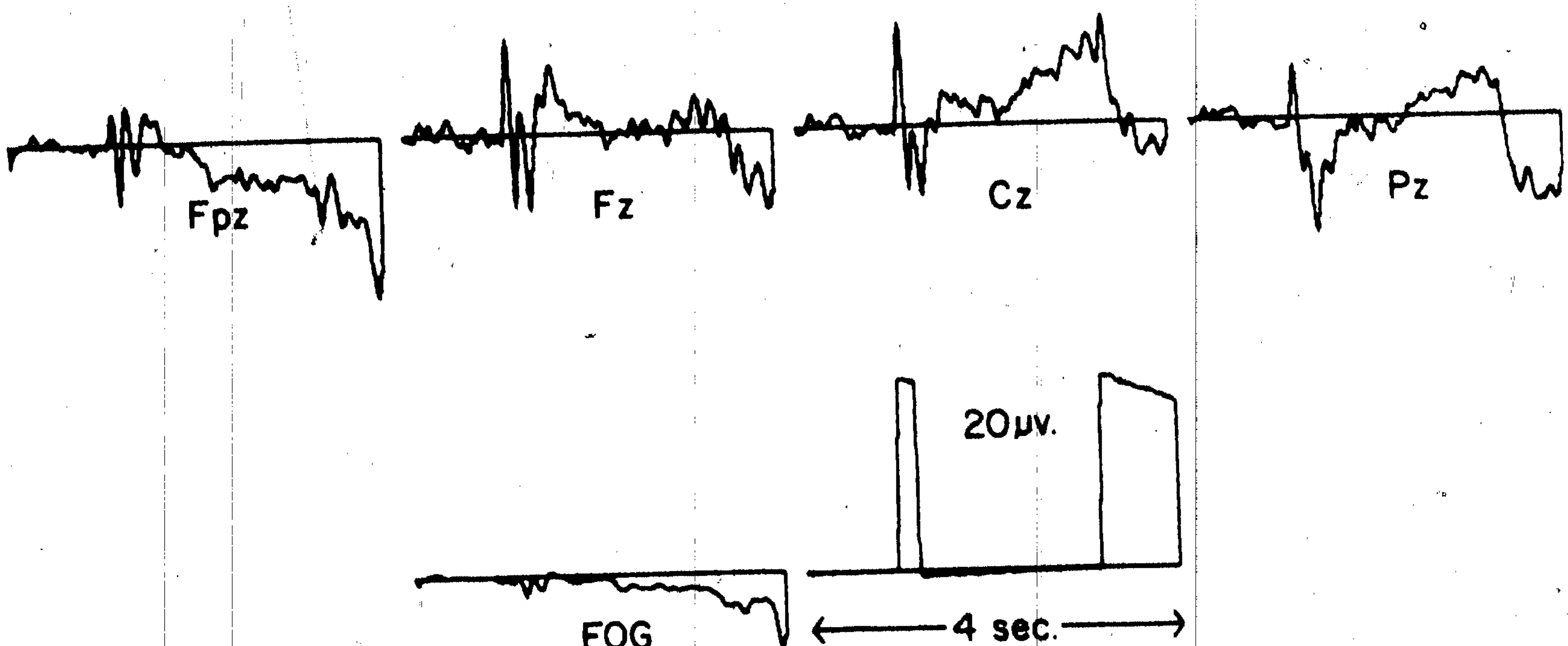
MALES - DAYS 1&2 - HIGH INCENTIVE - EASY



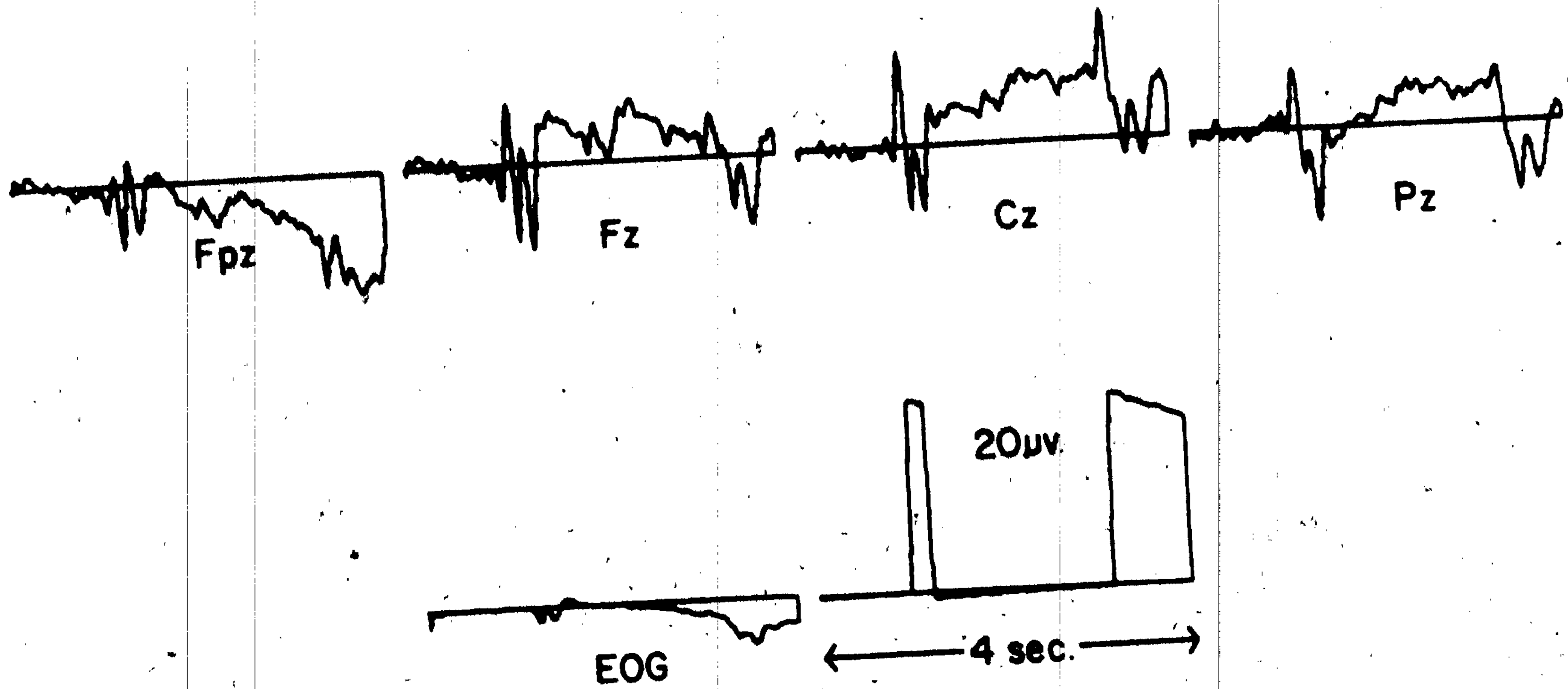
MALES - DAYS 1 & 2 - HIGH INCENTIVE - DIFFICULT



MALES - DAYS 1&2 - HIGH INCENTIVE - STANDARD



MALES - DAYS 1&2 - LOW INCENTIVE - EASY



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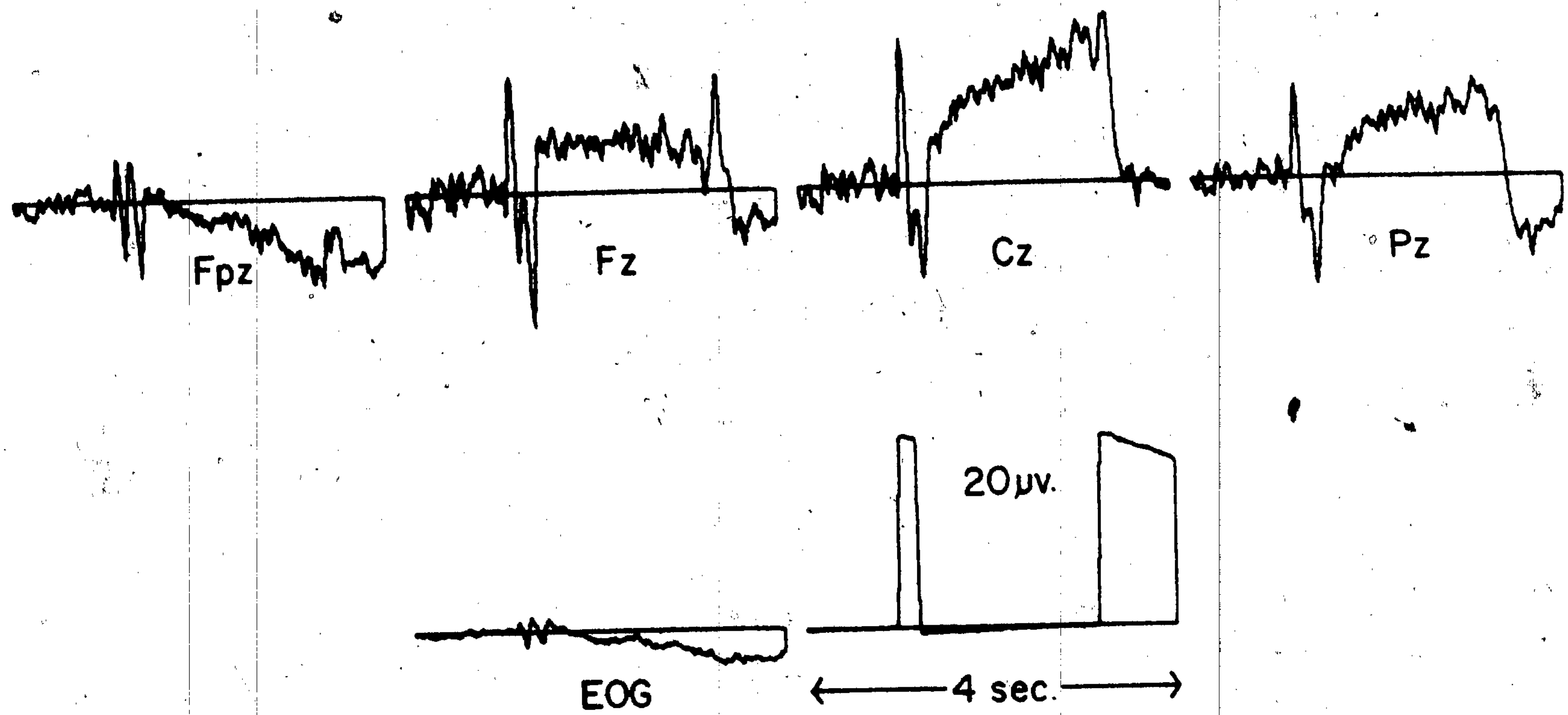
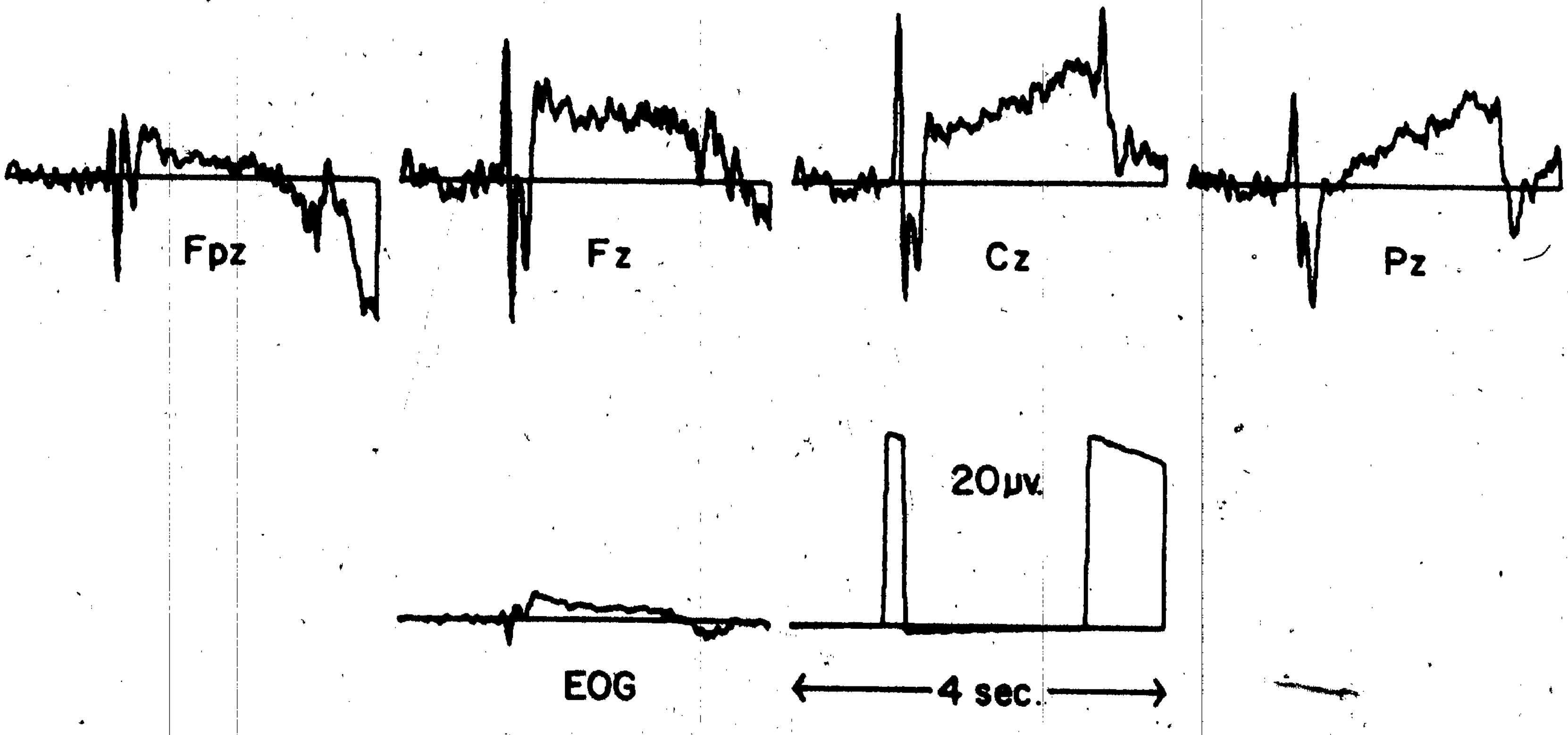


MALES - DAYS 3 & 4 - HIGH INCENTIVE - STANDARD



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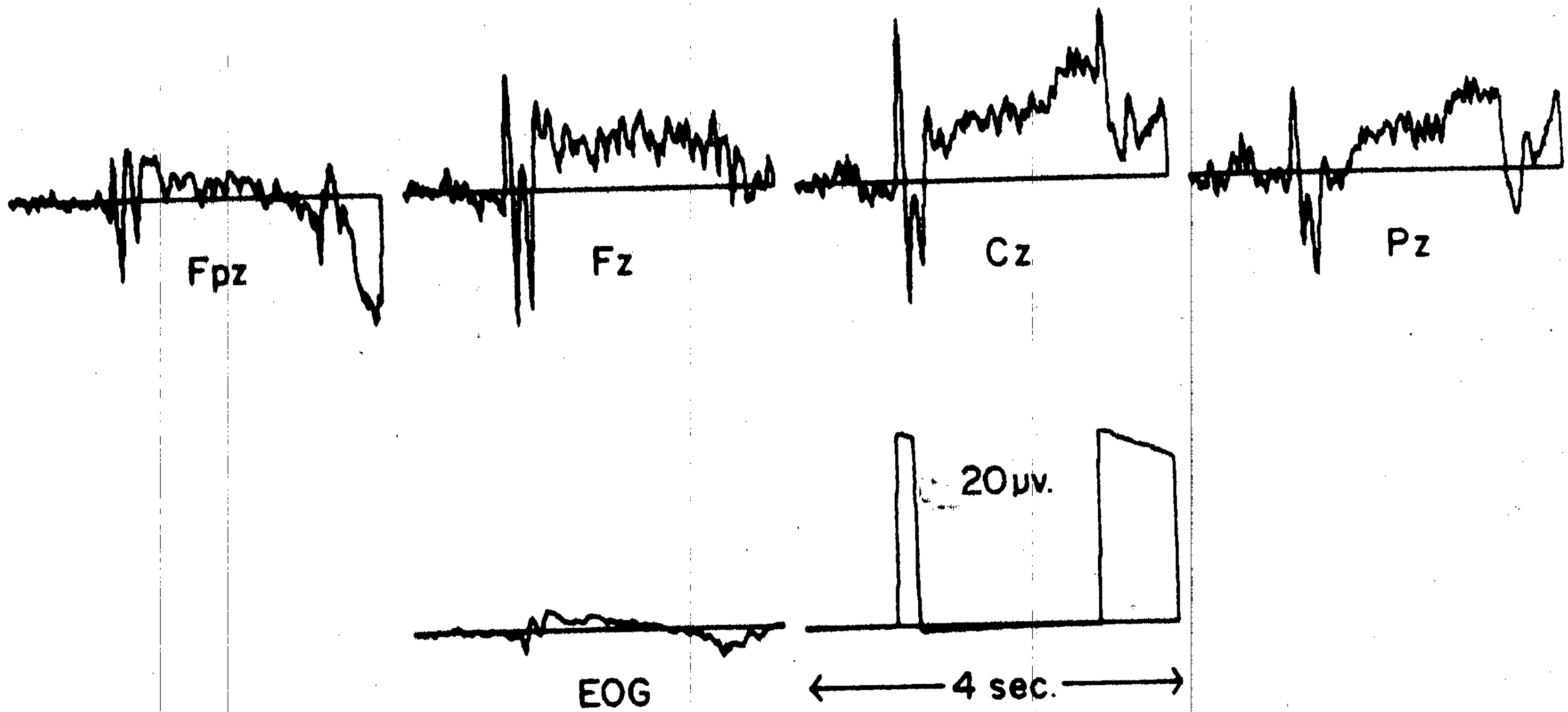

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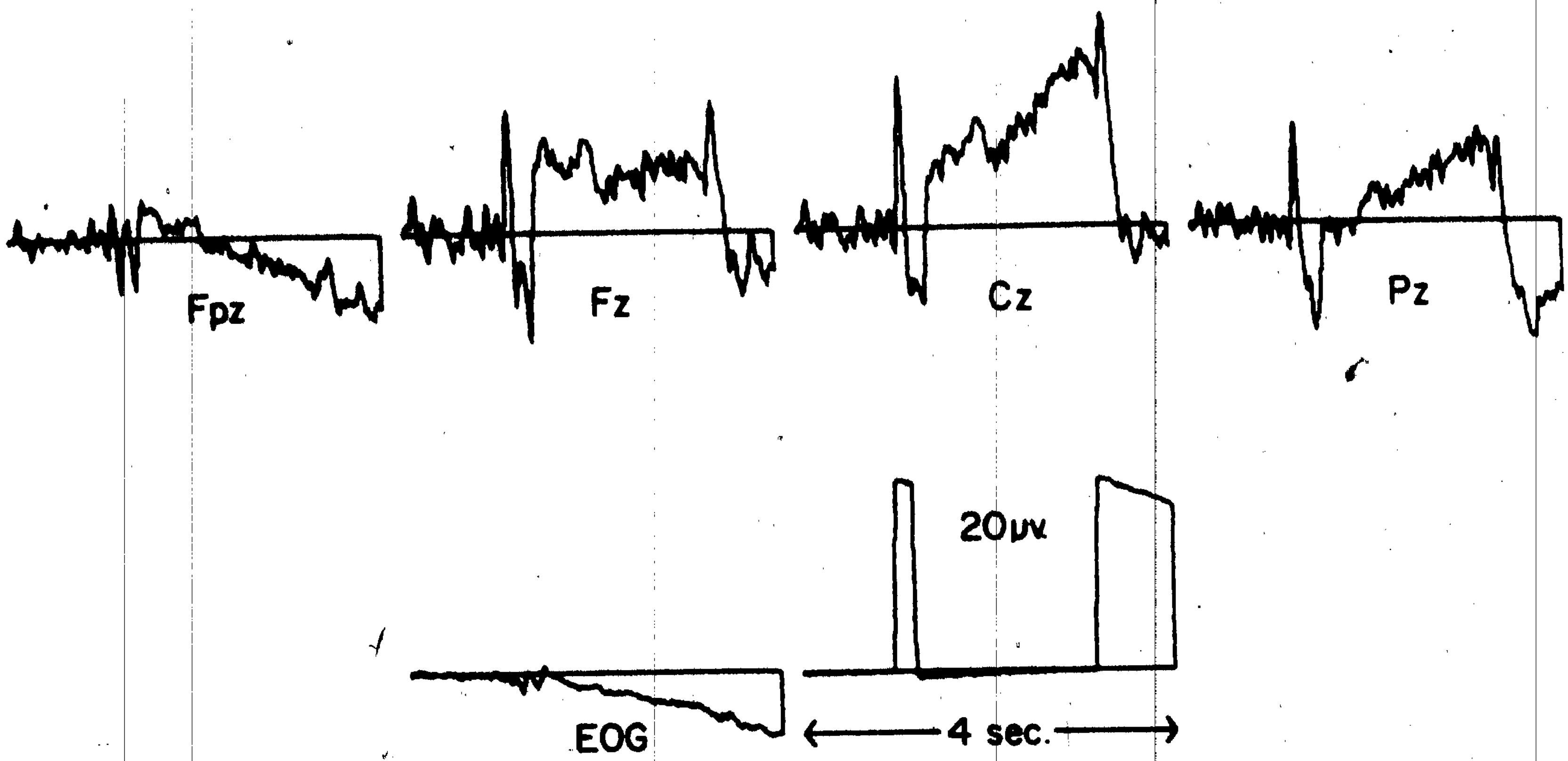

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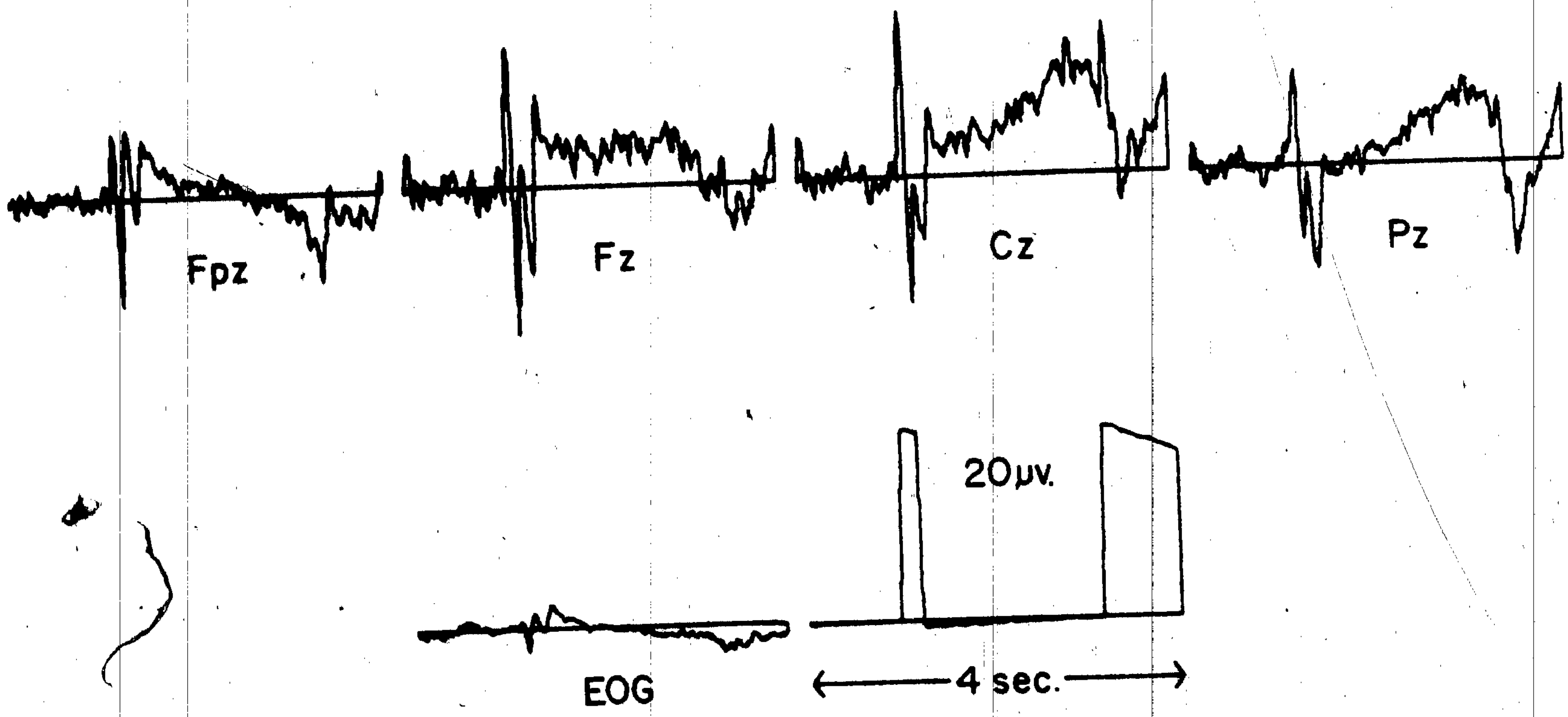

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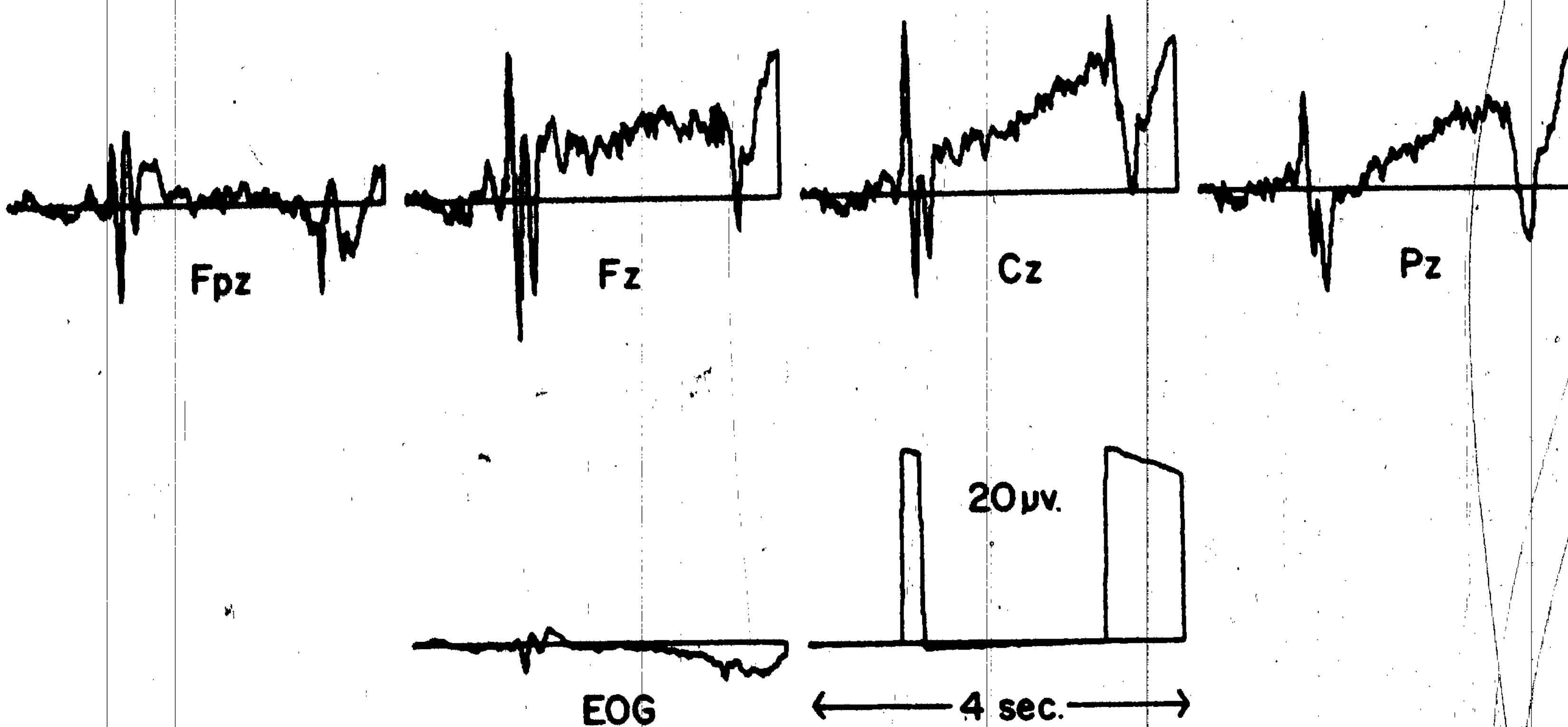

MALES - DAYS 3&4 - LOW INCENTIVE - DIFFICULT

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