ELECTROCORTICAL CORRELATES OF ASSOCIATION FORMATION IN HUMANS: AN EXAMINATION OF THE INTERACTION OF NEUROPHYSIOLOGICAL INDICES OF LEARNING

by

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Electrocortical correlates of association formation in humans: An examination of the interaction of neurophysiological indices of learning.

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ABSTRACT

An experiment was carried out in order to ascertain the interrelationships between spontaneous brain electrical activity (EEG) and event-related slow potentials (ERP) during the formation of a simple association. Monopolar recordings of brain electrical activity collected from normal female subjects were subjected to serial amplitude measures and power spectral analysis. Acquisition trials were compared to a psuedoconditioning and extinction series, with a variety of statistical treatments. A delayed conditioning paradigm was employed for the purpose of establishing the relationships between several indexes of acquisition and extinction. During the acquisition trials biphasic slow event-related potentials were observed in the S1--S2 interval. These biphasic responses were accompanied by changes in the spectral composition of the spontaneous EEG. The overall results are discussed in terms of the concepts of orienting and habituation, as they are reflected in EEG indexes of the learning process.

DEDICATION

This thesis is dedicated to Carol Karle Peters, at whose personal expense this has all been accomplished.

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CHAPTER 1

INTRODUCTION

In the original studies on the electrical activity of brain, Caton (1875, 1877, 1887) found that when a specific area of grey matter was in a state of "functional activity its electric current usually exhibits negative variation" (Brazier 1961). Some 15 years later, Beck (1891, see Brazier 1963), not knowing of Caton's earlier work, also succeeded in recording the electrical activity of brain and confimed Caton's report of the appearance of negative variations in functionally active areas. In addition, he wrote the first description of the blocking action of peripheral stimuli on the EEG which reads as follows:

> In addition to the increase or decrease in the original deviation during stimulation of the eye with light, rhythmic oscillations that have been previously described disappeared. However, this phenomenon was not the consequence of light stimulation specifically for it appeared with every kind of stimulation of other afferent nerves. (Brazier 1963)

Beck went on to hypothesize that the development of electro-negativity in an area of cortex indicates the creation of an "active state" in centers located there. He performed several stimulation experiments to induce steady potentials and blocking in various cortical areas, the results of which confirmed his hypothesis. Beck's teacher Cybulski published photographs of the ongoing EEG and so documented the increase in frequency following peripheral stimulation. Brazier (1961) equates these fast frequencies with the desynchronized activity described today as electro-cortical arousal. Credit for publication of the first pictures of the EEG, however, belongs to Pravdich-Neminsky (Brazier 1961). These findings remained little more than empirical observations until the publication of Hans Berger's work commencing in 1929 (see Gloor 1969) which showed that the electrical activity of the brain (electroencephalogram, EEG) could be recorded in intact humans and that these spontaneous rhythms also demonstrated "blocking or suppression" with sensory stimulation.

Berger reported that the EEG of a quiescent human was dominated by rhythmic activity varying from 8 1/3 to 11 1/2 Hz which he termed the alpha wave (-w), and that sensory stimulation resulted in the disappearance of the alpha rhythm and appearance of lower voltage fast activity, termed beta waves (-w). No baseline shifts were reported. Although no reference is made to any of the above, Jasper (1936) reported suppression of alpha activity in humans with visual stimulation. He also noted that blocking of rhythmic activity may be accompanied by a positive polarization and that the post-positive rebound was associated either with an increase in alpha amplitude and frequency or, when the negative wave was more proncunced, a continued blocking of rhythmic activity. He concluded that alpha blocking accompanied by a negative shift was indicative of a cortical "excitatory" state. A possible association between alpha blocking and negative baseline shifts was also discussed by Bishop (1936). Rheinberger and Jasper (1937) replaced the term "excitatory" with "activation pattern" to describe the EEG response to any stimulus condition which tends to arouse the animal (cat) to activity or increase neuromuscular tension, giving the impression of alertness. This complete blocking of rhythmic electrical responses in the cat was considered comparable in all respects to that observed for the occipital alpha rhythm in man in response to visual stimuli. The work of Moruzzi and Magoun (1949) and Lindsley et al. (1949) on the reticular activating system's effects on arousal mechanisms and EEG desynchronization (synonomous with blocking or suppression) provided support for Jasper's (1936) hypothesis of a central arousal mechanism.

Subsequently, the association of this mechanism with the blocking of the cortical alpha rhythm during visual attentiveness and orienting has gained relatively widespread acceptance (Lindsley 1960). Duffy (1962, 1972) has argued strongly for an electrophysiological definition of arousal and her concept of "energy mobilization" seems to follow a parallel argument. Subsequently, it has generally been assumed that the presence of low voltage, fast, desynchronized EEG represents "excitation" or "activation" of neural mechanisms, whereas the slower, higher amplitude alpha rhythm is a sign of relative inhibition (Grossman 1967).

Later studies have not in all cases supported this conclusion, and some authors have suggested that low amplitude fast EEG activity reflects inhibitory processes (Grossman 1967). In spite of this conflicting evidence, subsequent research in EEG has generally followed the train of thought that a cortical or subcortical area is involved in the task at hand when it exhibits one or more of the following EEG changes: (1) blocking of spontaneous EEG and appearance of low voltage fast activity; (2) larger evoked potentials with shorter latencies; and (3) negative shifts in resting steady potential baseline. The majority of investigations in the area have examined these waveforms individually in what can loosely be referred to as a classical conditioning paradigm. The following discussion of spontaneous rhythms, slow potential changes and evoked potentials will center on changes in these waveforms which have been elicited in a paradigm where the subject's task is to form an "association" between two stimuli (S1-S2 or CS-UCS, etc.). The subsequent chapter reviews the relevant literature to show that each waveform can be independently related to this paradigm and thusly, an interrelationship can be predicted.

CHAPTER 2

LITERATURE REVIEW

Alpha

The majority of investigations concerning EEG reactions to paired sensory stimuli have focused on blocking of the alpha rhythm as the dependent variable. There are four possible reasons for this: (1) the EEGs of a majority of intact humans contain a demonstrable alpha rhythm; (2) this rhythm is generally large in amplitude and well defined in comparison to other waveforms in the spontaneous EEG; (3) it responds by "blocking" to visual stimulation in an obvious way in the majority of the population exhibiting it; and (4) historically, its blocking has been associated with an active, aroused state in the organism.

As are many of the discoveries in electrophysiology, the finding that alpha blocking could be conditioned was serendipitous. Durup and Fessard (1935) were recording the response of the alpha rhythm to a visual stimulus with a camera, the shutter of which produced an audible "click" every time the visual stimulus was presented. Fortunately, the shutter "click" occurred without the visual stimulus and the alpha rhythm blocked as if the light had been presented. This blocking continued for several presentations of the "click" alone, eventually extinguishing. Since the "click" did not elicit alpha blocking prior to its association with the visual stimuli, Durup and Fessard concluded that the "click" had "acquired" the ability to block the alpha and that its acquisition and extinction appeared to parallel those found for overt motor responses.

These preliminary findings were quickly confirmed by Loomis *et al.* (1937) who reported that an auditory stimulus to which a subject had previously been adapted could again be made effective in blocking alpha by pairing it with a visual stimulus. Cruikshank (1937) and Jasper and Cruikshank (1937) demonstrated that an auditory stimulus which served as a warning for a light requiring an overt response acquired the ability to block alpha. These findings were further supported by Travis and Egan (1938) who reported alpha blocking (defined as a striking depression of alpha activity) on 34% of the trials in which the CS and UCS were paired (compared to 11% for CS alone) and that blocking returned to the 11% level following only 3-4 nonreinforced trials. In contrast, Martinson (see Knott and Henry 1941) was able to replicate Travis and Egan's results without pairing the tone with a light.

A more extensive examination of conditioned alpha blocking was conducted by Jasper and Shagass (1941a) who applied simple, cyclic, delayed trace, differential, differential delayed, and backward conditioning procedures to the problem. In some cases extinction and spontaneous recovery were also shown. Long delay and trace intervals (9-10 sec) apparently resulted in bored, sleepy subjects, as slow waves were noted in the EEG. They attributed the instability of the response and its rapid extinction to the low motivation of the setting. In a subsequent paper, Jasper and Shagass (1941b) concluded that the subjects were not pacing the CS-UCS interval, as their subjective estimates of the interval were considerably longer than the actual interval. In a similar vein, Shagass and Johnson (1943) were able to show an accelerated acquisition curve for subjects receiving partial reinforcement (50% of CS's followed by UCS) as compared to subjects given 100% reinforcement. However, as Knott (1941) points out, their usual definition of conditioning was extremely liberal: "conditioning was considered established when at least two consecutive responses to the conditioned stimulus occurred in which there was a sufficiently long depression of alpha rhythm to be clearly a response to the stimulus rather than a 'spontaneous' variation."

In view of Knott's objection, and the knowledge that almost any stimulus selected as a conditioned stimulus will initially block alpha, the question arose as to whether this is true conditioning or merely sensitization. Similarly, Voronin and Sokolov (1960) discussed alpha blocking as a component of the orienting reflex. Knott and Henry (1941), drawing on Martinson's data, attempted to differentiate sensitization from "true" conditioning by using a delayed conditioning task with a 4 second i.s.i. which would allow ample time for full recovery of alpha blocked by the CS. Thus, anticipatory responses should be fully measurable. Their results were somewhat equivocal in that the blocking was not only exceptionally labile, but the conditional blocking showed evidence of inhibition of reinforcement.

An alternative procedure would be to employ pseudo-conditioning (sensitization) trials in order to habituate the alpha blocking to the CS (Kling 1971). Esecover _et al_. (1964) and Milstein (1965) employed a light-alone series after tone habituation and demonstrated sensitization by a tone-alone series immediately thereafter. Esecover _et al_. inferred that sensitization does occur and that this effect is indistinguishable from that attributable to pairing of tone and light. Torres (1968) reported incomplete habituation to tones prior to differentially pairing them with light. He postulated that this incomplete habituation may have been due to "the sensitizing effect of interspersing two tones of different frequencies." However, the pairing of tone with the light resulted in significantly more alpha blocking response than presentation of either tone alone.

Putney (1966), in reviewing this literature, concluded that perhaps the multiplicity of experimental conditions employed in the area could account for the question of whether conditioned alpha blocking actually occurs (Jasper and Shagass 1941 a,b), is a weak and unstable phenomena (Albino and Burnand 1964; Gastaut _et_ _al_. 1957; Knott and Henry 1941), or does not occur at all (Stern _et_ _al_. 1961). Stern _et_ _al_. (1961) noted a consistent increase in subject alertness in habituation (tone alone), while during "conditioning" there was a consistent decrease as reflected by slow waves in the i.t.i. They further note, as have Lairy-Bounes and Fischgold (1953), that stimulation of drowsy subjects frequently results in alpha enhancement and that this enhancement may account for the absence of alpha blocking in their study.

Putney (1966, 1973) and Putney _et_ _al_. (1972) have conducted a series of studies to examine the role of overt motor responses and the method of response quantification as independent variables which might effect the presence of alpha blocking. Their results demonstrate fairly conclusively that alpha blocking can be conditioned and is not dependent on making an overt motor response, although the presence of one facilitates it. They further note that the scoring method pioneered by Knott and Henry (1941)--if three or more waves in a given epoch are 50% below prestimulus waves, blocking is said to occur--is too conservative a criterion for defining alpha blocking. This last point may well account for Wells' (1963) contention that alpha blocking is unstable, and may be absent even during paired trials. This phenomenon has been noted by a number of investigators (Gastaut _et_ _al_. 1957; Ito _et_ _al_. 1959; Morrell 1958) and Visser (1963) showed that conditioned alpha blocking decreased over trials while the galvanic skin reflex did not. A decrement in the response over trials was attributed to "inhibition of reinforcement" by Knott and Henry (1941).

A further problem is that suppression of alpha with eye opening or with the appearance of a bright light in a darkened room is not truly "unconditioned." Redlich _et_ _al_. (1946) found that 12 of 100 subjects failed to show any change, and 16 only slight changes, in alpha with eye opening. Wells (1959) has shown that a 3 sec light which is repeatedly presented to a subject does not invariably result in alpha blocking. Jus and Jus (1960) reported that over the course of time the alpha blocking response is changed from a generalized reaction to a focal one.

Beta

In the foregoing literature, frequent mention is made to an "activation pattern" (Rheinberger and Jasper 1937) seen as low voltage fast (beta), desynchronized, irregular activity which "replaces" the alpha when the latter blocks. These characteristics make beta waves easily confused with action potentials of the scalp muscles which have a similar frequency range (Gibbs and Grass 1947; Mark 1947; Finley 1944). In addition, beta waves are not readily affected by factors which modify alpha (Lindsley 1944). Although numerous reports are available which show changes in beta with various "mental tasks" (Mundy-Castle 1951, 1953, 1957; Berger 1929, 1930, 1931, 1932 in Gloor 1969), few studies have been done to relate beta to paired stimulus conditions in humans.

Perhaps the best known study is that of Thompson and Obrist (1963, 1964) concerning the EEG correlates of verbal learning and overlearning in a serial anticipation paradigm. They divided the EEG into alpha (8.5-12.5 Hz), beta (> 12.5 Hz), slow (< 8.5 Hz), and superimposed fast activity, separate from beta. The slow activity did not occur in sufficient quantity to warrant a separate analysis. Their results show a significant drop in alpha with corresponding increments in beta and superimposed activity when correct responses were first being elicited, which did not return to control levels with overlearning. Similar findings were reported by Thompson and Thompson (1965) with the additional note that alpha incidence to a given nonsense syllable was initially high, dropping to its lowest point when the syllable was learned, with a gradual return to pre-learning levels. Thompson and Obrist suggested that EEG desynchronization plays a significant role in verbal learning, not as a reflection of the strength of association bonds, but rather as a correlate of focused attention. In fact, those syllables which were not being "forcefully attended to" were associated with increased alpha and decreased beta. In a subsequent study, Thompson and Wilson (1966) reported that "good learners" had significantly more beta than "poor learners" in a paired associates paradigm. Freedman et al. (1966), on the other hand, reported a significant interaction between alpha and low frequency (5.5-8.5 Hz) activity in the form of a reciprocal relationship. Beta activity was seen as exhibiting nonsignificant random fluctuations over learning. They interpreted these findings to show that learning (paired associate) is associated with decreasing arousal appearing well in advance of response changes.

Motokizawa and Fujimori (1964) studied the alpha blocking response in humans and reported a significant drop in B1, B2 and B3 activity (13-20, 20-30 and 30-60 Hz) during alpha blocking to a 60 sec light. They offered no explanation for their findings.

The EEG was examined during the acquisition of a conditioned galvanic skin response by Motokawa and Huzimori (1949). They distinguished three EEG responses which they termed "excitation potentials" ("EP"): (1) alpha blocking, (2) beta augmentation, and (3) irregular baseline deflections of 3-5 Hz. Motokawa and Huzimori reported that the "EP" response developed during acquisition, occurred just before the GSR, was more easily established and resisted extinction longer than the GSR. Motokawa (1949) subsequently reported that differential "EP" responses were easier to establish than peripheral responses to the same stimulus. These findings were extended to conditioned salivary response in humans by Iwama and Abe (1952) which was also preceded by "EP's." Studies by Iwama (1950) and Iwama and Abe (1953), however, showed these "EP" responses to be unstable over trials, being replaced ultimately by alpha activity.

Beta bursts have also been reported to occur in the frontal orbital and para cingulate areas of one patient during the performance of a reaction time task (Kamp *et al.* 1972; Storm van Leeuwen and Kamp 1973). The bursts were prominent early on in the experiment, diminishing with repetition of the task over several days.

Although not directly comparable to a conditioning or learning paradigm, there have been several studies conducted relating alpha blocking and activity to reaction time paradigms. Knott (1939) and Bakes (1939) were able to relate the latency of the alpha blocking response to reaction time in both simple and choice reaction time paradigms. Subsequent studies focused more on the presence or absence of the response and may be conveniently divided into those showing shorter reaction time to be associated with alpha blocking to a warning stimulus (Monnier 1952; Lansing et al. 1959), and those which showed that alpha blocking was not significantly related to reaction time when no warning stimulus was present (Fedio et al. 1961; Lansing et al. 1959). Thompson and Botwinick (1966) examined the role of the preparatory interval in determining the relationship between alpha blocking and reaction time. Their data did not demonstrate a clear relation although they concluded that the alpha blocking and beta activity did appear to be related to anticipatory set. A subsequent study by Leavitt (1968) confirms the findings of Thompson and Botwinick that alpha blocking and reaction time do not covary within the context of a foreperiod reaction time paradigm. Both sets of authors suggest that behavioral and EEG arousal patterns are not one and the same.

Although beta is generally viewed as an indicator of behavioral arousal, or selective attention, the relationship is not one-to-one. Freedman et al. (1966) suspected "that upper frequencies merely become more visible as alpha decreases" and that "it is probable that these frequencies are present whether or not learning occurs." Mundy-Castle (1951), on the other hand, proposes two classifications of beta, B1 and B2, with B1 showing suppression during mental activity and often though not invariably related to alpha frequency, with B2 augmented by the same.

Delta and Theta

Both delta (< 4 Hz) and theta (4-7 Hz), as originally defined by Walter (1936) and Walter and Dovey (1944), are prominent in EEGs of infants and young children, but rarely noted in the EEGs of "normal" adults in the *awake* state (Cobb 1963). Their appearance is generally taken as a sign of drowsiness, sleep (Rechtschaffen and Kales 1968), or cerebral pathology (Walter 1936; Walter and Dovey 1944).

There are reports in the learning and conditioning literature which show focal slow waves (specific frequency usually given as < 7.0 Hz) to occur during conditioning paradigms. Gastaut *et al*. (1957) in their classic cooperative study on the conditioned blocking of both alpha and Rolandic rhythms (rhythm en arceau, Cobb 1963) reported that if paired stimuli were presented after formation of the response, the CS might be followed by either increased amplitude alpha, Rolandic activity, or slow waves. The appearance of the slow waves was interpreted as a sign of central inhibition.

Employing sound as CS and finger shock as the UCS, Alexander (1958) examined alpha blocking and GSR responses in normal and psychotic subjects. He noted occasional reductions, delays, or disappearance of the alpha and GSR responses ("central inhibition"), with the EEG becoming hypersynchronous during these periods. On the basis of a preliminary verbal instruction, Mayorchik et al. (1958) established a motor reflex followed by a conditioned reflex to sound. During the establishment of the reflex to sound the EEG showed alpha depression. Subsequently, at the first stages of the development of inhibition of delay when the second stimulus was separated from the light stimulus, clear cut slow waves appeared in all cortical areas. After repeated delays of the stimulus the slow waves became focal to the motor area involved. They explained this as the "concentration of internal inhibition."

Similarly, Grindel and Spirin (1958) showed that when a motor movement was conditioned to an acoustic stimulus delta waves appeared in the motor area in response to the first CS delivered during a repeated examination. Coinciding with these focal delta waves is a depression of alpha activity in the occipital areas. The delta waves were replaced by faster activity just prior to verbal reinforcement (the word "press") and the motor movement. However, when the motor action was firmly conditioned and performed without reinforcement the delta waves were not observed. When the conditioned reaction was reversed, slow (4-5 Hz) waves appeared in the EEG over the motor area in response to the first CS. These slow waves were subsequently replaced by faster frequencies. Again, "inhibition" was invoked as the explanation for the appearance of these waveforms. Verbal reinforcement was also used by Peimer and Fadeyeva (1958) to establish positive and inhibitory reflexes to cutaneous stimulation. They showed that in some subjects the depression of alpha rhythm during the CS was accompanied by a simultaneous apperance of delta activity. These slow waves, which were not elicited by the cutaneous stimulus, appeared in the parieto-occipital areas during the first combinations of stimuli, chiefly as an after discharge following the motor response. Subsequent stimulus pairings resulted in the activity shifting to the beginning of the CS. During formation of motor conditioned reflexes Christian (1960) observed generalized EEG changes in the form of a depression of activity simultaneously with focal slow activity. He postulated the generalized depression to be a correlate of a "surprise effect" whereas the focal slow waves were of an inhibitory nature.

Other investigators (Iwama 1950; Iwama and Abe 1953; Morrell and Ross 1953; Motokawa and Huzimori 1949) noted that if the CS-UCS interval was prolonged then the desynchronization usually present throughout the interval was often interrupted by hypersynchronous bursts. These slow bursts gave way to a brief burst of beta just prior to the UCS. In differential conditioning paradigms the differential stimulus elicited a brief burst of beta followed by a prolonged period of hypersynchrony. Tan (1970) divided the CS-UCS interval into two halves, inhibition and excitation, with slow synchronous activity being equated with the inhibition in the first half of the interval, and beta activity appearing in the last half. He noted that if the subject happened to be drowsy the order of appearance was reversed, excitation then inhibition, as was the appearance of the EEG concomitants.

These observations suggest that hypersynchronous slow rhythms are the electrical concomitant of inhibition (Morrell 1961). A similar conclusion was reached by Rowland (1957) concerning hypersynchronous slow waves seen in the cat following presentation of an unreinforced CS.

Paradoxical increments in theta activity have also been associated with high arousal states, namely in young children. In his initial description of this pattern, Walter (1950) stated that it could be elicited by any pleasurable stimulus. Subsequently, Walter (1959) emphasized the ability of unpleasant stimuli to evoke this response. Unpleasant emotional states accompanying repetitive photic stimulation, embarrassment, and frustration were reported to elicit theta activity in normals by Mundy-Castle (1951, 1953). A four-fold classification of theta with only the fourth class being related to emotional stimuli was subsequently proposed by Mundy-Castle (1957). More recently, Berkhout et al. (1969) has shown slow activity to be prominent in EEGs of subjects answering emotionally laden personal questions. Maulsby (1971) concluded from the data on one infant that it could be elicited by either pleasure or displeasure and labelled it "hedonic hypersynchrony." Period analysis of Borman's EEG on Gemini VII revealed several long epochs dominated by theta and delta activity which coincided with a behavioral state of high arousal during lift off and following a system malfunction (Burch et al. 1967),

In spite of these special cases in which slow activity may be associated with high arousal, the majority of the evidence supports a conclusion of its reflecting an inhibitory state (Grossman 1967; Gastaut 1957).

In summary, either of two basic types of changes in the spontaneous EEG may be seen during the interval between pairs of stimuli about which a subject has formed an association.

The first blocking of ongoing activity (generally alpha) and the appearance of beta activity is generally seen with short interstimulus intervals (1-3 secs) and few trials. The second blocking of ongoing activity and appearance of hypersynchronous slow activity occurs with longer interstimulus intervals (4-16 sec) and a larger number of trials. The first type is generally associated with arousal or activation whereas the second has been linked to inhibition.

SLOW POTENTIALS

Steady Potentials

Subsequent to the work of Caton and Beck, the development of capacitance coupled amplifiers effectively eliminated slow potential (SP) components from investigations into the electrical activity of brain (EEG) until the late 1940's and early 1950's.

Slow or steady potentials have been defined as a nonrhythmic potential difference between cortical surface and subjacent white matter which does not fluctuate by more than 0.5 millivolts over several hours and on which the conventinal EEG "rides" (O'Leary and Goldring 1964). These potentials are generally seen to fluctuate only with changes in "state" of the organism; for example, awake-asleep (Wurtz 1965) or during epileptic seizures (Caspers and Speckman 1969). Although its presence in sub-human species is well documented (O'Leary and Goldring 1964; O'Leary 1963), its existence in man has not been extensively investigated (Chatrian *et al*. 1968; Cowen 1974; Goldring *et al*. 1958). In contrast to Wurtz's (1965) findings in animals, Davis *et al*. (1939) reported no correlation between stages of sleep and slow potentials in human subjects.

Slow potential shifts or changes (SPCs) are relative changes in SP in time, generally in response to discrete stimuli (Rowland 1968). These shifts are described by the following parameters: polarity--either positive or negative, depending on direction from some arbitrary zero baseline, recording convention, and reference site if "monopolar" recording is employed; amplitude--magnitude of the shift from baseline either in microvolts or millivolts; time--duration of the shift usually in seconds.

A third class of slow potentials, referred to as infra slow rhythmic oscillations, are slow frequency changes of 0.5 to 8/min which may develop spontaneously or appear 20-30 minutes after intense sensory stimulation (Aladjalova 1957, 1969).

Slow Potential Changes

Of principle interest to this review are those waveforms referred to as slow potential changes, i.e., those bearing a temporal relationship to external stimuli.

Morrell (1960) is generally credited with the first demonstration that SPCs could be conditioned. He combined an auditory signal with low frequency electrical brain stimulation to elicit an SPC in the cortex ipsilateral to the site of stimulation. These SPCs were frequently but not always associated with EEG desynchronization. These changes were interpreted as reflecting a "dendritic locus of closure." Shvets (1969-70) and Rusinov *et al*. (1969) have recorded SPCs during formation of conditioned reflexes in rabbits, similar to those reported by Morrell.

The suggestion that SPCs are reflections of loci in closures is supported by studies dealing with dominant foci recently reviewed by Rusinov (1973). The dominant focus concept implies that association between a stimulus and a motor response can be topographically determined (focused) by a low-level somatosensory cortical polarization. The polarization itself is incapable of eliciting the response; rather, it establishes the site of the dominant focus for the central system, usually auditory, to form a temporary connection with the cerebral system responsible for the response. In his excellent review, Rusinov points to the close similarity between the mechanisms of formation of the dominant focus and mechanisms of temporary connections. That this exogenous polarization appears to simulate an SPC similar to that found by Morrell and others led Rowland (1968) to postulate that the applied currents and SPCs might be involved in an essential mechanism underlying formation of the temporary connection, i.e., learning.

Perhaps the most extensive work in this area has been conducted in cats and rabbits by Rowland (1963, 1968) and his colleagues (Rowland and Goldstone 1963; Rowland et al. 1967; Rowland and Anderson 1971; Rowland and Dines 1973). They have examined both the SP and SPC to a variety of stimuli and behavioral situations (eating, drinking, sexual stimulation, electrical brain stimulation, conditioning) and have repeatedly shown the two to be separable events. In summary, they have shown that slow potential changes in response to nonreinforcing stimuli rapidly diminish in amplitude with repeated stimulus presentations, but are retained to reinforcing stimuli as a function of drive level and may be acquired in a classical conditioning paradigm to previously nonreinforcing stimuli. These findings have suggested to Rowland and his colleagues that SPCs may reflect the Hullian concept of reaction potential.

Examination of SPCs as recorded at the scalp in man were conducted by Kohler and Held (1949) and Kohler and Wegener (1955) in search of an electrocortical correlate of auditory and visual perception which could be interpreted as an isomorphic cortical registration of the stimulus. That they initially interpreted these responses as being positive in polarity can be accounted for by their choice of the vertex as a reference site. Kohler and Wegener (1955) subsequently changed to an active electrode at the vertex referenced to the neck which gave them "clearer results" and responses negative in polarity. More recently, David _et_ _al_. (1969) have shown sounds of variable intensity and duration to be capable of eliciting negative SPCs which are maintained over the duration of the stimulus. These responses are maximal at the vertex but can be localized in the occipital areas if visual rather than auditory stimuli are employed. Keidel (1971 a,b) suggested that these SPCs were not identical to the contingent negative variation (CNV) described by Walter _et_ _al_. (1964), but rather objective correlates of the stimulus during its duration, similar to those of Kohler and his colleagues. However, Jarvilehto and Fruhstorfer (1973) showed that both a short sound (1.0 sec) and a pause within an otherwise continuous sound elicited negative SPCs which did not differ in their characteristics. From these data, they argued that the response reported by Keidel _et_ _al_. (1971 a,b) is analogous to the CNV and not an "objective correlate of the sound."

Contingent _Negative_ _Variation_

The CNV as initially described by Walter _et_ _al_. (1964) is a negative SPC occurring in the interval between two stimuli about which a subject has formed an association. It is generally maximal in amplitude at the vertex (Cohen 1969) and can be elicited by a stimulus pair as long as the subject maintains an active interest in them.

Although Walter (1964b, 1968) originally viewed the CNV as an electrophysiological representation of the formation of the classical Pavlovian conditioned response with S1 the CS, S2 the UCS, and the motor response to S2 as an operant, few subsequent investigations have employed a conditioning paradigm (habituation, acquisition, extinction). The majority of studies (for reviews see Tecce 1971, 1972; McCallum and Knott 1973, 1976; Dargent and Dongier 1969) have established the S1-S2 association with verbal instructions to the subject (Price 1974).

In their classic study on CNV, Walter _et al._ (1964) initially presented the subject with clicks (S1) and flashes (S2) separately, repeatedly paired, repeatedly paired with S2 requiring a motor response, and finally S1 with S2 either absent or present only part of the time. The responses (vertex electrode) to S1 and S2 alone showed typical evoked potentials (EPs) with brief negative components. When S1 and S2 were paired, both EPs were essentially unchanged and both "dwindled to noise-level after about 50 presentations." Addition of the motor response resulted in the formation of a CNV on the S1-S2 interval which reached its peak at S2. When S2 was withdrawn, the CNV progressively diminished in size, disappearing almost completely after 30 trials. If S2 is not withdrawn completely (probability dilution) the response does not drop completely to zero. This pattern of acquisition was slightly different during the formation of a classical defensive eyelid response. In this paradigm, CNV amplitude increased rapidly over the first 24 trials, at which time the response is well formed. Subsequent trials lead to a progressive reduction in amplitude, until after 60 trials the CNV was scarcely above baseline and the eye was closed well before the air puff. Under partial reinforcement, both the CNV and the response disappeared completely. Supporting data have been reported by Lopes da Silva and Storm van Leeuwen (1969) which also shows the reacquisition of the response following extinction and its restoration following reduction in a distraction paradigm.

A subsequent series of studies by Low *et al*. (1965, 1966 a,b) used a paradigm similar to that of Walter *et al*. in which S1 and S2 were presented singly, paired, and with S2 requiring a motor response. All of their subjects (N=63) showed a general pattern: with initial S1-S2 pairings a late negative response (analogous to CNV) to S1 was readily apparent which diminished with repeated pairings, eventually disappearing. When S2 required a motor response the late negativity to S1 reappeared and progressively increased in amplitude over trials. During extinction this late negative wave gradually diminished, disappearing entirely after 36-48 or more trials. Verbal statements to the subjects that S2 would no longer occur results in immediate reduction of CNV (Walter 1968) or in 6-12 trials (Low et al. 1965, 1966 a,b). Walter (1965a) suggested that this social extinction was equivalent to 20-50 unreinforced presentations of S1.

Of particular interest was their note that while an operant response (motor response) was not necessary for the initial development of the slow negative wave, some form of intentional response may be necessary for its maintenance. The motor response then may serve to "maintain" the subject's level of interest in the task at hand (Walter 1965b). Walter later demonstrated that appearance of the CNV was not strictly dependent upon anticipation of a motor response but could be elicited when a subjectively "interesting" or "informational" stimulus was expected. More recently, Kakigi et al. (1975) examined changes in CNV amplitude over 10 blocks of 20 trials. They reported CNV amplitude to progressively decrease over blocks and related this to a combination of fatigue, lowered attention, reduced arousal and central adjustments.

The dependence of the CNV upon the probability of association between S1 and S2 initially discussed by Walter et al. and Low et al. was further examined by Walter (1965c). In this report, Walter was able to manipulate CNV magnitude by changing the probability of the occurrence of S2 from 100% to 50% and back several times. These findings led Walter to emphasize "expectancy" as the key psychological variable relating to the CNV. An excellent study by Hillyard and Galambos (1967) compared CNV acquisition over trials in two groups of subjects, one which had prior experience with S1-S2 pairs (Group R), and the other (Group P) with experience with S1 and S2 presented singly but where S2 required a motor response. In Group P the CNV was small but present when no motor response was required and increased rapidly in size following institution of the motor response requirement. Group R, on the other hand, showed a more gradual increment in CNV amplitude as S1-S2 pairs were repeatedly presented. Neither group showed any significant decrease in CNV amplitude with probability dilution but a dramatic decrement was found during extinction in both groups. They interpreted the different acquisition rates in terms of the subject's differential experiences with the relevant stimuli, concluding that the learning of stimuli configurations is a major factor in regulating subjective expectancies. Similar gradual increments in CNV amplitudes were reported by Karrer _et al._ (1973) to occur in subjects during the acquisition of a light--sound--response sequence. During extinction trials in which S2 was omitted, CNV amplitude dropped to zero.

Making the response ineffective with respect to the termination of S2 only slightly reduced CNV amplitude. Changes in CNV were consistent at both the vertex and frontal recording sites.

Cant and Bickford (1967) investigated differential changes in CNV magnitude and distribution with non-noxious, noxious, and avoidance of noxious stimuli. A progressive increment in CNV amplitude was found when a non-noxious (S1-S2 both clicks) baseline condition was modified to include the following: an unavoidable noxious shock (S1-S2-S3); an operant response (S1-S2-O); an operant response plus shock (S1-S2-O-S3); and avoidance of the shock when the operant response was made within 286 msec of S2 [S1-S2-O-(S3)]. Maximal amplitude was seen at the vertex in all but the last condition, during which it shifted to the frontal areas. They interpreted the data as suggesting that the CNV was not a unitary phenomena (an idea which did not gain prominence for several years). When subjects were required to press a button in the last 2 secs of a 15 sec interval to avoid a noxious buzzer, a CNV like waveform was seen in the record (Low _et_ _al_. 1966 b).

That the CNV appears to behave as a "conditioned response" suggested to McCallum (1973) that it might relate to the reduced conditionability of psychopaths in classical conditioning situations. McCallum investigated both classical eyelid conditioning and motor response (button press) acquisition paradigms in pscyhopaths and normal subjects. Although the data were confounded by artifacts (eye movement) and the short i.s.i., a CNV was observed to some degree in all subjects which tended to be smallest on the initial 12 trials, largest during the second and third sets of 12 trials, and steadily decreased thereafter. In addition to following the general trend of the response acquisition, CNV amplitude also discriminated between the groups, being significantly larger in the normals. McAdam (1966, 1967) reported the CNV to bear an inverted--U relationship with the learning of a temporal interval. In a similar experiment, McAdam _et_ _al_. (1969) showed that when the subject predicted the duration of the i.s.i. their CNVs terminated approximately at the point at which they had predicted S2 would occur.

Lelord _et_ _al_. (1976) employed sound either alone or in combination with light, ulnar nerve stimulation, percussion of Achilles tendon, or verbal instructions for a motor response, to condition slow potentials. Initially, slow potentials were only seen following the motor response, but repeated presentation of a stimulus 700 msec prior to the command stimulus eventually led to the appearance of a slow wave in the i.s.i.

The studies reviewed above are paralleled in their findings in animal studies (cats and monkeys) in which SPCs have been recorded from cortical and subcortical areas during the acquisition of appetitive and aversive jaw movement (Rebert and Irwin 1969), conditioned leg flexion (Chiorini 1969), lever pressing for food reward (Borda 1970) and shock avoidance (Hablitz 1973). Together, the data support the conclusion that SPCs are susceptible to conditioning and as such behave in accordance with the level of involvement of the organism regardless of whether "involvement" is interpreted as conation, expectancy, motivation, drive, or some other psychological construct.

EVOKED POTENTIALS

Analysis of evoked potential changes during various conditioning and learning paradigms is well documented in subhuman species. In general, the data show a gradual disappearance of the EP to the CS during habituation with a rapid reappearance when the CS is paired with a meaningful UCS. The EP is initially widespread, being recorded throughout cortex and numerous subcortical areas, becoming progressively focal to that portion of brain actively involved in the response itself. Once the response is firmly established, the focal EP may then in fact disappear or shrink further in size. Further detailed reviews may be found in Bartlett et al. (1975); John (1961, 1967); John et al. (1973, 1975); Morrell (1961); and Thompson et al. (1972).

According to Rusinov (1960), Kats employed a sequence of three clicks with equal interstimulus intervals and required subjects to squeeze a bulb following the third stimulus. If the third stimulus was absent or delayed in time, an evoked response appeared at that point at which the clicks should have occurred. Davis (1939) reported the occurrence of "anticipatory" on and off effects when a regularly spaced sequence of tones was unexpectedly stopped or the interstimulus interval prolonged. These responses could be analogous to the P300 subsequently described by Sutton et al. (1967). In spite of a detailed search, Walter (1964a) found no trace of a "conditioned" brain response, that is, a consistent waveform at the moment when an unconditioned response would have appeared when the UCS had actually been withdrawn. On the other hand, he frequently found conditioned motor and autonomic responses in those conditions. Walter suggested that the response may have been there on the first few trials but was reduced to zero by signal averaging.

Studies relating EPs, as recorded at scalp in man, to conditioning per se are relatively few. The majority of studies have examined EP correlates of paired stimuli or relevant stimuli by verbally focusing the subject's attention on the stimulus. Naatanen (1975) has critically reviewed these studies. Consistently, investigators in this area report increases in amplitude of the late components (> 100 msec) when stimuli are attended to and a corresponding reduction in the nonattention state. If the stimuli are sufficiently relevant to the subject, an additional late positive component (P300) may be recorded (Sutton _et al_. 1967).

Meszaros (1966, 1969) and Meszaros and Adam (1968) (see Meszaros 1972 for a review) employed a click as the CS and a flash for the UCS, separated temporally by 200 msecs. With this paradigm, they have been able to demonstrate habituation of the EP to the CS and its re-establishment following CS-UCS pairings. Interestingly, during extinction they report the appearance of a "conditioned evoked response" at the time the UCS formerly occurred. Further, once the subject had been exposed to hundreds of CS-UCS pairs the "conditioned" EP could not be extinguished, persisting for several months. They also reported the occurrence of a large slow negative wave in the interstimulus interval which they equated with the CNV reported by Walter _et al_. (1964). Adam (1973) has proposed that changes in these patterns may reflect memory processes in both man and animals.

Begleiter and Platz (1969) employed a discriminative conditioning paradigm in which CS+ (arrow pointing up) was coupled with a click on only 50% of the trials, and the CS- (arrow pointing down) was presented alone. A comparison of the EPs to the unreinforced CS+ to those elicited by the CS- showed the former to be approximately 25% larger in peak to peak amplitude (negativity at 65-70 msec to positivity at 210-220 msec) following the acquisition trials. There was no difference between the two during baseline conditions in which neither was reinforced. In a subsequent report, Begleiter and Platz (1971) employed the same paradigm modified to include a generalization condition in which an additional CS+ and CS- tilted 10 degrees off vertical were used, neither of which were reinforced. They reported no difference in EPs to the two CS+'s but both were substantially larger than the EPs to the two CS- arrows. The results of both studies were interpreted as consistent with John's (1967) hypothesis that the EP waveform is composed of neuronal activity evoked by the stimuli and neuronal activity representing the stored information pertinent to that stimulus situation.

In order to assess EP correlates of affective verbal stimuli, Begleiter <u>et al</u>. (1967) imparted affective content to a line drawing by repeatedly following its presentation (upright or rotated 90 or 180 degrees) with a spoken word of either positive, negative, or neutral affect. The subsequent EPs to each of the line drawings were significantly different in amplitude, being largest for the arrow associated with neutral words, and smallest for the arrow paired with negative words. Peak latencies changed in the reverse order, being shortest for the negative arrow and longest for the neutral one. As this conditioning was carried out without the subject being explicitly informed of the association Begleiter et al. (1969) repeated the experiment with subjects either receiving no information about the relationship between the arrow and the word, being told that there was a relationship but not its nature, or told the exact nature of the relation. Results of this study confirmed those obtained previously, but also showed that when subjects were partially aware of the relation EP amplitude was larger for the positive and negative arrows relative to the neutral stimulus. When the subjects were fully aware of the relation, no significant differences were found between the three stimuli. Thus, the level of subject awareness about the CS-UCS relation must be known and controlled. This may be one reason that no consistent relation has yet been reported between the EP to S1 and ensuing CNV amplitude in CNV experiments (Tecce 1972).

Based on the work of Begleiter and his colleagues, Lelord et al. (1973) paired auditory and visual stimuli in a conditioning paradigm to differentiate between normal and autistic children. For the normal children, they reported small, variable occipital EPs to sound alone which stabilized and increased in magnitude with conditioning. The response remained small and variable in the autistic group who responded instead with a diffuse slow negative potential.

The classic work in this area was done by Walter (1963, 1964a) which can be interpreted as a forerunner of his work on the CNV published in 1964. His basic experimental design involved presentation of stimuli as follows: (a) clicks and light flashes alone; (b) a click or a flash followed 1 sec later by a repetitive stimulus in the opposite modality; (c) same as 'b' with a motor response required to the second stimulus of the pair; (d) 'c' repeated with the motor response terminating the second stimulus; and (e) presentation of first stimulus only. A complete experiment consisted of 25-30 sets of 12 stimuli, lasting 1-2 hours.

Walter discussed his results as reflections of the following processes. Habituation was seen as a progressive diminution in the late negative components of the nonspecific response following 20-100 stimulus presentations. Contingent Amplification was coined to refer to the restoration of an habituated response to at least its original magnitude in response to the first stimuli of a pair. This response was further enhanced and stabilized with the addition of an operant response. Contingent Attenuation was involved in the progressive reduction in amplitude of the response to the UCS. When the response to the UCS disappeared completely it could be restored by withdrawing the CS and presenting UCS alone in a process known as Unconditioned Restoration. In subsequent research with long time constant recording (Walter et al. 1964) it was noted that the disappearance of the response to the UCS was the result of its becoming buried within the CNV. Walter (1960) employed a complex set of specific, neutral, and conditional stimuli presented to the subject in a quasi-random fashion. As subjects learned the intricate relationship between certain stimuli and could press a key to avoid a noxious sound, the EPs to the signal became "clear cut." However, "wide variations" in EP amplitude, and morphology, were seen across subjects.

Requiring the subjects to count the occurrence of certain stimuli has been a popular method of focusing subject's attention to certain stimuli (Naatanen 1975). This procedure generally results in stable EPs of relatively high amplitude. However, it has been shown by Beck et al. (1969) that conditioning subjects to flex their finger to each stimulus by shocking the finger results in larger and more stable EPs to the stimulus.

Perhaps the most intriguing aspect of the relation between EPs and relevant or salient stimuli is the appearance of a late positive component with a latency of approximately 300 msec (P300), as initially described by Sutton et al. (1967). Subsequent investigations have related P300 to resolution of uncertainty, information delivery, orienting, matching of perceptual expectancy, and decision making, to mention only a few (see Donchin et al. 1976 for a review). Courchesne et al. (1975) have recently shown the amplitude and latency of P300 to covary with the task relevance of the stimulus, stimulus novelty, and stimulus recognition, depending upon whether it is recorded from the frontal, central, or parietal area.

A negative peak (N1) at around 100-150 msecs and a subsequent positive one (P3) at 300-600 msecs seem to be the components most subject to investigation of conditioning and learning. A recent review of these components (Tueting 1976) has described N1 as being a correlate of "attention" while P3 is more reflective of the cognitive processing of a stimulus.

SUMMARY

The principle concern of this selective review has been to point out the EEG correlates of conditioning process in humans. There has of necessity been selectivity in choosing studies for detailed review, in order to present adequate evidence upon which to construct an electroencephalographic model of the changes accompanying conditioning in man; contrary data, however, have not been intentionally omitted. Using the classic alpha blocking paradigm as a base, the following summary may be drawn:

(1) Alpha -- Initially, alpha blocking occurs to both the CS (sound) and UCS (light), but habituates to the former. Pairing of CS-UCS results in alpha blocking in the interval, which dissipates with time. If a motor response is required the response will be facilitated and more persistent. This is by definition an occipital response.

(2) Beta (low voltage fast activity) -- Initially augmented to both CS and UCS followed by habituation. During CS-UCS pairings beta appears to replace alpha activity; if alpha returns, this response subsides. Initially the response is widespread but becomes focal to auditory, visual, and motor cortex.

(3) Delta and Theta -- Presence of this activity is dependent upon the length of CS-UCS interval. For short intervals (< 1 sec) it is not generally seen; for intervals over 6 sec it may appear in the first half of the interval, being replaced by beta activity in the last half. If present, it is usually focal in the same areas as the beta activity, or maximal over motor cortex if a manual response is involved.

(4) Slow Potential Changes -- SPCs are elicited by the first few presentations of CS and UCS, but may habituate rapidly. During CS-UCS pairings, SPCs develop as slow negative shifts throughout the interstimulus interval. A motor response will increase its amplitude and maintain it over trials. It is generally maximal at the vertex and bilaterally symmetrical.

(5) Evoked Potentials -- EPs are initially large to both CS and UCS, showing progressive habituation, being smallest to the CS when it no longer elicits alpha blocking. The magnitude of this diminution is dependent upon the interstimulus interval (Ohman et al. 1972). When CS and UCS are paired the EP to CS increases in size (N1-P2 component) and a P300 component may appear. Latency changes, if present, will become shorter with CS-UCS pairings.

Throughout the course of this review, no studies were found which examined all five of these potentials within one paradigm. However, that they all have a common denominator in terms of their elicitation in an S1-S2 conditioning paradigm implies that one should be able to examine all of them concomitantly. If this can be done one can then talk about the EEG in relation to conditioning in a meaningful manner. For example, Loveless and Sanford (1974, 1975) and Weerts and Lang (1973) have contended that the CNV is not a unitary process but a compound response composed of an early and late response. This biphasic response is best seen with a long interstimulus interval (3-4 secs). These authors propose that the initial negative shift which declines rapidly over trials is a correlate of the orienting reflex, while the negative shift in the latter part of the interval is a correlate of the subject's expectancy of the imperative stimulus. These findings have been extended by Klorman (1975) who showed that this biphasic waveform follows the cardiac deceleration curve in a reaction time paradigm, and Klorman and Bentsen (1975) report that the early and late components are topographically dissimilar. If this biphasic waveform covaries with the synchronous slow--low voltage fast activity pattern reported in other conditioning studies which did not examine SPCs then one will have to make a choice as to whether this reflects "inhibition" or "orienting." Perhaps that portion of the S1-S2 interval is related to both inhibition and orienting at different points in the conditioning process, but the analysis method employed (signal averaging) is confounding the two. If the latter is the case, then single trial analysis should uncover the relation.

CHAPTER 3

METHODS

Subjects

The subjects were five right-handed and one left-handed females recruited from the university community as paid volunteers ($2.50/hour). The subjects ranged in age from 18 to 23 years. All subjects were naive with respect to the hypothesis under investigation. An additional six subjects were run but discarded due to excessive artifact in the EEG recordings.

Recording Techniques

Beckman biopotential electrodes were affixed to the scalp with collodion impregnated gauze patches over the vertex (Cz), occipital midline (Oz), left and right central (C3, C4) and left and right temporal (T3, T4) areas (Jasper 1958) to record brain electrical activity (EEG). Biopotential electrodes were also attached to each mastoid process and linked for the reference. Eye movements (EOG) were monitored from a biopotential electrode placed on the infra-orbital ridge of the right eye and referenced to the linked mastoids. All electrode sites were briskly abraded with Redux prior to electrode application. Impedances of scalp electrodes never exceeded 2.0 Kohms and the eye electrode was under 5.0 Kohms as measured with a Grass EZM-1 impedance meter.

An 8-channel Elema-Schcnander Mingograf EMT-12B and Mingograf 800 combination was used to record EEG and EOG activity along with a stimulus marker. The recording montage and amplifier settings for each channel are given in Table I.

Output signals from the Mingograf were stored on a PI 6200 FM tape recorder for subsequent off-line analysis on a Hewlett-Packard 2116B computer. Prior to each experimental run a series of 50 microvolt calibration pulses (Grass SWC 1B) were also stored on the FM tape.

Stimuli

A dual Marconi AF Oscillator was used to generate the two tones used as S1 (1000 Hz) and S- (800 Hz). Both tones were 125 msec in duration and delivered from speakers located under the bed at 50 dB (General Radio Company Type 1551-C sound-level meter) above ambient noise level of the room. None of the subjects reported having any difficulty distinguishing the tones.

The imperative stimulus S2 was the flashing of a Grass PS-2 photic stimulator located 1.0 meters away in direct line with the subject's gaze. The PS-2 was set at an intensity of 16, and flashed at 13 per sec until the subject

TABLE I

Recording montage and amplifier settings employed for all subjects.

CHANNEL	ELECTRODE	SENSITIVITY	TIME CONSTANT	HIGH FREQ. FILTER
1	Infra-orbital Ridge (Eye)	50 uv/cm	DC	30 Hz
2	Cz	50 uv/cm	DC	30 Hz
3	Oz	50 uv/cm	DC	30 Hz
4	Linked Mastoids C3	50 uv/cm	DC	30 Hz
5	C4	50 uv/cm	DC	30 Hz
6	T3	50 uv/cm	0.15 sec	30 Hz
7	T4	50 uv/cm	0.15 sec	30 Hz
8	Marker	2000 uv/cm	DC	30 Hz

responded with a button press or for a maximum of 1.0 secs. An EAI 6200 counter was used to measure the subjects reaction time to the nearest msec. Stimulus presentation and timing were controlled by a Grason Stadler system.

A Tektronix J16 digital photometer equipped with a J6502 probe was used to measure radiant light levels of the subject preparation area and inside the cubicle both with and without the PS-2 flashing. These levels, initially measured in micro watts per square centimeter, were converted to foot candles (ft-c), as one ft-c is equal to 1.733 micro watts per square centimeter. The resultant values were 24.262 ft-c for the subject preparation room; 38.126 ft-c for the chamber without the PS-2 flashing; and 180.232 ft-c for the chamber with the PS-2 flashing.

Procedure

During the experimental session the subject reclined on a comfortable hospital bed inside an electrically shielded, sound attenuating cubicle (Bell-Croft Industries). The cubicle illumination was just sufficient to allow monitoring of the subject via closed circuit television. A 5-10 minute period following the subject's placement in the cubicle was used for electrode balancing and subject relaxation.

Each subject was presented with a continuous experimental session modeled after a delayed conditioning paradigm. The total session is heuristically divided into three sessions: pseudoconditioning, acquisition, and extinction. No "rest periods" or instructional communications were given to the subject once the session commenced.

Pseudoconditioning consisted of the presentation of either S1, S-, or S2 in a random order with the constraint that S1 was never followed by S2 without at least one intervening S- (Rescorla 1967). A total of 30 presentations (10 of each stimulus) were made with the intertrial interval varying between 11 and 60 secs.

During acquisition, S1 and S2 were temporally paired such that S1 always preceded S2 by 4.0 secs. The imperative stimulus S2 was never presented alone or in close temporal relation to S-. The S1-S2 pair and S- were presented in random order 70 times each for a total of 140 trials. Again, the intertrial interval varied from 11 to 60 secs.

The final condition, extinction, consisted of the random presentation of either S1 or S- alone 10 times each for a total of 20 trials. In extinction, S2 was never presented.

Prior to data collection each subject was instructed as follows:

> From time to time you will hear one of two tones coming from a speaker under the bed, or this light (point to PS-2) will come on and flash very rapidly and intensely. When this light comes on press that button (held in preferred hand) as fast as you can and you will shut the light off.

Any questions the subject had were then answered and further instructions were given relative to the necessity of holding eye and body movements to a minimum and the use of the intercom.

Following the experimental session, the subjects were questioned with regard to their analysis of the experiment in an attempt to ascertain whether they had grasped the association between S1 and S2.

Data Storage

The EEG and EOG data along with calibration and timing pulses which had been stored on FM tape were subsequently played back through the Mingograf into the Hewlett-Packard for storage on digital magnetic tape. Data for each subject were played into the computer three times in order to obtain the best combination of filter settings on the Mingograf and sampling rates on the computer for the waveform of interest. For the first replay to obtain the slow potential (SPC) data the Mingograf was set to pass activity from DC-30 Hz and the sampling epoch was 5.530 secs over 1024 points per channel. The second pass to store the background EEG (BEEG) employed a bandpass of 1.0 (T.C. = 0.15 sec) to 30 Hz on the Mingograf and a 5.530 sec sampling epoch with 1024 points on the computer. The third pass collected the evoked potential (EP) to the tone stimuli. For the EP data, the Mingograf was set to pass DC-30 Hz activity and the computer sampled for 1.024 secs over 1024 points.

Due to programming limitations, every time interval which contained a stimulus was stored on the digital tape. However, only those trials which the on-line paper record showed to be free of eye movements and other artifacts were used for subsequent analysis.

For display purposes, the SPC data for each subject were averaged into distinct blocks within the pseudoconditioning, acquisition, and extinction periods. For the pseudoconditioning and extinction conditions averages were constructed for each of the stimulus conditions presented. The 140 acquisition trials were vincentized into 5 blocks of 28 trials and all the usable S1-S2 and S- trials within each block were averaged separately. A total of 15 averages were thus constructed at each electrode for each subject.

All statistical analyses were, however, based on the "usable" single trials obtained from each subject rather than the averages. Each single trial was quantified three different times according to the type of EEG activity (SPC, BEEG, or EP) of interest.

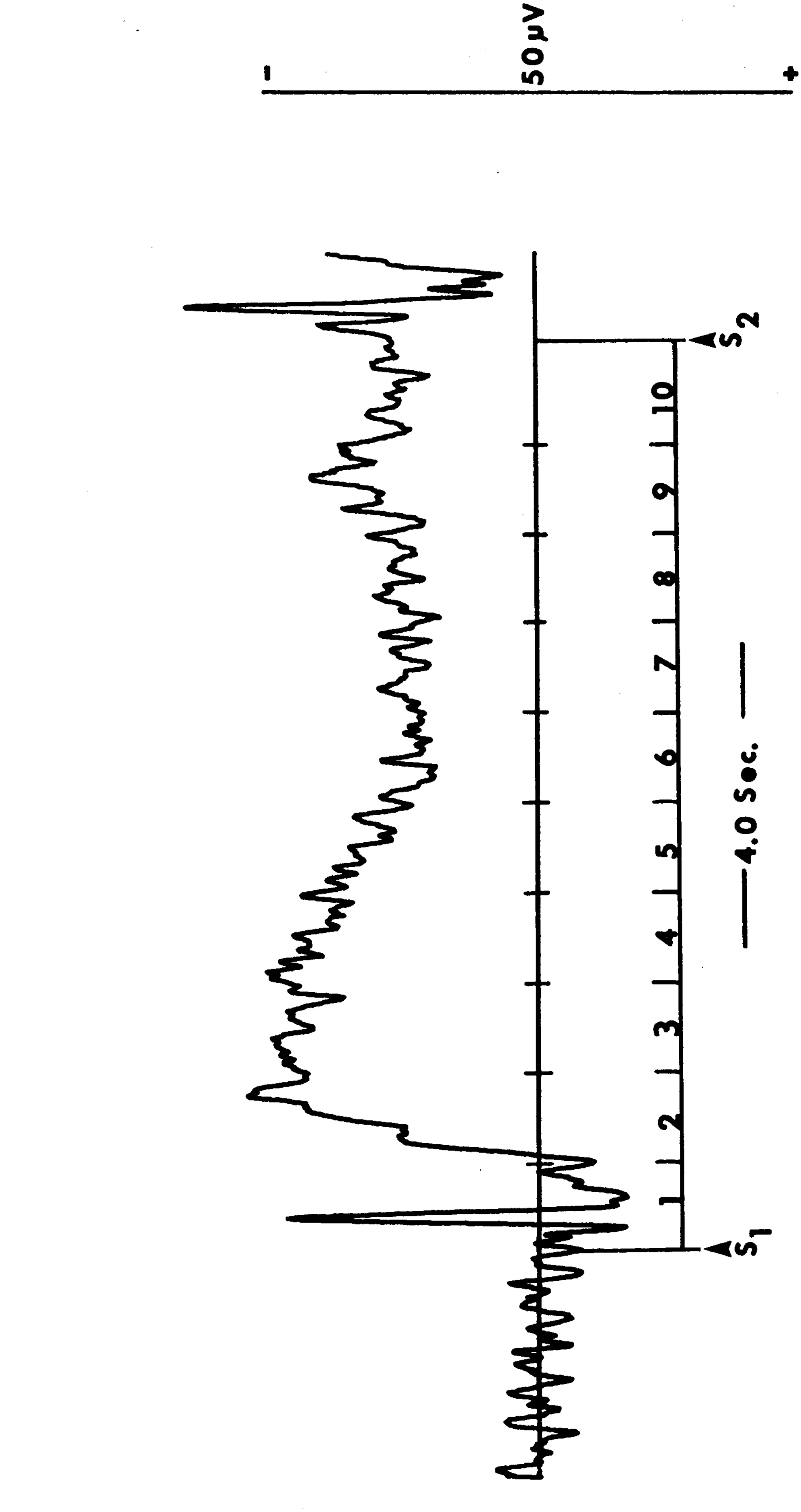
Data Quantification

Slow potentials were quantified as the mean amplitude in each of 10 segments beginning at S1 onset and ending at that point at which the light (S2) either did or would have occurred. These mean amplitudes were taken relative to a "baseline" defined as the mean of the activity in the 1.0 sec interval prior to tone onset. These mean amplitudes were converted to microvolts by comparison to the 50 microvolt pulses which had been stored prior to each experimental run. Figure 1 depicts the intervals quantified for an averaged SPC obtained at Cz. Each single trial waveform was digitally filtered with a brick wall low pass filter (Michalewski 1976) at 8.0 Hz prior to amplitude quantification. Measurements of SPC amplitude were not performed for the data recorded from T3 and T4 as the short time constant used (0.15 secs) filtered out any SPC responses which may have been present.

Baseline to peak amplitudes and latencies for a negative peak occurring with a latency of 80-160 msec (N1) and a positive peak with a latency of 300-600 msecs (P3) as recorded at Cz were quantified for the EP data. Prior

FIGURE 1

Sample averaged vertex response from subject number 01 depicting the segment analysis method. Negativity at the active electrode is reflected as an upward deflection in this and all subsequent figures.

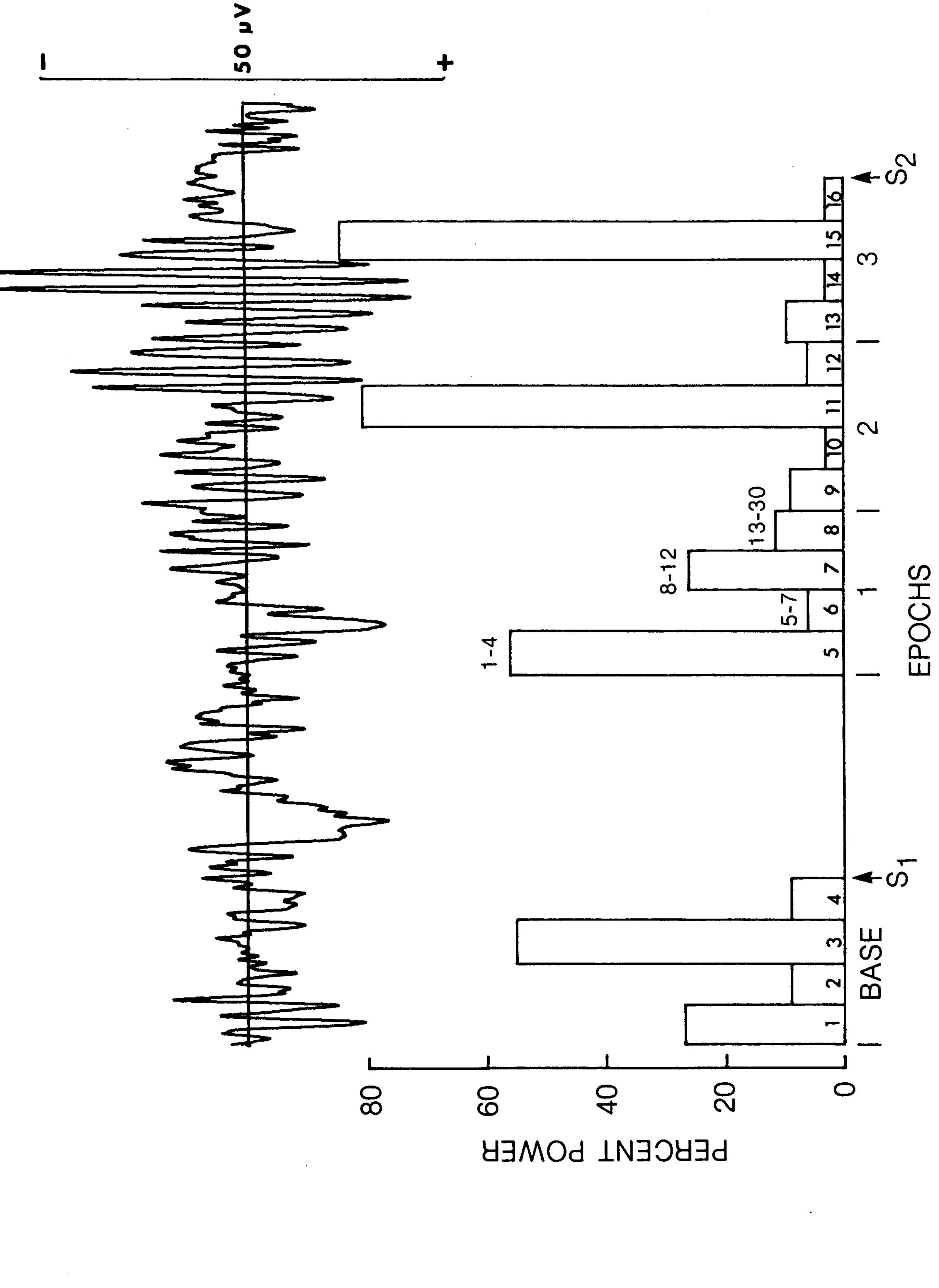

50µV
-
+
S1
S2
1
2
3
4
5
6
7
8
9
10
4.0 Sec.

to quantification each trial was filtered with the brick wall filter at 5.5 Hz and the baseline was set as the mean of the activity in the 200 msec pre-tone interval. Similar measurements were attempted for the other electrode sites; however, the EPs at these sites were too obscure even after filtering to be reliably quantified. In fact, P300 was not clearly distinguishable in every trial for each subject and was omitted from the statistical analysis.

Analysis of the BEEG data for each channel was done by calculating a series of Fourier transforms (FT) at successive time points along the waveform as shown in Figure 2. The FT subroutines were taken from the IMSL package (Note 1) and assembled into a unit by Dr. R.F. Koopman. Each FT was calculated for 184 data points over a 993.6 msec time period, resulting in spectral components covering 1.006 to 92.593 Hz in 1.006 Hz increments. The power (sum of sine and cosine squared values) for each component within four separate frequency bands, 1.006-4.026, 5.032-7.045, 8.052-12.077 and 13.084-30.193 Hz were summated for each of the FTs calculated. This power present in each band was then expressed as a percentage of the total power (sum of sine and cosine squared values of all components) in the 1.006-30.193 Hz band (Matousek 1967). These percent power figures thus form a linear combination with a sum of 100%.

FIGURE 2

Intervals over which Fourier Transforms were calculated, and the percent power obtained in the frequency bands of each transform for that waveform. Bands are consecutively numbered from 1 to 16 and are subsequently referred to by those numbers in the discriminant analyses. The notations 1-4, 5-7, 8-12 and 13-30 refer to the approximate frequency limits of each band.


50 μV
−
+
PERCENT POWER
0
20
40
60
80
BASE
1
2
3
4
S1
EPOCHS
1
2
3
5
6
7
8
9
10
11
12
13
14
15
16
S2
1-4
5-7
8-12
13-30

As a result, an increase in percent power in any one frequency band must be accompanied by a decrease in another, or vice versa. There is no reason to expect that this should be a one-to-one relationship of any two frequency bands, where, for example, a decrease in 8-12 Hz always results in an increment in 1-4 Hz activity. The lower portion of Figure 2 depicts these data as obtained for that single trial.

A series of 50 microvolt sine waves varying in frequency from 1-105 Hz were stored on-line on digital tape to check the FT routine. The FTs calculated on these data showed no evidence of aliasing and the appropriate spectral components were identified in each. In addition, activity in the 31.200-92.593 Hz band was expressed as a percentage of the total power from 1.006-92.593 Hz. That this value was routinely less than 1.0% is further insurance against possibility of high frequency activity being present which would fold over into the lower frequency bands.

Data Analysis

Donchin (1966, 1969 a,b) and Donchin and Herning (1975) have demonstrated the efficacy of stepwise discriminant analysis (SWDA) in identifying those evoked potential components which the experimental variables have affected.

As the principle question being asked here is not only "are these waveforms (SPC or BEEG) different" but "at what point(s) in time is this difference maximal" the SWDA (Note 2) procedure was chosen as the principle statistic for this thesis. Wilks' lambda was employed as the measure of group discrimination. With this criterion the variable which maximizes the *F* ratio, thereby minimizing the value of lambda, is the variable either entered into or removed from the discriminant function. Additional analyses were conducted with related *t*-tests (Note 2) to determine if the BEEG changed significantly within a single trial. Canonical correlations (Note 2) were employed in an attempt to predict SPC amplitude from the BEEG. All analyses were performed individually for each subject at each recording site using trials as replications. Thus, heuristically speaking, the N for any analysis could vary from 8-14 depending on how many artifact free trials were available for that condition.

CHAPTER 4

RESULTS

Behavioral Data

Figure 3 is an overlay of the reaction times obtained for the six subjects on every trial. Trials 1-10 were light alone presentations during psuedoconditioning while 11-80 were S1-S2 pairs in acquisition. Although there is considerable variability both between trials and between subjects, a general trend towards faster reaction times can be seen. This decrement reaches a plateau around trial 20 remaining relatively stable thereafter.

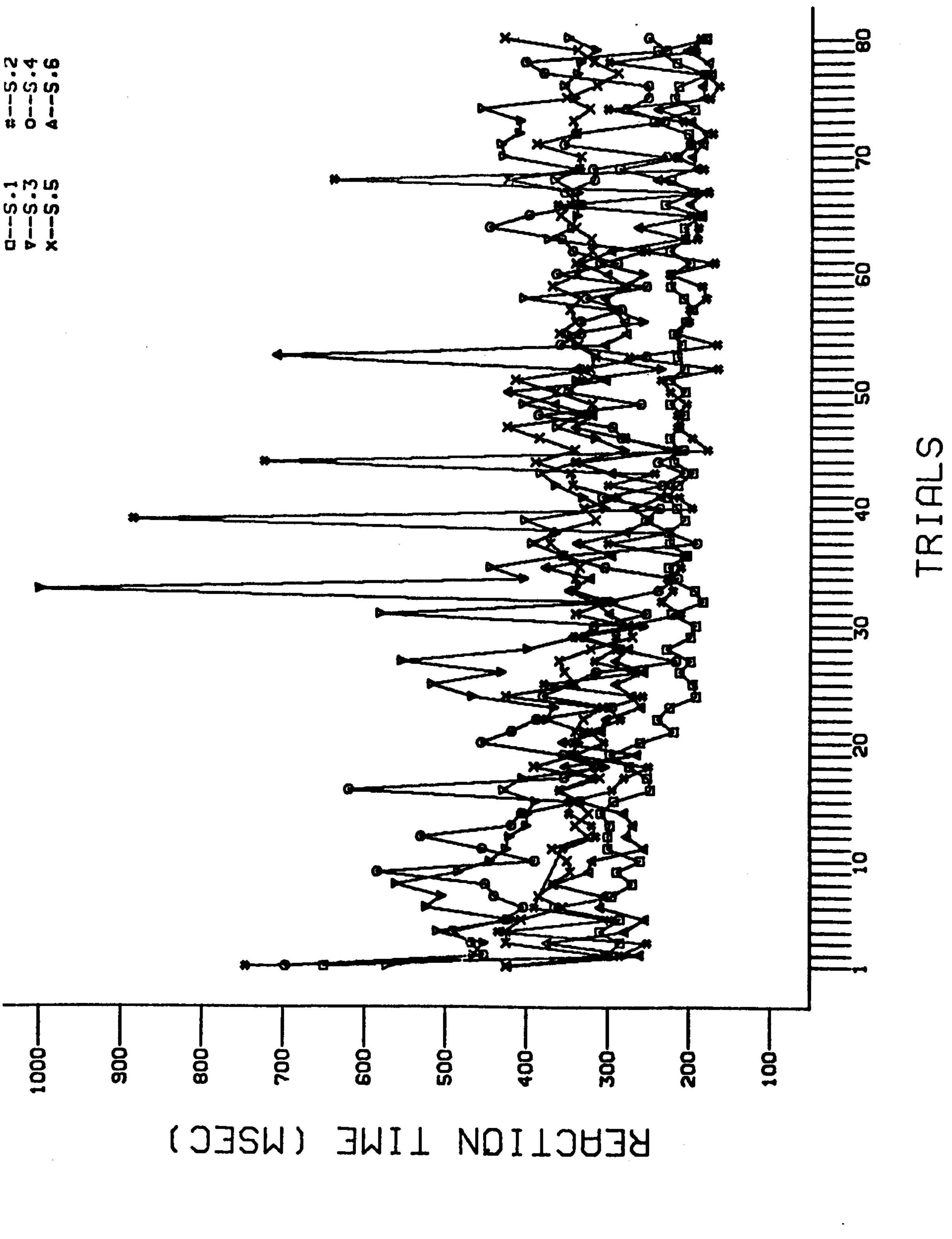
All subjects but number 3 were able to spontaneously verbalize some relation between the appropriate tone and the light at the post-experiment interview. Subject number 3, however, confessed that she had spent the entire experiment worrying about "termite problems in houses in Africa." This subject, along with subject 2, is responsible for most of the aberrant points seen in the reaction time data. In spite of her occasional aberrant performance, subject 2 was one of the two subjects displaying the fastest overall reaction time.

Slow Potential Changes

Figures 4-9 show the averaged SPC waveforms obtained for each subject in the pseudoconditioning, acquisition and

FIGURE 3

Reaction time for all subjects on every trial. Trials 1-10 were light alone (S2) presentations in Pseudoconditioning. Trials 11-80 were S1-S2 pairings in Acquisition.


□—S.1
#—S.2
∇—S.3
o—S.4
x—S.5
A—S.6
REACTION TIME (MSEC)
1000
900
800
700
600
500
400
300
200
100
TRIALS
1
10
20
30
40
50
60
70
80

extinction conditions. Presentation of either S1 or S- during pseudoconditioning elicits an evoked potential in the central areas (Cz, C3, C4) followed by a prolonged negative deflection (SPC) which gradually returns to baseline. Occipital potentials to the same stimuli, however, consist of a prominent positive deflection followed by occasional marked negativity prior to returning to baseline. During acquisition, the responses elicited by tone-light pairs at Cz, C3 and C4 appear to take on a biphasic morphology being maximal just post-S1 and pre-S2, with a low point in the middle section. Visually, these changes appear to correspond respectively to segments 2-3, 8-10 and 4-7 as depicted in Figure 1. Responses to S- generally do not have the late rising negativity seen on the paired trials. Rather, they seem to show a progressive decline in amplitude following the initial peak around segments 2-3. Early components (segment 1-3) of the occipital (Oz) responses are similar in both conditions showing a large positive component, which is followed by a later slow negative rise in the S1-S2 trials only. During extinction, the late negative rise following S1 subsides and the two waveforms again become essentially similar although there is evidence of a more sustained post-EP negativity than was seen in acquisition. The exception to these general trends is, of course, subject 3 who shows essentially no SPC changes over

FIGURE 4

Averaged SPC waveforms for subject number 01.

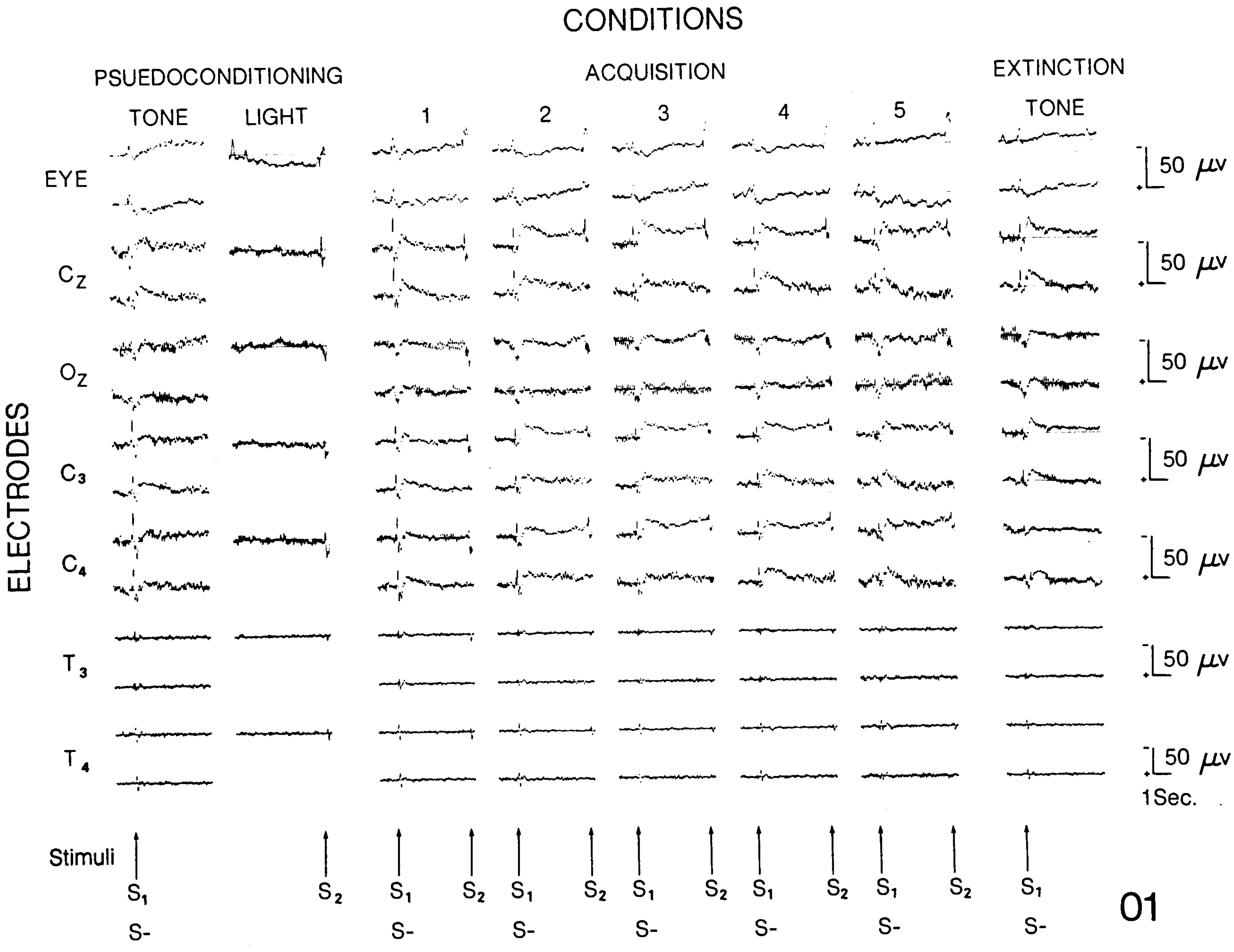

CONDITIONS
PSUEDOCONDITIONING
TONE
LIGHT
ACQUISITION
1
2
3
4
5
EXTINCTION
TONE
ELECTRODES
EYE
C_Z
O_Z
C_3
C_4
T_3
T_4
50 μv
50 μv
50 μv
50 μv
50 μv
50 μv
50 μv
1Sec.
Stimuli
S_1
S_2
S-
01

FIGURE 5

Averaged SPC waveforms for subject number 02.

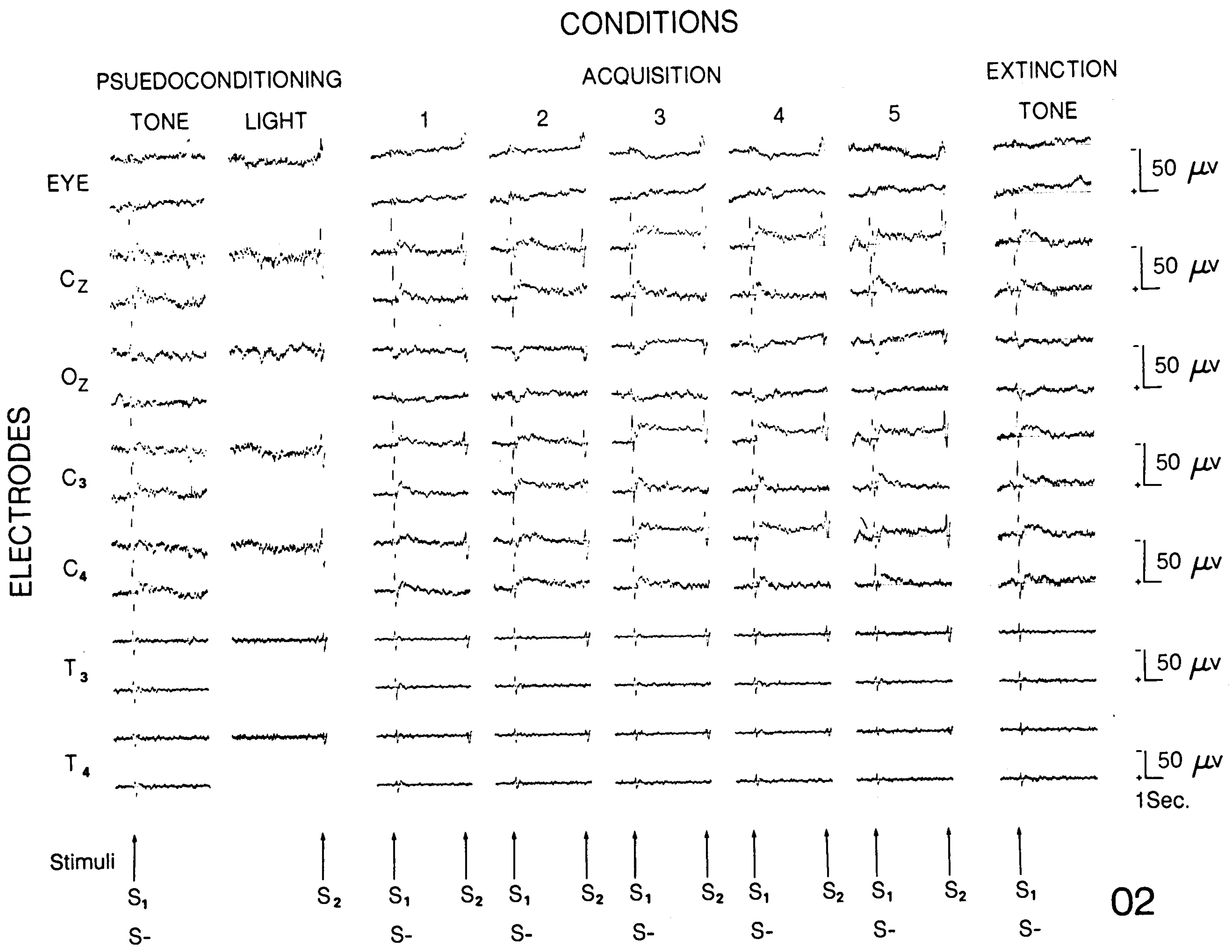

CONDITIONS
PSUEDOCONDITIONING
TONE
LIGHT
ACQUISITION
1
2
3
4
5
EXTINCTION
TONE
ELECTRODES
EYE
C_Z
O_Z
C_3
C_4
T_3
T_4
Stimuli
S_1
S_2
S-
50 μv
1Sec.
02

FIGURE 6

Averaged SPC waveforms for subject number 03.

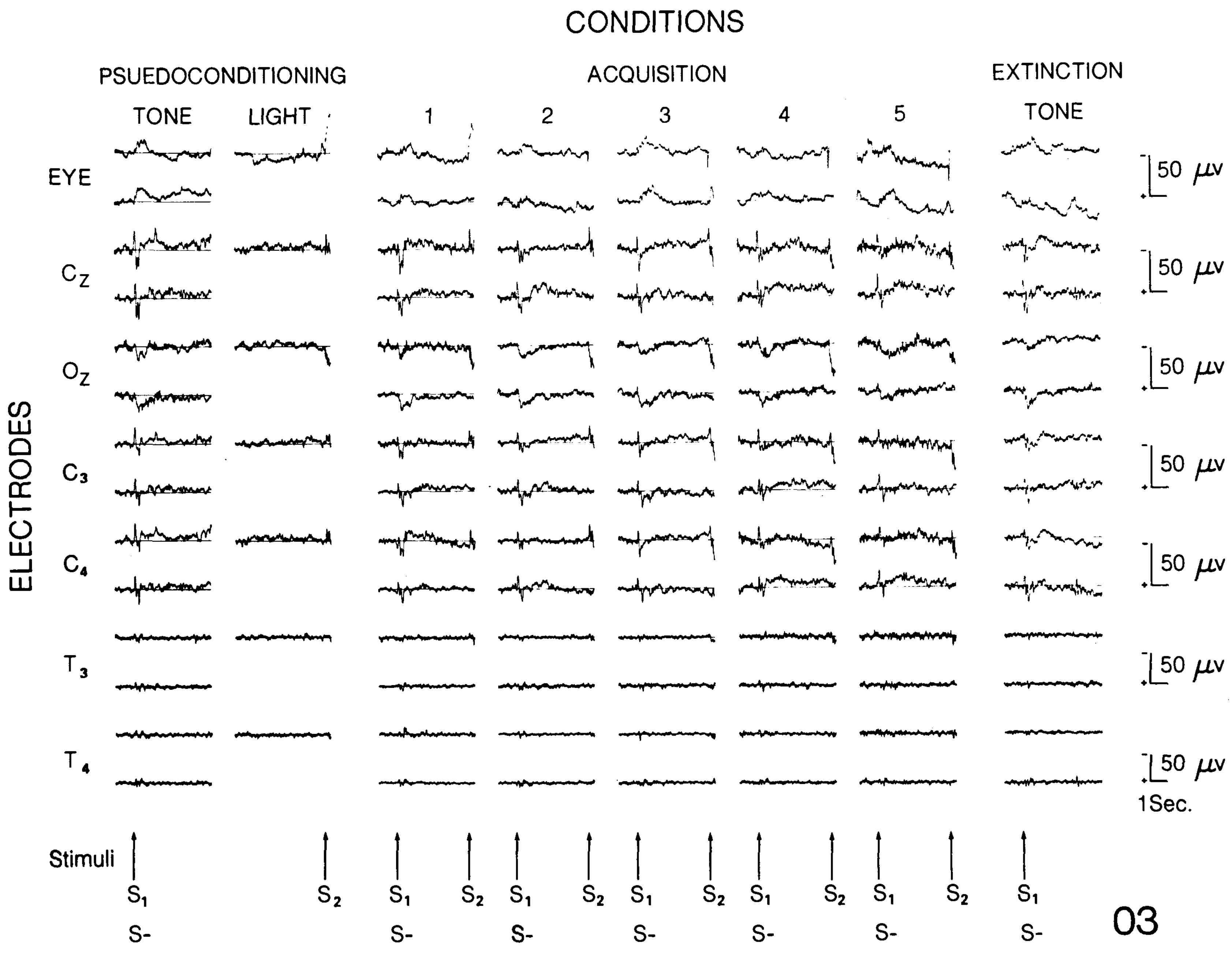

CONDITIONS
PSUEDOCONDITIONING
ACQUISITION
EXTINCTION
TONE
LIGHT
1
2
3
4
5
TONE
ELECTRODES
EYE
C_Z
O_Z
C_3
C_4
T_3
T_4
50 µV
50 µV
50 µV
50 µV
50 µV
50 µV
50 µV
1Sec.
Stimuli
S_1
S_2
S_1
S_2
S_1
S_2
S_1
S_2
S_1
S_2
S_1
S_2
S_1
S-
S-
S-
S-
S-
S-
S-
03

FIGURE 7

Averaged SPC waveforms for subject number 04.

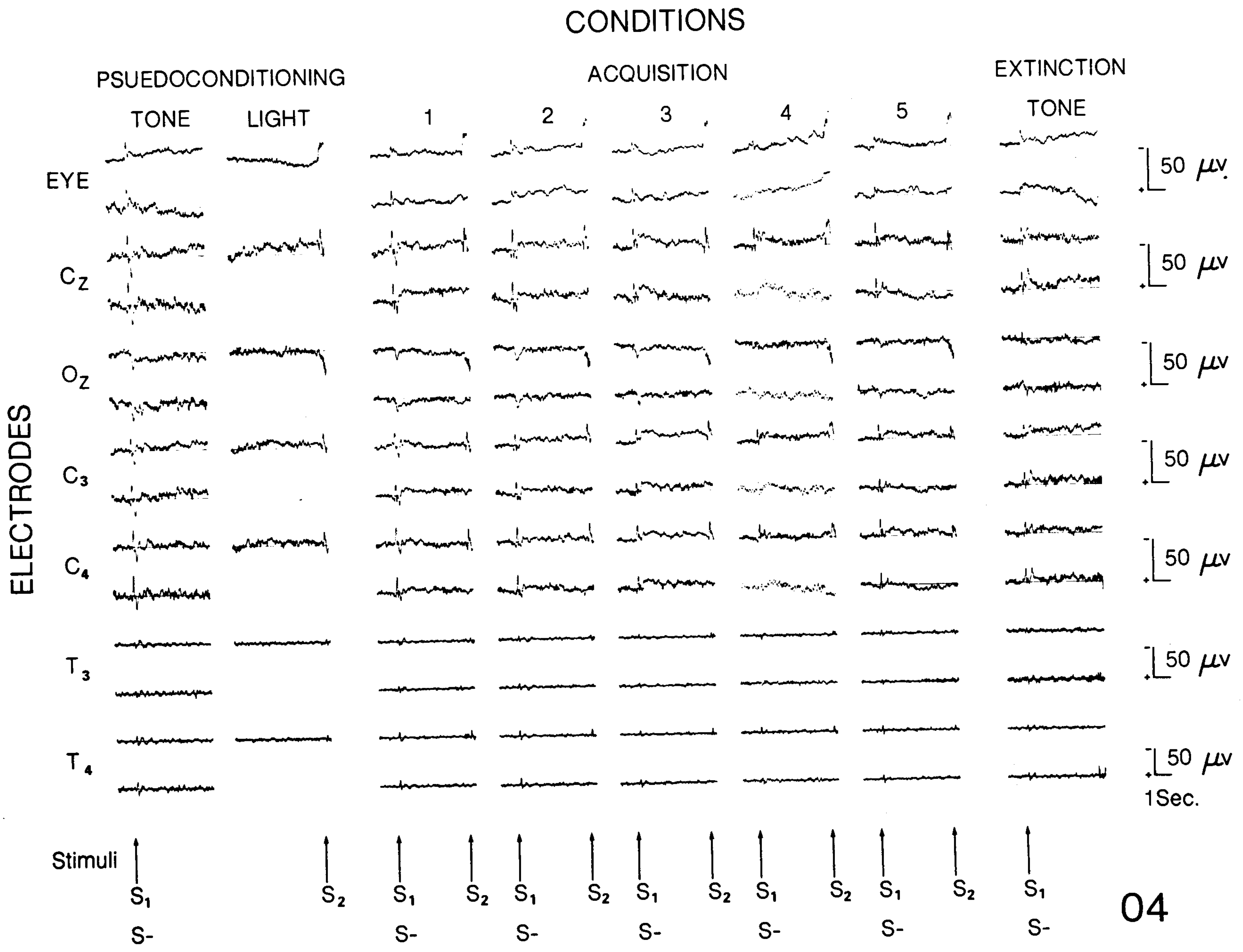

CONDITIONS
PSUEDOCONDITIONING
TONE
LIGHT
ACQUISITION
1
2
3
4
5
EXTINCTION
TONE
ELECTRODES
EYE
C_Z
O_Z
C_3
C_4
T_3
T_4
50 µv
50 µv
50 µv
50 µv
50 µv
50 µv
50 µv
1Sec.
Stimuli
S_1
S_2
S-
04

FIGURE 8

Averaged SPC waveforms for subject number 05.

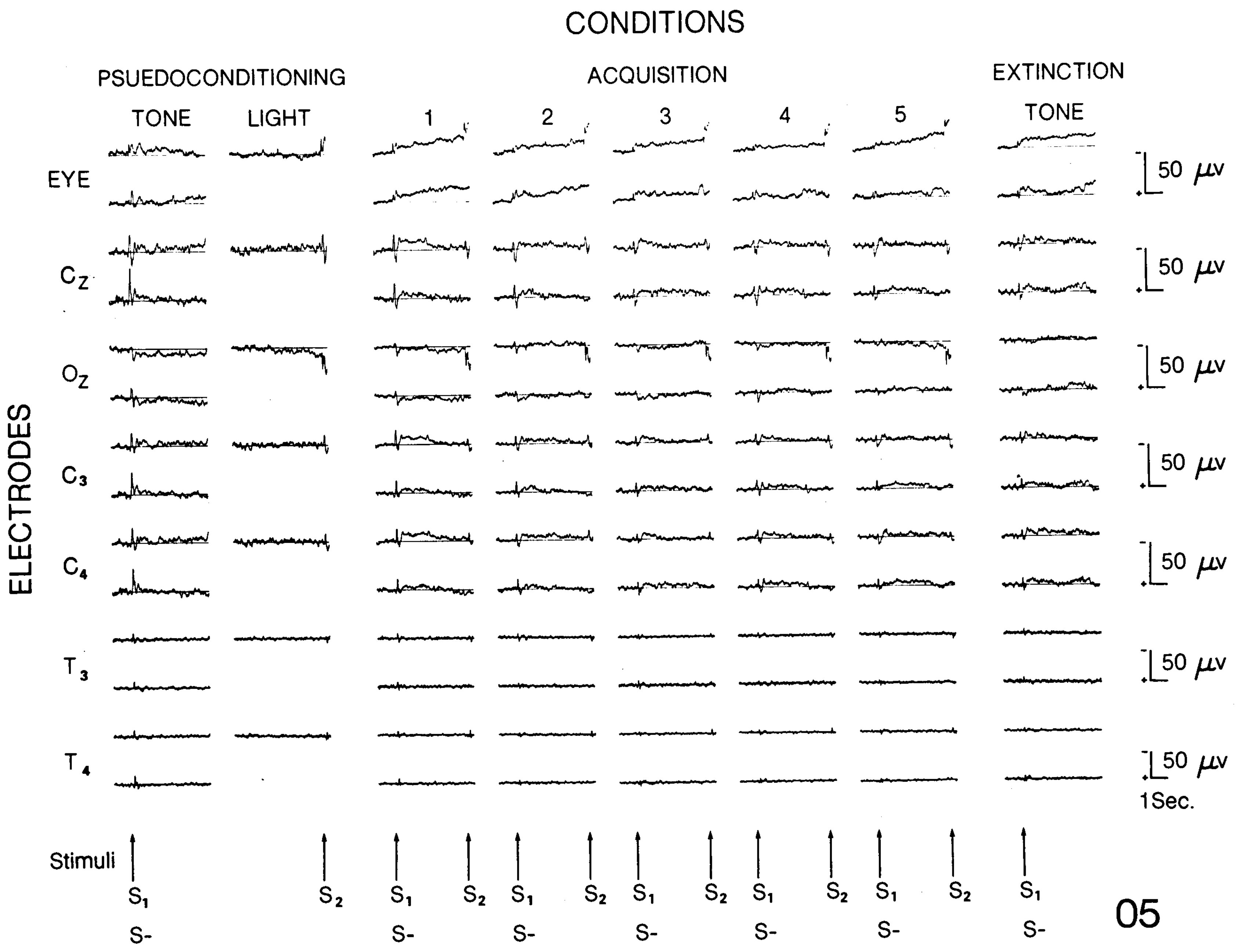
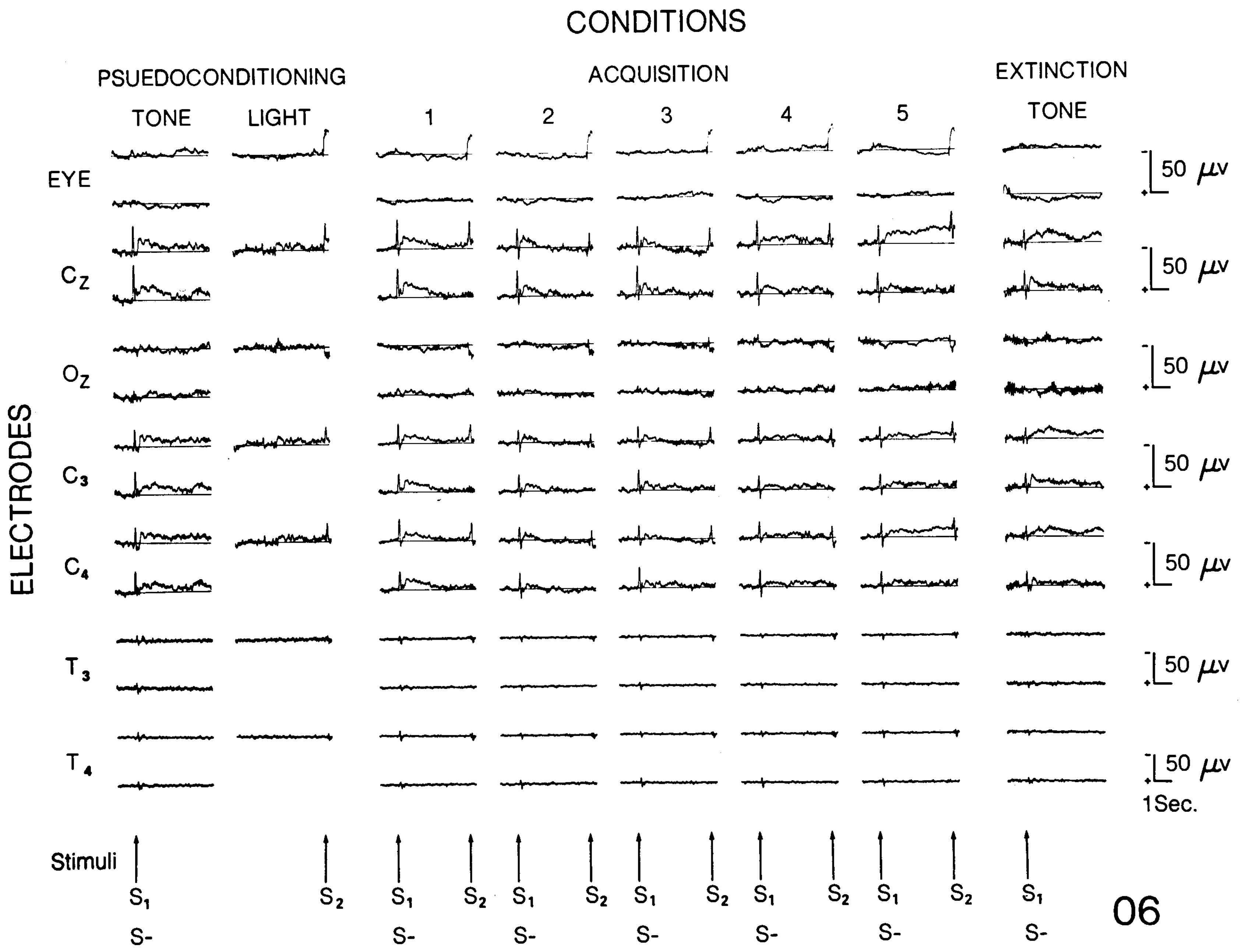

CONDITIONS
PSUEDOCONDITIONING
TONE
LIGHT
ACQUISITION
1
2
3
4
5
EXTINCTION
TONE
ELECTRODES
EYE
C_Z
O_Z
C_3
C_4
T_3
T_4
50 μv
1Sec.
Stimuli
S_1
S_2
S-
05

FIGURE 9

Averaged SPC waveforms for subject number 06.


CONDITIONS
PSUEDOCONDITIONING
TONE
LIGHT
ACQUISITION
1
2
3
4
5
EXTINCTION
TONE
ELECTRODES
EYE
C_Z
O_Z
C_3
C_4
T_3
T_4
50 µv
50 µv
50 µv
50 µv
50 µv
50 µv
50 µv
1Sec.
Stimuli
S_1
S_2
S_1
S_2
S_1
S_2
S_1
S_2
S_1
S_2
S_1
S_2
S_1
S-
S-
S-
S-
S-
S-
S-
06

acquisition. The flat appearance of T3 and T4 in all conditions attests to the filtering characteristics of the short time constant (0.15 sec) employed for these channels.

Mean SPC amplitudes for the 10 segments at each electrode obtained with the SWDA analysis of each subject's single trial data are tabled in Appendix A. The grand mean of these amplitudes obtained across subjects are plotted in Figures 10-14. Initially, data for the S1-S2 and S- trials were analyzed separately as drawn in Figures 10-14 to determine if there were any changes in SPC morphology over acquisition. Table II shows the number of times each segment was entered into the SWDA for the S1-S2 comparisons. The consistent entry of segments 1-3 and 7-10 into the SWDA at the central electrodes supports the visually apparent changes in SPC morphology seen in the averaged SPC waveforms. Examination of Figures 10-14 reveals these changes to be of an initial increase and subsequent decline in negativity of segments 1-3 while a general increase in negativity occurred in segments 7-10 for Cz, C3 and C4. Occipital (Oz) recordings on the other hand show a marked positive deflection in segments 1-3 with an abrupt rise in negativity in segments 9-10. This early positivity in Oz shows an irregular growth in amplitude up to block 4 of acquisition with a decline in block 5. Mean amplitudes for the later segments (9-10) attain a negative

FIGURE 10

Grand mean SPC amplitude obtained over all subjects for each condition at the eye electrode.

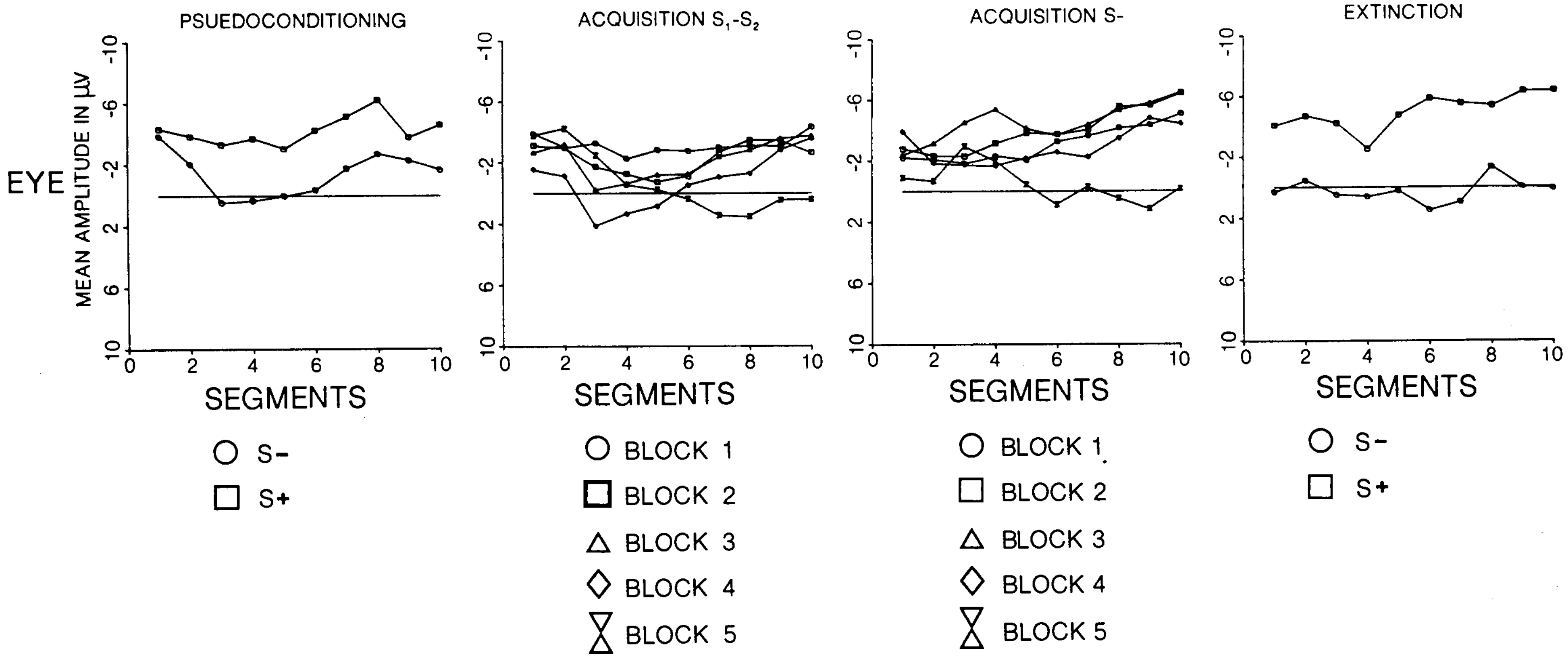

EYE
MEAN AMPLITUDE IN µV
PSUEDOCONDITIONING
ACQUISITION S$_1$-S$_2$
ACQUISITION S-
EXTINCTION
-10
-6
-2
2
6
10
0
2
4
6
8
10
SEGMENTS
○ S-
□ S+
○ BLOCK 1
□ BLOCK 2
△ BLOCK 3
◇ BLOCK 4
⧗ BLOCK 5

FIGURE 11

Grand mean SPC amplitude obtained over all subjects for each condition at Cz.

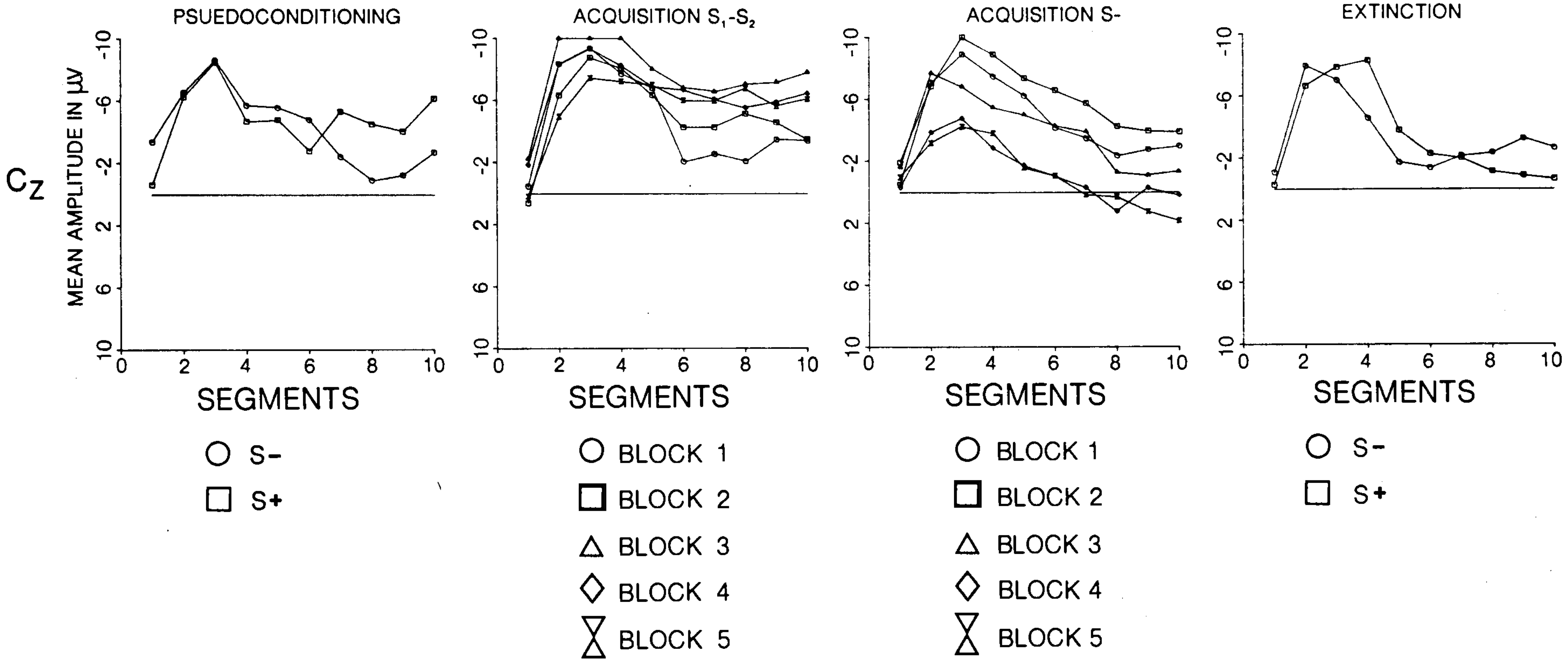

Cz
MEAN AMPLITUDE IN µV
PSUEDOCONDITIONING
ACQUISITION S1-S2
ACQUISITION S-
EXTINCTION
-10
-6
-2
2
6
10
0
2
4
6
8
10
SEGMENTS
○ S-
□ S+
○ BLOCK 1
□ BLOCK 2
△ BLOCK 3
◇ BLOCK 4
⧗ BLOCK 5

FIGURE 12

Grand mean SPC amplitude obtained over all subjects for each condition at Oz.

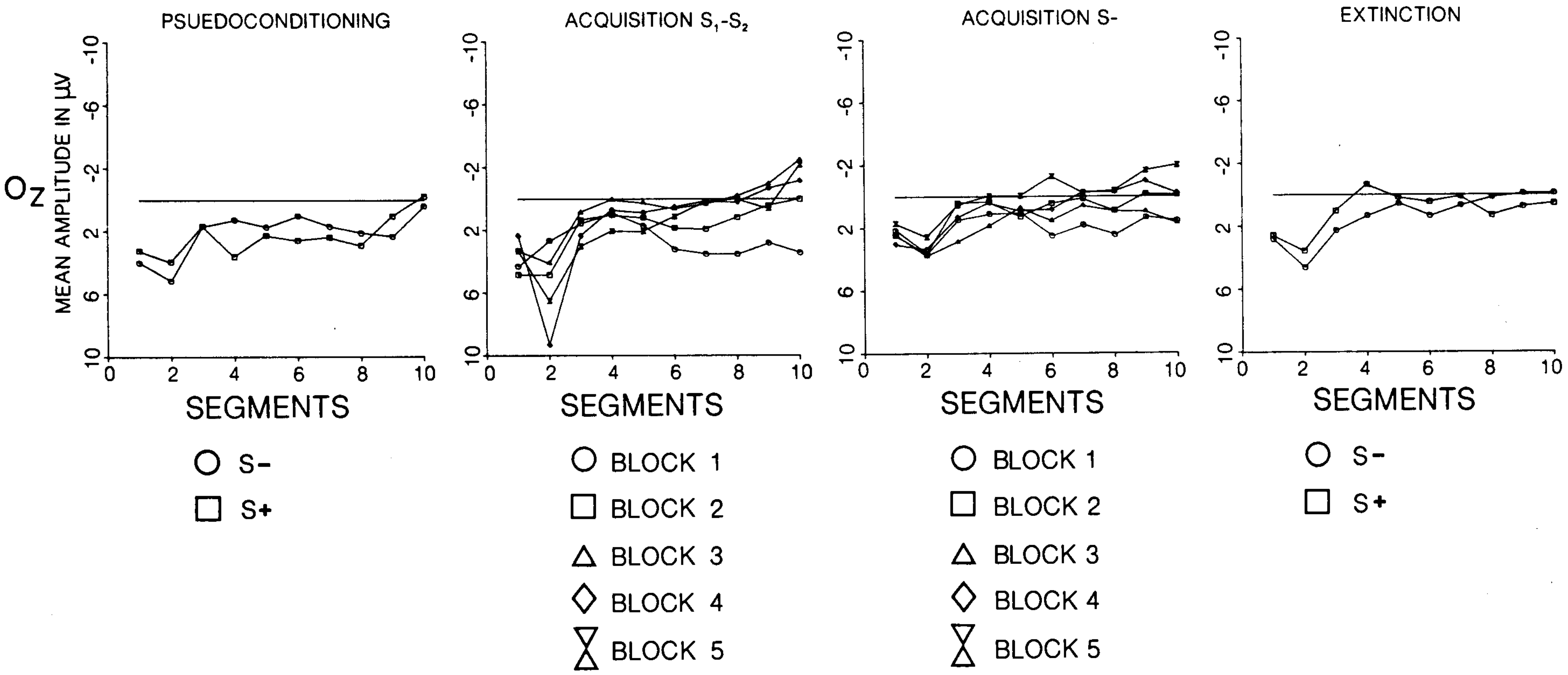

Oz
MEAN AMPLITUDE IN µV
PSUEDOCONDITIONING
ACQUISITION S1-S2
ACQUISITION S-
EXTINCTION
-10
-6
-2
2
6
10
0
2
4
6
8
10
SEGMENTS
S-
S+
BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4
BLOCK 5

FIGURE 13

Grand mean SPC amplitude obtained over all subjects for each condition at C3.

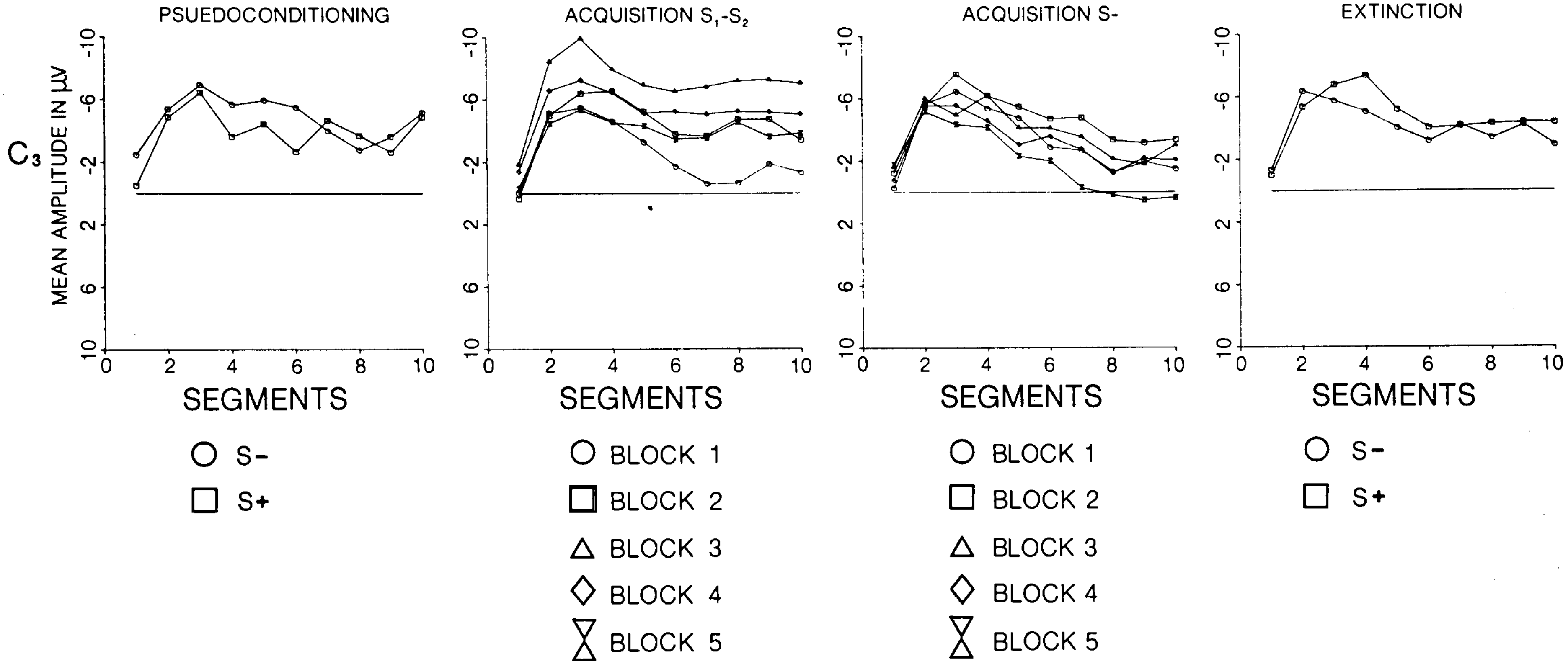
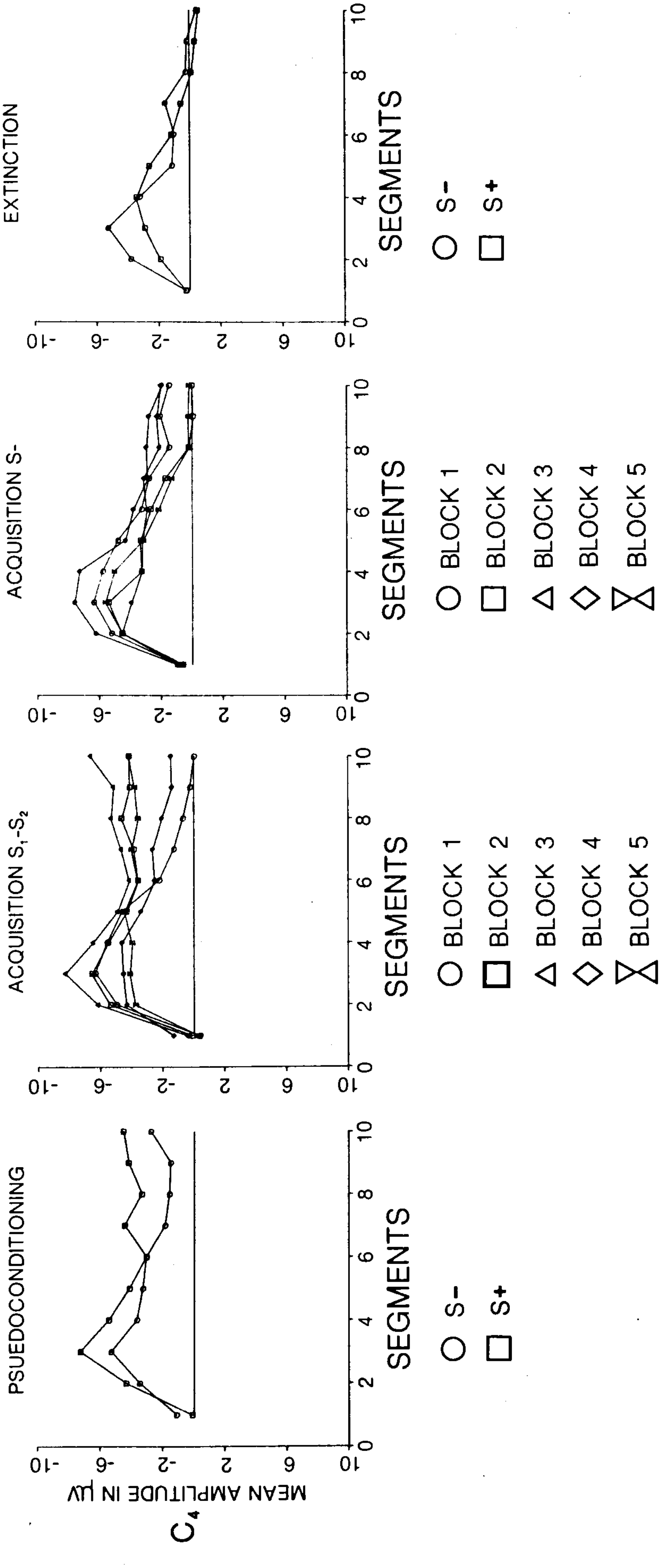

C$_3$
MEAN AMPLITUDE IN µV
PSUEDOCONDITIONING
ACQUISITION S$_1$-S$_2$
ACQUISITION S-
EXTINCTION
-10
-6
-2
2
6
10
0
2
4
6
8
10
SEGMENTS
○ S-
□ S+
○ BLOCK 1
□ BLOCK 2
△ BLOCK 3
◇ BLOCK 4
⧗ BLOCK 5

FIGURE 14

Grand mean SPC amplitude obtained over all subjects for each condition at C4.


C4
MEAN AMPLITUDE IN µV
PSUEDOCONDITIONING
ACQUISITION S1-S2
ACQUISITION S-
EXTINCTION
-10
-6
-2
2
6
10
0
2
4
6
8
10
SEGMENTS
○ S-
□ S+
○ BLOCK 1
□ BLOCK 2
△ BLOCK 3
◇ BLOCK 4
⧖ BLOCK 5

polarity by the second block of acquisition which continues to increase in magnitude. Similar analysis for the S- trials are also summarized in Table II. Examination of this table and Figures 10-14 show the changes in SPC amplitude to be similar in all components at Cz, C3 and C4, taking the form of a generally decreasing negativity. The initial positivity is again seen at Oz although smaller in amplitude and exhibiting less change over time than in the S1-S2 trials. The remainder of the waveform at Oz fluctuates near the arbitrary baseline with a small late (segment 9-10) rise in negativity occurring only on the last acquisition block.

Subsequently, pairs of SPCs elicited by S1 and S- were evaluated in pseudoconditioning, 5 blocks of acquisition, and during extinction. Those segments which contributed to the SWDA analyses are summarized in Table III with the results for individual subjects tabled in Appendix B. No consistent significant differences were seen in SPC morphology during pseudoconditioning trials at any electrode. This is further supported by the essentially overlapping curves in Figures 10-14. However, over the course of acquisition the twc waveforms were frequently dissimilar. The temporal location and degree of these differences varied for each electrode site as acquisition progressed. Initial differences between the

TABLE II

Total number of times each SPC segment was entered into the SWDA analysis of S1-S2 comparisons and S- comparisons over acquisition.

SEGMENTS

	1	2	3	4	5	6	7	8	9	10
					EYE					
S1-S2	3	1	1	2	3	1		1	1	3
S-	1	1	1		1	1		2	2	
					Cz					
S1-S2	6	3	2	2	2	3		2	2	3
S-	1	3	3		2		3	3		
					Oz					
S1-S2	3	3	3		3		2	1	2	2
S-		2	1	2		2	2		3	3
					C3					
S1-S2	4	3	1	2	2	4		3	3	3
S-	2	3	1		1	1	1	2	1	
					C4					
S1-S2	5	4	3	2	3	3	1	2	3	4
S-	2	2	4	2	2	1	3	1	1	1

TABLE III

Total number of times each SPC segment was entered into the SWDA analysis comparing S1 and S- trials in each condition.

SEGMENTS

		1	2	3	4	5	6	7	8	9	10
						EYE					
PSD		1				2	1		1	1	
ACQ	01		2		4	2	1	1		2	1
	02		1	2	1		1		1		1
	03		2		1			1		1	1
	04	1	2		2	2	2		1		1
	05	2	4		1		1	1	2	3	1
EXT		4	2	1	2	1	1	2	2	1	2
						Cz					
PSD		5	3	1	1	1	2		2		2
ACQ	01	1	2	2	1	3	1	1	2	3	1
	02	1	4	5	4	2	4		3	4	1
	03	6	2	4	4	1	2		6	2	3
	04	1	1	1	1		1	2	2		2
	05	2	2	3			1		1		3
EXT			2	5	1		2	2	1	2	
						Oz					
PSD		3	1	3			1			3	2
ACQ	01	4		2	1	3	1	3	4	4	4
	02	1	2	2	1		2			1	1
	03	3	1	1	2	3		1	1	1	6
	04	2	2	2	1	1	2	1	5	2	1
	05	2	1	1	2		4	2	4	4	4
EXT		1			2	3	3	5	1	2	3
						C3					
PSD		1	3		1	3	1	2	2	3	4
ACQ	01	1	1	1					1		
	02	2	1	2	2	1	2	1		1	4
	03	3	2	4	4	2	4	4	5	4	3
	04	1	2	1	2		1		2	2	4
	05	4	4	4	2	2		1	1	1	3
EXT				1	1	1	2	1			
						C4					
PSD		4	3	3	3	7	2		4		2
ACQ	01	2	2	1	1		2	1	1	3	2
	02	2			2	3	1	1	1	2	3
	03	3		1		2	1		1	3	
	04	1	1	2	2	1		1		1	1
	05	3	1	2	1	1		1	3	3	3
EXT		3	2	2	2	1			3	2	1

two waveforms recorded at Cz, C3 and C4 are in segments 1-4, which exhibit substantially larger negativity for the S1-S2 trials. The contribution of the latter segments 7-10 to this difference appears to be concentrated at block 3 of acquisition. Furthermore, these components do not play as prominent a role as the early components in the discriminant function. Recordings from the occiput, however, appear to be maximally differentiated by the later segments (8-10) throughout conditioning from block 2 on. The early positivity does discriminate between the two waveforms to some extent but not as strongly as the later components. The significant differences seen in the two waveforms during extinction have essentially the same scattered patterns as seen in pseudoconditioning for each electrode.

In summary, significant changes in SPC amplitude were seen over the course of the experiment for all subjects. That these significant changes were reflected at different points along the SPC waveforms supports the notion of a biphasic morphology similar to that previously described in the CNV literature by Weerts and Lang (1973).

Evoked Potentials

As the quantification of single trial EP waveforms is inherently ambiguous, few trials were available for statistical analysis within any one condition for any subject. This was particularly true of the late positive component (P3) and no statistical analysis of that data was attempted.

Fortunately, the N1 component of the EP with a latency of 80-160 msecs as recorded at Cz was more robust and a sufficient number of these components were available for tabulation. Tables IV and V give the means (M) and standard deviations (s.d.) of the latencies and amplitudes for N1 in each condition for every subject. It is apparent from these Tables that with exception cf Subject 1 there were no systematic changes in latency of N1 within a given condition. Amplitude, on the other hand, does show an almost continuous reduction over conditions but no systematic differences between S1 and S-. However, in view of the small differences in means, and large standard deviations of both latency and amplitude data, no further statistical analyses were done. That some of these means are based on as few as 3 trials further mitigates against any subsequent statistical analysis.

Background EEG Data

Tabled in Appendix C is the mean percent power in each frequency band of the four epochs shown in Figure 2 separated by conditions and subjects. A separate SWDA

TABLE IV

Mean (M) and standard deviation (s.d.) of the N1 latencies for each subject, measured at Cz.

LATENCY

			PSEUDO	ACQUISITION					EXT.
				1	2	3	4	5	
S #01	S1	M	145.5	149.2	149.1	145.1	147.3	141.6	156.3
		s.d.	5.6	5.7	10.0	15.0	13.2	19.2	16.5
	S-	M	144.8	143.6	137.7	132.5	151.6	152.4	152.0
		s.d.	5.2	7.5	6.1	19.7	12.9	17.6	13.5
S #02	S1		134.7	135.6	137.9	139.2	134.0	135.5	137.3
			7.5	6.7	4.5	4.6	6.4	6.9	8.0
	S-		137.6	137.7	137.8	137.2	137.5	136.7	139.6
			3.6	5.0	4.5	6.8	6.3	8.8	4.2
S #03	S1		133.6	128.0	128.4	119.5	112.8	134.7	128.0
			12.2	22.6	20.3	5.0	16.3	18.5	21.7
	S-		125.3	132.4	127.3	132.0	131.0	112.7	117.0
			17.3	21.4	18.0	26.4	20.3	10.6	11.9
S #04	S1		136.0	135.6	148.5	145.0	141.3	136.0	130.4
			4.0	8.9	9.7	14.4	15.3	7.2	11.9
	S-		138.4	138.5	144.0	140.7	134.4	145.1	128.6
			3.6	12.6	10.3	6.9	14.3	12.4	14.9
S #05	S1		157.4	142.2	126.4	130.9	128.3	117.3	145.6
			9.2	9.4	20.1	23.1	19.0	19.0	11.9
	S-		148.6	148.6	145.6	138.9	127.5	140.0	132.0
			10.7	7.2	15.9	19.1	30.0	18.4	11.1
S #06	S1		146.0	147.1	146.9	142.6	145.0	145.3	145.7
			4.2	4.1	8.5	8.4	9.0	13.8	8.3
	S-		154.6	153.7	144.0	148.1	147.3	143.4	137.7
			9.3	13.2	5.8	7.5	9.3	8.9	25.5

TABLE V

Mean (M) and standard deviation (s.d.) of the N1 amplitudes for each subject, measured at Cz.

AMPLITUDE

			PSEUDO	ACQUISITION					EXT.
				1	2	3	4	5	
S #01	S1	M	-41.6	-29.4	-18.2	-14.9	-17.7	-10.5	-16.4
		s.d.	10.7	13.0	5.2	8.7	10.3	7.2	10.6
	S-	M	-45.6	-27.7	-22.9	-13.6	-23.5	-11.6	-15.3
		s.d.	8.7	13.1	5.6	6.4	9.5	6.2	8.8
S #02	S1		-42.1	-32.2	-39.9	-37.2	-30.1	-31.6	-35.3
			5.7	8.8	8.7	10.7	7.9	9.8	7.8
	S-		-51.9	-33.6	-36.3	-33.3	-27.3	-26.0	-31.8
			13.6	12.9	10.8	15.1	7.4	10.3	11.1
S #03	S1		-20.8	- 5.1	-12.6	-11.5	-18.7	-12.8	-12.3
			8.6	2.8	6.9	5.4	10.9	13.9	3.3
	S-		-20.7	- 8.1	-13.6	-13.7	-16.3	-18.8	-11.4
			14.1	6.9	7.8	8.0	9.4	2.6	9.0
S #04	S1		-16.9	-19.5	-22.2	-21.8	-17.2	-20.2	-16.8
			12.2	8.8	7.2	7.6	6.0	7.3	17.7
	S-		-21.1	-19.6	-20.1	-17.0	-18.5	-16.1	-16.2
			14.0	8.0	8.7	10.3	11.6	6.6	9.9
S #05	S1		-26.9	-18.8	-14.5	-10.5	- 9.5	- 6.8	-19.8
			12.5	6.4	7.4	8.1	7.9	4.6	9.0
	S-		-19.5	-17.7	-13.9	-10.5	-13.1	- 9.7	-10.6
			10.3	4.7	5.9	5.3	3.8	4.1	4.2
S #06	S1		-33.3	-26.7	-18.7	-20.4	-23.4	-17.7	-16.6
			10.3	9.5	10.9	7.1	11.2	7.2	8.4
	S-		-26.8	-31.0	-25.1	-29.8	-22.9	-20.7	-16.3
			10.2	10.1	8.2	5.7	9.5	5.6	10.1

analysis was conducted for the data from the BASE interval and the post-tone epochs at each electrode for each subject. An across subjects summary of this analysis is seen in Table VI and Figures 15-18. Examination of Table VI shows significant changes in percent power occurring at all electrodes as the experiment progressed with the prominent changes occurring in the 8-12 and 13-30 Hz bands. Reference to Figures 15-18 shows these changes to be a general increment in activity in both the 8-12 and 13-30 Hz bands while activity in the other two bands, 1-4, 5-7 Hz, remains relatively stable.

A similar analysis conducted for the frequency bands in the post-S1 epochs (see Appendix D) revealed markedly different results as seen in Table VII which summarizes these comparisons across acquisition for all subjects. Percent power changes were seen in all four frequency bands in the central (Cz, C3, C4) and occipital (Oz) electrodes. Background EEG activity did not, however, change as dramatically in the temporal (T3, T4) electrodes.

Analysis of the percent power data in the five blocks of acquisition compared the S1-S2 and S- trials as seen in Appendix D. These comparisons are summarized across subjects in Table VIII. Consistently, it is data from the later portion of the trial (variables 13-16) which discriminate maximally between the conditions at all

TABLE VI

Total number of times each frequency band of the base epoch was entered into the SWDA analysis of each condition.

	1-4 Hz	5-7 Hz	8-12 Hz	13-30 Hz
Cz				
PSD			1	1
ACQ S1-S2		1	1	
ACQ S-				1
EXT	1			1
Oz				
PSD	1	2		3
ACQ S1-S2	1	1	1	3
ACQ S-		1		2
EXT	1		1	3
C3				
PSD			1	
ACQ S1-S2			1	2
ACQ S-		1		1
EXT	2		2	1
C4				
PSD				1
ACQ S1-S2		1	2	1
ACQ S-	1			1
EXT				
T3				
PSD	1		1	1
ACQ S1-S2	1	1		1
ACQ S-	1			1
EXT		2	1	
T4				
PSD				
ACQ S1-S2		1	1	2
ACQ S-		1	1	1
EXT			1	1

FIGURE 15

Grand mean percent power changes in the baseline epoch at each electrode in the 1-4 Hz frequency band.

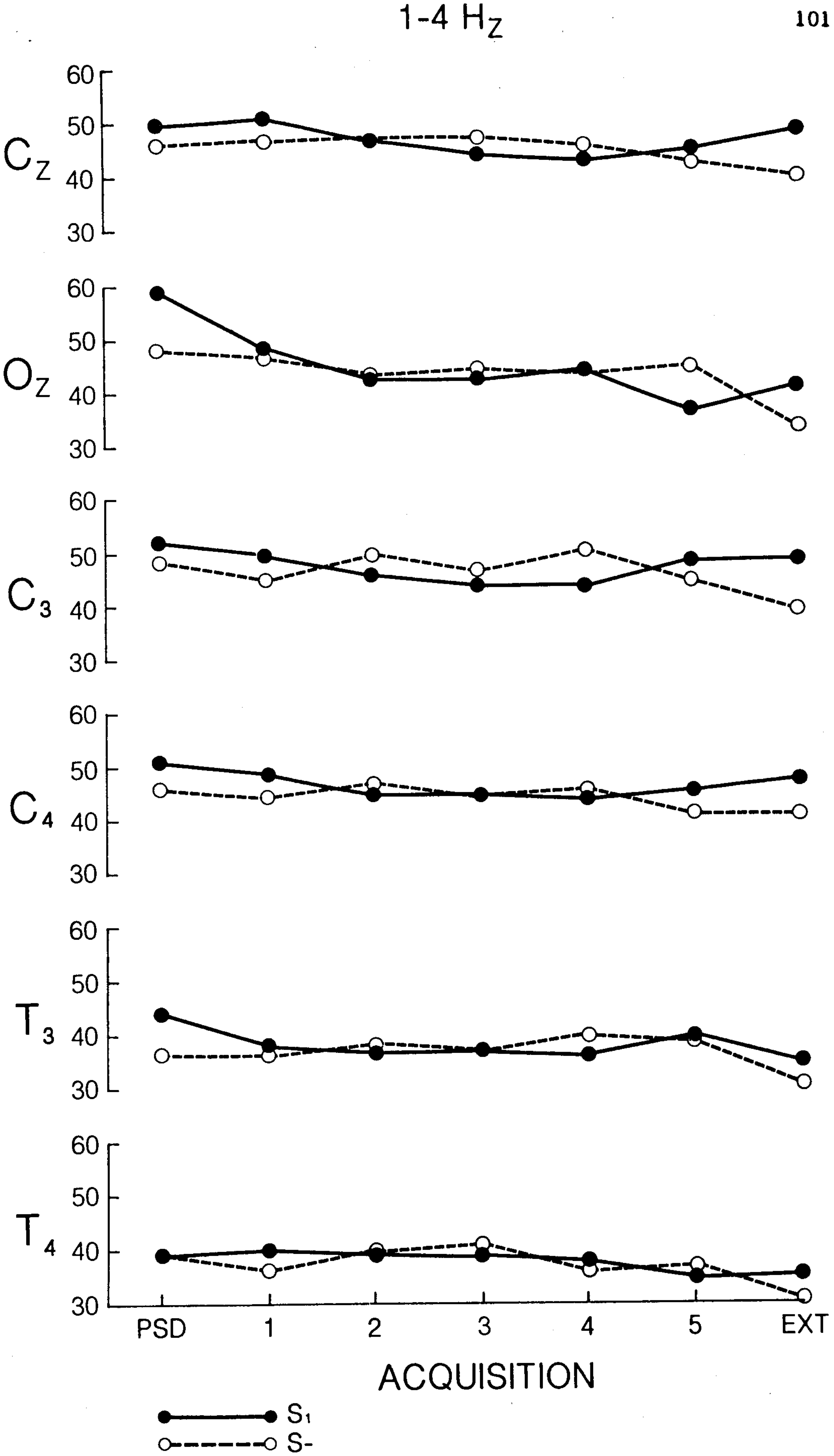

1-4 Hz
Cz
Oz
C3
C4
T3
T4
60
50
40
30
PSD
1
2
3
4
5
EXT
ACQUISITION
S1
S-

FIGURE 16

Grand mean percent power changes in the baseline epoch at each electrode in the 5-7 Hz frequency band.

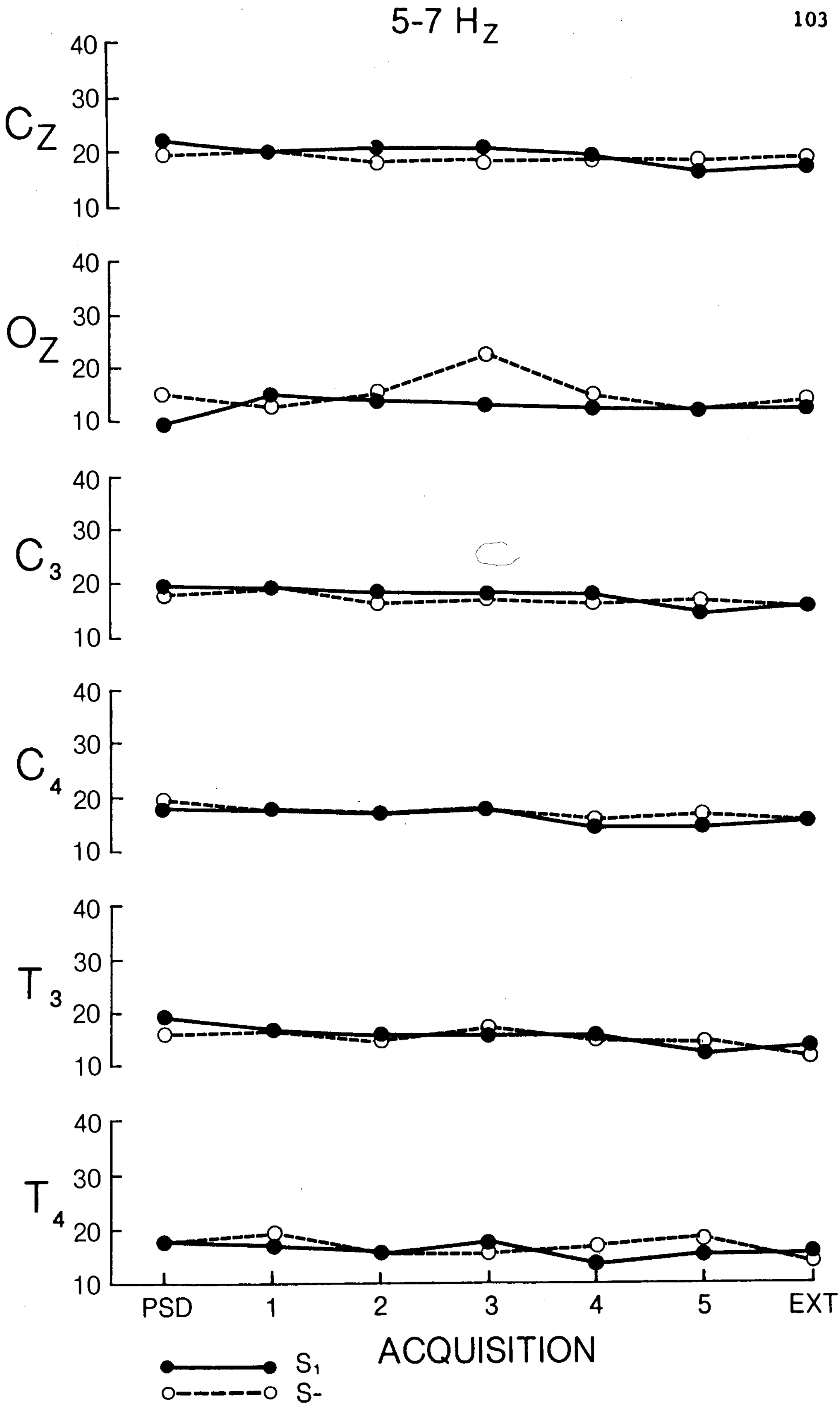

5-7 Hz
C_Z
O_Z
C_3
C_4
T_3
T_4
40
30
20
10
PSD
1
2
3
4
5
EXT
ACQUISITION
S_1
S-

FIGURE 17

Grand mean percent power changes in the baseline epoch at each electrode in the 8-12 Hz frequency band.

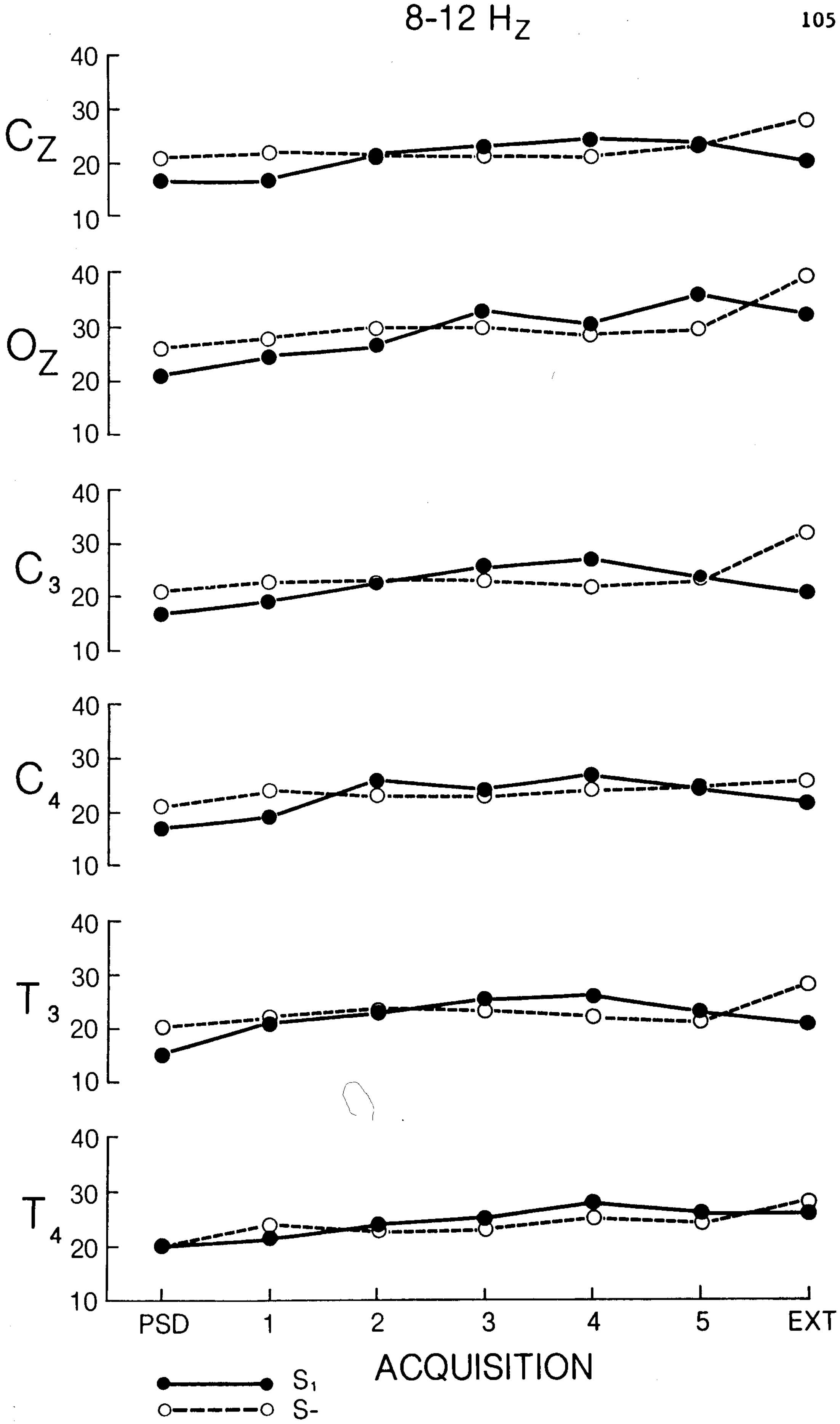

8-12 H_Z
C_Z
O_Z
C_3
C_4
T_3
T_4
10
20
30
40
PSD
1
2
3
4
5
EXT
ACQUISITION
S_1
S-

FIGURE 18

Grand mean percent power changes in the baseline epoch at each electrode in the 13-30 Hz frequency band.

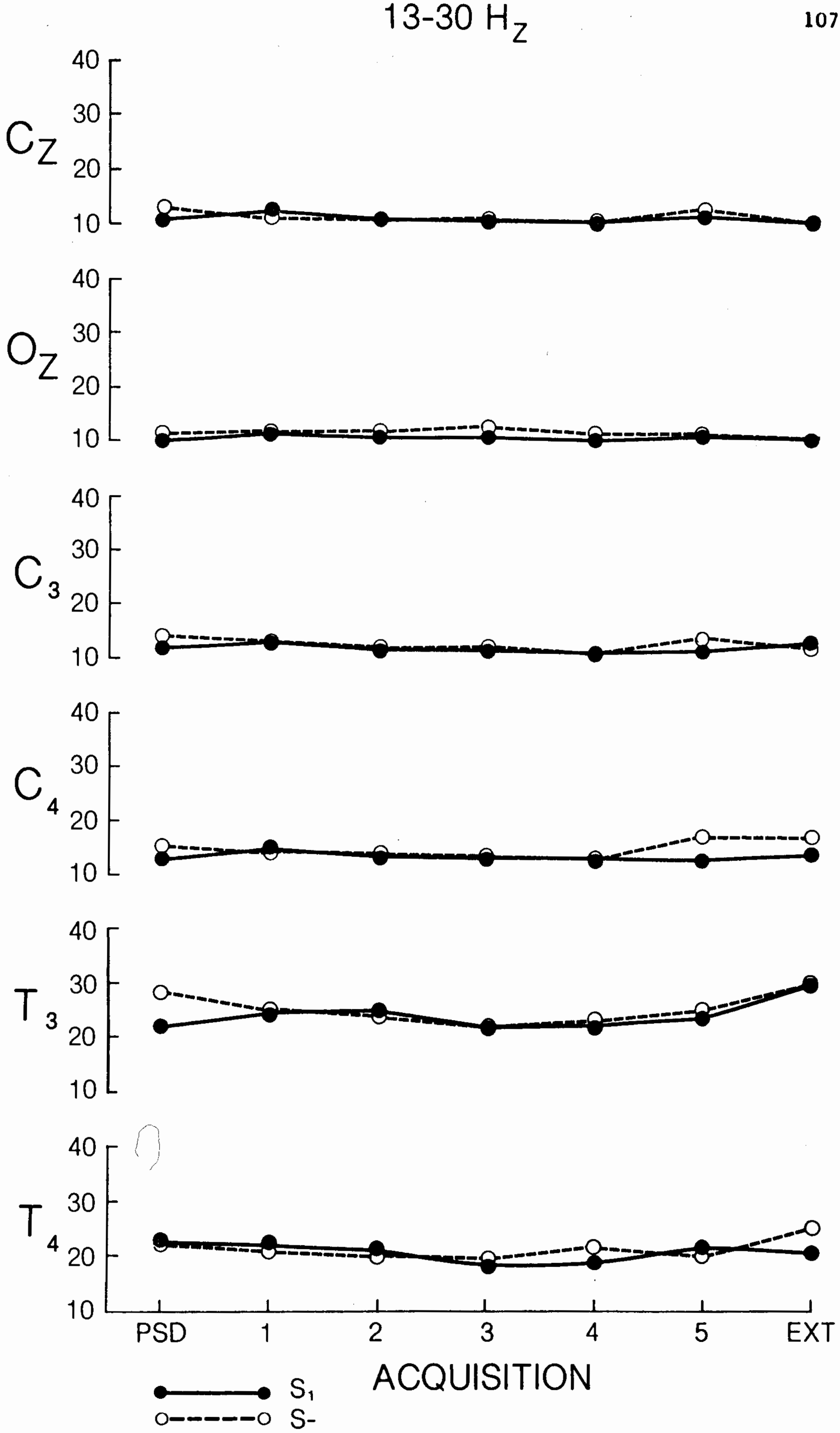

13-30 Hz
Cz
Oz
C3
C4
T3
T4
40
30
20
10
PSD
1
2
3
4
5
EXT
ACQUISITION
S1
S-

TABLE VII

Total number of times each frequency band of the post-tone epochs were entered into the SWDA analysis of S1-S2 comparisons and S- comparisons over acquisition. The numerical column headings within each frequency band correspond to the variable numbers indicated in Figure 2.

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
Cz												
S1-S2	1	1	1		1	1		2	1	2	2	2
S-	2	1		2	1	1	2	2	1	1	3	3
Oz												
S1-S2	2	2	2	2	3			2	1	2	3	2
S-	2	1	1	2		3	2	1	1	2	2	4
C3												
S1-S2		2		1		1		1	3	1	2	3
S-	1	1	1	1	2	2	1		2	3	4	2
C4												
S1-S2	2	1	1		2	1	1	1	2	1	4	3
S-		1	2		2	1	2			1	1	1
T3												
S1-S2	1	2		1				2	1	2	2	2
S-	3	2	3	1	2	3	2		2	1	1	1
T4												
S1-S2	1	2	2	2	2	3	2		1	1	3	1
S-	2	1	1	2	2	1	2	2	2	3		1

electrodes. Comparison of these variable numbers to the percent power tables for individual subjects and the grand means shown in Figures 19-22, shows the changes to be maximal in the 1-4 and 8-12 Hz frequency bands. Changes are also present but to a lesser extent in the 5-7 and 13-30 Hz bands. The degree of these changes also fluctuates with the electrode sites and position within the acquisition series. At the occiput, 1-4 Hz activity is maximal following S1 whereas the 8-12 Hz activity is maximal following the S-. The central electrodes (Cz, C3, C4), on the other hand, show more 1-4 Hz activity following S- in later acquisition (blocks 3-4) which reverses at block 5. The 8-12 Hz activity at these electrodes shows only minor changes until block 5, where S- trials exhibit more 8-12 Hz activity than do S1-S2 trials. In fact, on S1-S2 trials, 8-12 Hz activity decreases over the first epoch, whereas on S- trials it shows a progressive increase. Recordings from the temporal electrodes, on the other hand, do not appear to show any consistent changes in any frequency bands. During extinction, 1-4 Hz activity is largest following S1 in all electrodes, while activity in the 8-12 Hz bands shows inconsistent changes, being larger at S1 in Cz, Oz and at S- in C3, C4. Again, T3 and T4 do not appear to show any consistent changes.

TABLE VIII

Total number of times each frequency band of each post-tone epoch was entered into the SWDA comparison of S1 and S- trials in each condition. The numerical column headings within each frequency band correspond to the variable numbers indicated in Figure 2.

Cz

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
PSD	1	2	2	2	1	2		2	2	1	1	2
ACQ 01	2	1	1		2	1		1	2	2	1	3
02	1			1	2		1		1	1		1
03				1				1	2	2	1	1
04	1				3		1			1		
05	1	3		1	2	1		2	5	2	1	2
EXT	3	1	1	2	2	2	1	2	3	1	2	2

Oz

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
PSD			1	2	3	2		1		1	2	2
ACQ 01	2	1	1	2	3	2		1	2	3	3	4
02	1				1	2		1	2	1		1
03				1				1	1	1		2
04		1			1	2	1	1		2	1	
05	1	3	1	2		1	1	1	3	2	2	1
EXT	1		1	1		1		1	3	3	1	2

C3

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
PSD		1			2				2	1		2
ACQ 01	2	1			1	1		2	2		1	2
02				1		2	1	2	1		2	2
03		1	2		1	1	1	1	2	2	2	
04	2	1	1	1		2	1	1	1	2	2	3
05	2	2	1	1	1	3	1	2	4		1	3
EXT	2		2	1	2	3	1	1	2	1	1	1

C4

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
PSD	1	1	2	1	1	2	2			2	1	1
ACQ 01	1	1	1	1	2	1	1		2	1	1	3
02		2	1	1	1	2	1	1		2	1	2
03	1	1					1	1	1		1	1
04	2				2	2	3	2	1			1
05	2		2	2	1	2	2	3	1	2	3	3
EXT	1	1		1			2	2	3	1	3	

T3

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
PSD	2	2	2		1	1	1		1	2		2
ACQ 01	1			1	1	1	1					
02		1	1		2	3		1	2		1	2
03	2	1	2		2	1	1	2	2		2	1
04	1				2	2			1	1	2	
05	1		2		4	4	3	1	2	3	1	2
EXT	2	2	2	2			3	2	2	1	1	1

T4

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
PSD	1		2	2		2	1		1		2	2
ACQ 01	3	1		1	1		1	2	1	3		1
02		2					1	1		1	1	1
03	1	1	1	1		2		1	1		3	
04	1	1		1	2		1		1		1	1
05	2	1	2	2	2	1	1		1	1	2	2
EXT	1	1	1		2	1	2		3	1	3	3

FIGURE 19

Grand mean percent power changes in the post-tone epochs at each electrode in the 1-4 Hz frequency band.

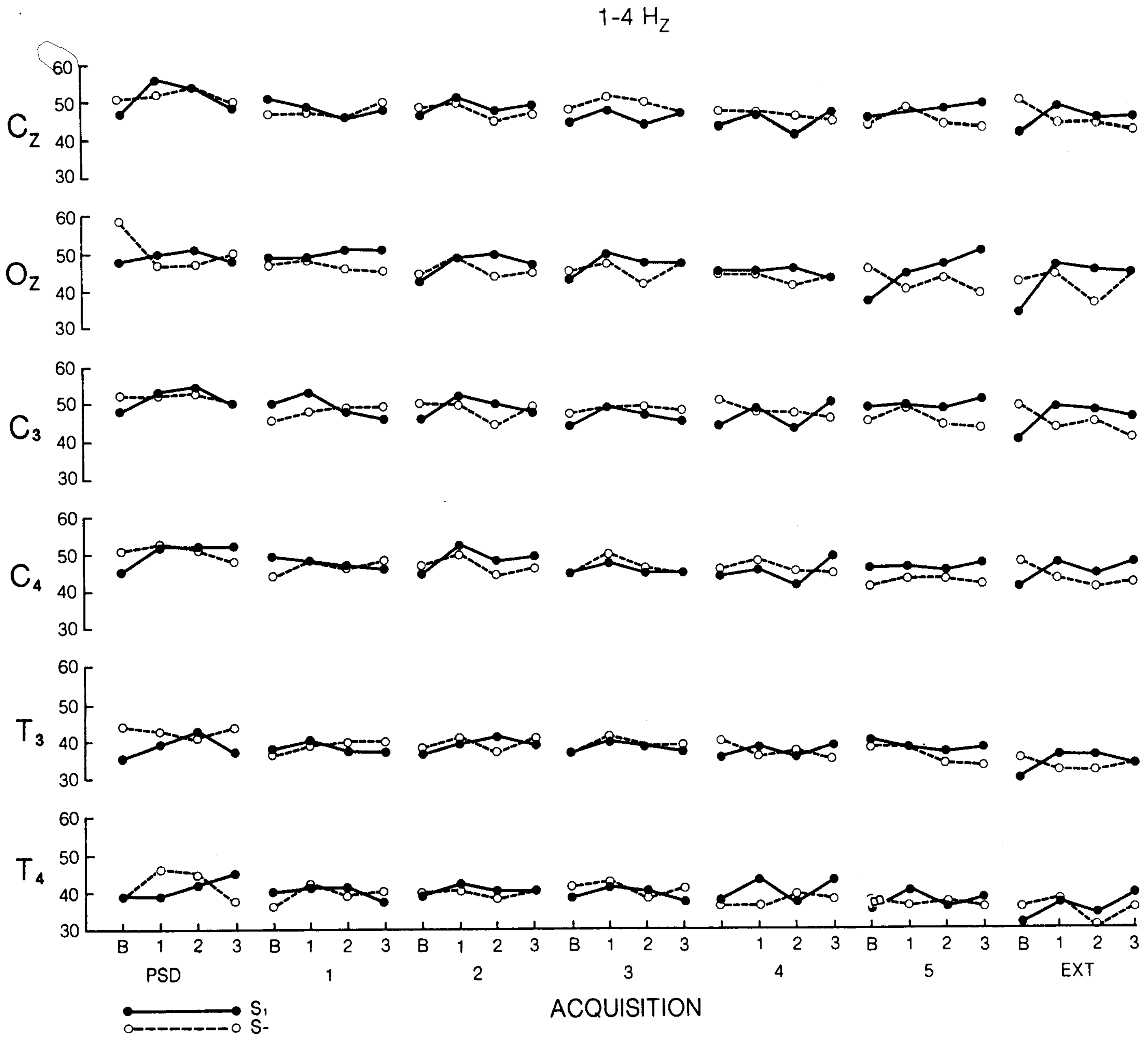

1-4 Hz
Cz
Oz
C3
C4
T3
T4
60
50
40
30
B 1 2 3
PSD
1
2
3
4
5
EXT
ACQUISITION
S1
S-

FIGURE 20

Grand mean percent power changes in the post-tone epochs at each electrode in the 5-7 Hz frequency band.

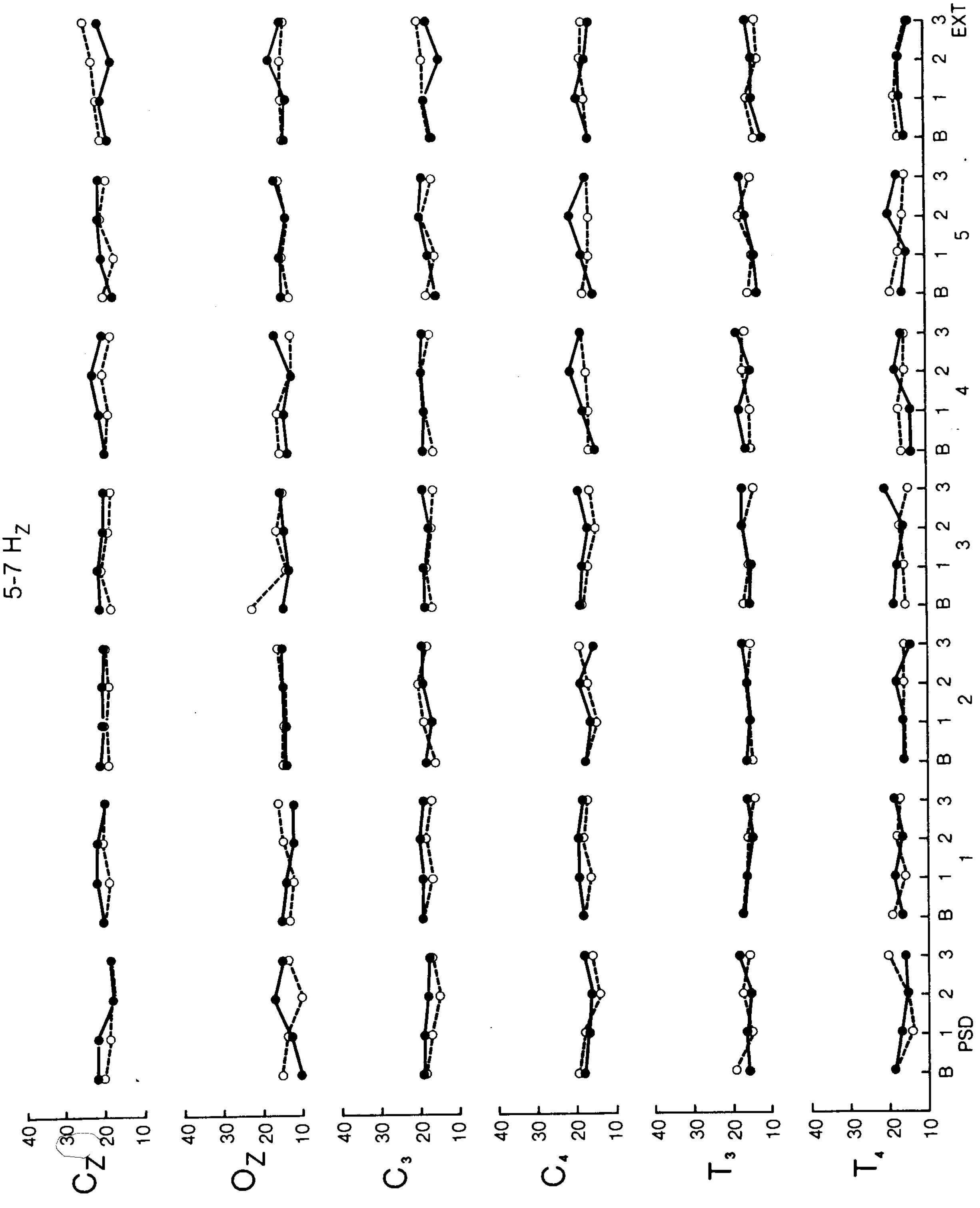

5-7 Hz
CZ
OZ
C3
C4
T3
T4
40
30
20
10
B 1 2 3
PSD
1
2
3
4
5
EXT
ACQUISITION
S+
S-

FIGURE 21

Grand mean percent power changes in the post-tone epochs at each electrode in the 8-12 Hz frequency band.

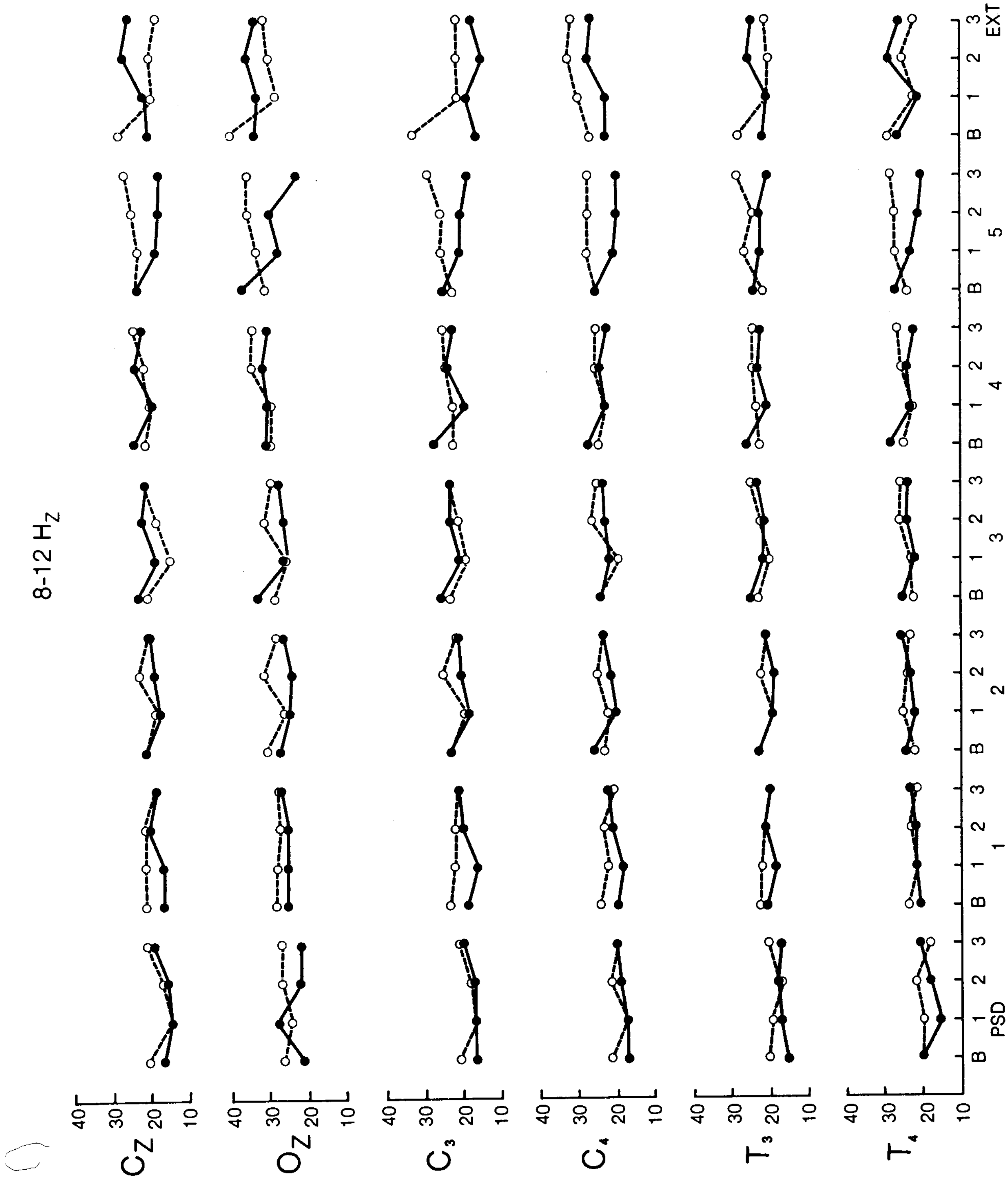
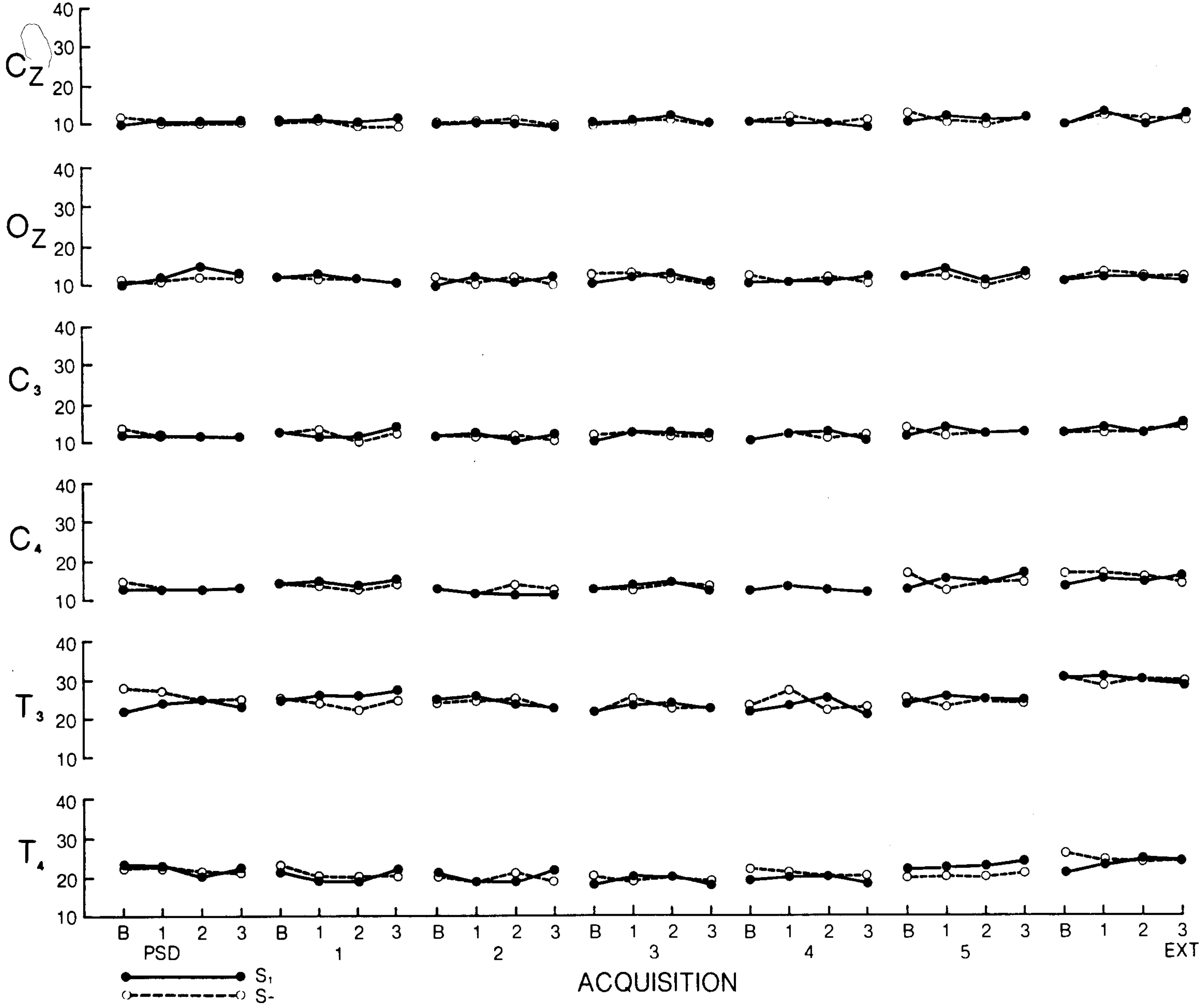

8-12 Hz
CZ
OZ
C3
C4
T3
T4
40
30
20
10
B
1
2
3
PSD
1
2
3
4
5
ACQUISITION
EXT
S1
S-

FIGURE 22

Grand mean percent power changes in the post-tone epochs at each electrode in the 13-30 Hz frequency band.

13-30 Hz



Repeated measures *t*-tests were used to evaluate post-tone changes in the four frequency bands relative to the BASE interval for each electrode site. The tables in Appendix E give the mean difference scores in those intervals for which a significant ($p < .05$, 2-tail) *t* value was obtained. Subject 1 contributed the majority of the signficant mean differences at every electrode. This subject demonstrates essentially a classic pattern, with decreased power in the 8-12 Hz band and an increment in 1-4 Hz following S1 which subsides over blocks of trials, only to return during extinction. These results are clearly summarized in Figure 4 which shows her averaged SPC data. The initial blocking and subsequent return of occipital (Oz) alpha are quite marked for this subject.

Possible relationships between BEEG and SPC were examined with a canonical correlation (CC) routine. These analyses were again conducted at each electrode for each subject. In order to bolster the N for this procedure, data were collapsed across trials such that one CC was calculated for pseudoconditioning, two for acquisition (S1-S2 and S-trials separately) and one for extinction. A fourth CC was obtained by collapsing across all trials of the experiment. For each of the CCs calculated, three separate relations were examined: (1) BASE percent power with SPC amplitude;

(2) post-stimulus percent power and SPC amplitude; and (3) BASE percent power with post-stimulus percent power. Of the 360 separate CCs calculated, only 21 obtained statistical significance at $p < .05$. These 21 significant CCs were scattered randomly across the comparisons and across subjects and as such are not indicative of any meaningful relations.

In summary, the SPC data definitely support the subjects' post experimental statements concerning the formation of an "association" about the correct tone and the light. Changes in the BEEG data seem to follow the same temporal course as the SPC, that is, the maximal changes occur just prior to S2. In spite of this similar temporal pattern, no predictive relationship between the SPC and BEEG data could be established.

CHAPTER 5

DISCUSSION

The principle concern of this thesis was to examine changes in event-related potentials (SPC and EP), the ongoing EEG (BEEG), and their covariation within a conditioning paradigm in human subjects. Based on materials reviewed in the introduction, it was expected that a biphasic SPC would develop during acquisition. Furthermore, the BEEG was expected to show increased slow activity in the early portions of the interstimulus interval, changing to a low voltage fast pattern as S2 approached. It was further anticipated that this enhanced slow activity would be maximal following presentation of S-. Chapter 4 shows that the data supported certain of these simplistic assumptions to a greater extent than others. The most prominent support is found for expectations of a biphasic SPC with acquisition.

The stepwise discriminant analyses confirmed the signficance of the changes in SPC morphology which are apparent in Figures 4-9. What initially appears to be a protracted negative component of the EP to S1 as recorded at Cz, C3 and C4 takes the form of a sustained slow potential shift with a biphasic form. That the "acquisition" of this sustained SPC is relatively complete by the second and affirmed by the third block of trials (28-52, S1-S2 pairings) appears to coincide with the final stabilization of reaction times as seen in Figure 3. This acquisition pattern is consistent with the growth rate of the contingent negative variation (CNV) previously shown by Walter et al. (1964) and Low et al. (1965, 1966 a, b). It is, however, slower than the 10-20 trials Cohen's (1969) subjects reportedly needed to achieve maximum CNV amplitude. When subjects are informed verbally of the relation between S1 and S2, a definite CNV may be recorded as early as the first trial, and definitely by the sixth (Cohen 1969).

Recordings at the occiput, however, show an initial positivity with a subsequent late negative component being acquired in the final block of acquisition. Responses with a similar early positive-late negative morphology have been reported by Rohrbaugh et al. (1976) to occur in the parietal (Pz) area. Their subjects were instructed as to the relationship between S1 (tone) and S2 (lighted figure).

The comparability of the present data with the studies discussed above and that of Hillyard and Galambos (1967) which employed substantially shorter i.s.i.'s (1.0-1.5 sec.) would seem to argue against 4.0 sec intervals being too long for the conditioning of most overt behavior (Kling 1971; Grossman 1967). In addition, McAdam et al. (1965) have discussed the possibility that when "diffuse preparatory responses" are being conditioned, the optimal interval for conditioning may be longer than the 200-500 msec reported for skeletal muscle responses. The apparent plateauing of the reaction time data after the 20-25th trial would seem to support this conclusion. A long i.s.i. is, however, necessary for the demonstration of the compound nature of the CNV (Loveless and Sanford 1973) and for that reason a 4.0 sec interval was employed for the present study.

Although McAdam _et al_. (1969) investigated the temporal growth of the CNV over various S1-S2 intervals and described an essentially biphasic CNV occurring with a 4800 msec i.s.i., Loveless and Sanford (1973) and Weerts and Lang (1973) were the first to describe the response in detail. The latter authors described the response as "biphasic," displaying an initial abrupt increase in vertex negativity upon presentation of the warning stimulus followed by a return toward baseline, reaching a minimum at approximately sec 4. A second slow increase in negativity peaked at the onset of the imperative stimulus. Weerts and Lang related this early negative phase to "signal stimulus orientation" and the later negativity appearing just prior to the imperative stimulus to the "true CNV." Subsequently, Loveless and Sanford (1974) referred to the two components of the waveform as the "O wave" which peaks with a relatively short and constant latency (1.0 sec) after S1, and an "E wave", the latency of which is related to the anticipated occurrence of the S2. Loveless and Sanford (1974 b), Loveless (1975) and Klorman and Bentsen (1975) have since shown these waveforms to vary independently with duration and intensity of warning stimuli, and instructional set. In addition to being differentially responsive to the above, the amplitudes of the components change differently over trials within an experiment. Specifically, "O wave" amplitude decreases over trials (Weerts & Lang 1973) while that of the "E wave" increases (Klorman 1975). Converse results have been reported by Rohrbaugh et al. (1976). The present data are to an extent in agreement with those of Klorman (1975). They further extend his findings, however, by showing the amplitude changes in both the early and late components of the SPC to be differentially dependent on the number of trials. In the present experiment, both components show a progressive rise in amplitude over the first half of acquisition with a subsequent decline. The early component, however, begins to decline in amplitude sooner. Kakigi et al. (1975) have also shown CNVs elicited over a 1000 msec i.s.i. to differentially decrease in amplitude at different points on the waveform over trials.

Thus, the present data support the notion of a non-unitary CNV (Borda 1970, Cant & Bickford 1967, Donchin et al. 1971, Jarvilehto & Fruhstorfer 1970), the early components of which are related to "orienting" while the later components are related to preparation for the motor response to, or expectation of, S2. Rohrbaugh et al. (1976) postulated that this late negative rise prior to S2 is primarily a readiness potential analogous to that originally reported by Kornhuber and Deecke (1965) and Deecke et al. (1969). The prominent appearance of this late component in the occiput (Oz) and the minimal size (< 20% of vertex amplitude) of the negative component of the readiness potential in this area (Vaughan et al. 1968) seems to argue strongly against such a position.

The rapid rise time (700-1000 msec) of this early component to peak amplitude is temporally similar to the optimal i.s.i.'s (250-500 msec) for classical aversive conditioning of finger withdrawal in man (Wolfle 1930). It appears then, that some type of "cerebral" orienting response may be occurring during short CS-UCS intervals which may in fact account for the rapid conditioning seen with these intervals. In a similar vein, Russian investigators have long argued that the orienting response plays an inportant part in conditioning, especially in the early stages. It seems possible that part of the effect of the orienting response is a wide spread shift in the brain's tonic activity which contributes to rapid conditioning (Martin & Levey 1969).

It is interesting to speculate at this point as to what relation, if any, this post-stimulus negativity may have to the post-imperative negative variation (PINV) reported by Timsit-Berthier _et al_. (1973 a,b, 1976). Sokolov (1963) has identified a conditioned orienting response that is elaborated when a weak stimulus is reinforced by a strong one. In fact, the response may be more persistent than to the strong stimulus alone. Timsit-Berthier _et al_. routinely employ a single click (intensity unknown) as S1, followed by a repetitively flashing strobe lamp (intensity unknown) as S2, a situation which on the surface at least seems analogous to that described by Sokolov to result in a persistent orienting response. Hypothetically then, the PINV may be an electrocerebral reflection of a prolonged orienting response to S2. If the PINV can be influenced by manipulations in S2 intensity and duration in a manner similar to that shown for the "O wave" (Loveless 1975), the hypothesis would seem to be supported. An abbreviated attempt to demonstrate such a relation by using a near threshold auditory S2 resulted in "little difference in the PINV" (Dubrovsky and Abraham 1976). One further question arises from the conflicting data as to whether or not the orienting response is enhanced in schizophrenics as compared to normals (Stern & Janes 1973). Nevertheless, as Gullickson (1973) pointed out, the hypothesis seems worthy of further investigation.

The absence of significant changes in the N1 component of the EP is surprising if one accepts the current hypothesis concerning the psychological correlates of the various EP components (see Tueting 1976 for a review). Of the 15 odd components identifiable in auditory EPs, N1 and P3 are the earliest which may be reliably affected by changes in a subject's attentive state (Picton and Hillyard 1974). The key words are "attentive state" as N1 is currently taken as a correlate of "selective attention" (Hillyard *et al*. 1973, Roth *et al*. 1976) whereas P3 is considered to reflect the subject's cognitive evaluation of the stimulus (Tueting 1976). However, recent studies by Schwent and Hillyard (1975), Schwent *et al*. (1976 a, b) and Roth *et al*. (1976) have shown these effects to be task and stimulus dependent. Specifically, these studies note that enhancement of N1 amplitude is best seen, and possibly only seen, in tasks which require the subject to pay a high degree of attention to stimuli coming at short intervals. In the present study, the tones occurred very infrequently (11-60 sec i.s.i.) compared to the 200-3040 and 750-3000 msec i.s.i.'s employed by Schwent *et al*. (1976 a,b) and Roth *et al*. (1976) respectively. In addition, the level of attention that these subjects had to maintain to detect and discriminate the stimuli was minimal compared to the difficult discrimination of stimuli differing by 25 Hz or

8 dB required by Schwent et al. (1976 a) and Roth et al. (1976) respectively. In view of these methodological differences, the absence of a significant enhancement in N1 is understandable.

Discrepancies between the present data and that of Meszaros (1972) and Begleiter and Platz (1969, 1971) who observed an enhanced EP with conditioning must be examined in view of different methods of measuring EP amplitude employed. Those authors relied on a peak-to-peak (negative at 65-70 msec to positivity at 210-220 msec for Begleiter and Platz 1969, 1971) amplitude measure. From such measures it is impossible to ascertain which component actually changed with conditioning in their studies. Quite possibly it was the latter positive component, as a positive peak of about that latency has been related to stimulus evaluation (Tueting 1976). In addition, N1 and P2 have been shown to be differentially affected by attention (Hillyard et al. 1973). This compounding of changes in different peaks of the EP by peak-to-peak amplitude measures is precisely why this method of measurement has been argued against so strongly (Friedman et al. 1973, Roth et al. 1976).

Unfortunately, single trial analysis did not yield a sufficient number of trials with reliable P3 components to warrant statistical analysis. That P3, when present, frequently failed to recross the arbitary baseline might indicate that the SPC began as early as 200 msec after tone onset on some trials. Similar negative deviations in the early components of the vertex response to warning stimuli suggested to Rebert and Knott (1970) that the CNV may begin as early as 100 or 150 msec after a warning stimulus. Walter (1964b, 1965a) suggested that the CNV begins approximately 200 msec after the warning tone. That the grand mean amplitudes seen in segment 1 were generally negative except at Oz would support this suggestion and rule against the possibility of this being an artifact of the short (200 msec) baseline used for the EP measurements. Simple visual inspection of the averages in Figures 4-9 does not give any impressions of demonstrable changes in this last positive component.

With the exception of subject 1, the changes in the background EEG were not as obvious as was hoped. However, the data as reflected in Figures 19-22 do follow the general pattern described in the literature. Of particular interest is the inverse relationship between activity in the 1-4 and 8-12 Hz frequency bands. That this complex response is generally maximal in the first post-tone analysis epoch suggests that it may be a reflection of the orienting response. Sokolov (1963) discussed the ultimate significance of the orienting reflex as a swing towards increased excitation, coincident with a progressive increase in EEG frequency (delta activity is replaced by alpha which may be replaced by beta activity). The present data as seen in Figures 19-22 follow approximately the same temporal course.

Such an hypothesis would seem at odds with the previous proposals that increment in 1-4 Hz activity is a sign of internal inhibition (Gastaut _et_ _al_. 1957, Morrell 1961). Conceivably, both hypotheses could hold at different times in the experiment. The increments in 1-4 Hz activity seen in pseudoconditioning and blocks 1 and 2 of acquisition are essentially the same whether S1 or S- is presented. As such, an interpretation of "orienting" would be appropriate. Subsequently, the pattern changes with 1-4 Hz activity being maximal following S- in blocks 3, 4 and 5 and maximal following S1 during extinction. This type of responsivity has been previously described for the 1-4 Hz activity linked with internal inhibition (Grossman 1967). Further support for this dual hypothesis might be found in the amplitude changes of the early component of the SPC which has been convincingly related to orienting. Specifically, the initial increase and subsequent decline in amplitude of this SPC component follows a similar time course.

Two alternative hypotheses should, however, be mentioned. The first would view this response as a correlate of some increment in general arousal or vigilance level of the subject. Daniel (1967) first proposed such a hypothesis to account for the higher incidence of theta activity preceeding correct choices in a vigilance task. The second hypothesis would consider the SPC and 1-4 Hz activity as one and the same event. Rush _et_ _al_. (1976) recently showed time locked 0.75 to 4.0 Hz activity to occur for up to 3500 msecs after a shock to the median nerve. The presence of 1-4 Hz activity following the tones, particularly during psuedoconditioning, would be consistent with the findings of Rush _et_ _al_. (1976). Walter (1973) has suggested that certain psychological processes might lead to the coherence of intrinsic rhythms resulting in a CNV-like waveform or to increase its amplitude. He went on to show how convincing CNVs could be synthesized from a collection of sine-waves of appropriate phase. The power spectrum of his generated waveform was composed of activity at 1, 2, 4, 6 and 8 Hz. That the 1, 2 and 4 Hz components contributed the most to his waveform, coupled with the present data and that of Rush _et_ _al_., would seem to support such an hypothesis.

That the canonical correlations did not show any consistent significant relations between the ongoing EEG and SPC amplitudes is not surprising. Although no previous studies have attempted to predict SPC amplitudes per se from changes in frequency of BEEG, numerous attempts have been made to relate BEEG to evoked potential amplitude. These reports have generally not met with any particular success, with some investigators finding a direct relation (Dustman and Beck 1965, Kooi and Bagchi 1964), others an inverse relation (Fruhstorfer and Bergstrom 1969), and others no relation of any kind (Chapman and Bragdon 1964). In fact, Salamy (1974) came to the conclusion that the size of the averaged evoked response is independent of spontaneous EEG fluctuations.

Although no predictive relations could be established, the temporal continuity of the significant SPC and BEEG changes is of prime interest. The present data show two temporally independent processes occurring within the interval between two stimuli about which a subject has formed an association. The first component is characterized by a large negative SPC with a duration of approximately 1 sec which is accompanied by an increase in (1-4 hz) activity in the background EEG and blocking of 8-12 Hz activity. These three events are labile, showing an initial increase in magnitude with each stimulus but declining thereafter. The second component occurs in close proximity to a stimulus requiring an overt response. This component is composed of a ramp-shaped negative SPC and the return of BEEG to near prestimulus levels. In terms of behavioral processes, these events would seem to be electrophysiological reflections of "orienting" and "expectancy."

In summary, this thesis has examined three different aspects of the human electroencephalogram--background rhythmical activity, slow potential changes, and evoked potentials--over the course of a conditioning paradigm. The most consistent finding was the appearance of a biphasic slow potential change (SPC) in the S1-S2 interval, the two components of which changed differentially over trials. Analysis of the background rhythmical activity (BEEG), based on the four classic frequency bands, showed an inverse relationship between activity in the 1-4 and 8-12 Hz bands, with little change in activity at 5-7 and 13-30 Hz. Evoked potential data failed to show any consistent changes across conditions. From these data it is concluded that electrographic correlates of orienting and expectancy do exist and do so at temporally different points in the course of a conditioned reaction time paradigm.

APPENDICES

APPENDIX A

MEAN SPC AMPLITUDES FOR EACH SUBJECT

Mean SPC amplitude in the ten segments as shown in Figure 1. Letters A through O represent the following conditions:

	Stimulus	Condition
A	S-	Pseudoconditioning
B	S1	
		Acquisition
D	S1-S2	Block 1
E	S1-S2	Block 2
F	S1-S2	Block 3
G	S1-S2	Block 4
H	S1-S2	Block 5
I	S-	Block 1
J	S-	Block 2
K	S-	Block 3
L	S-	Block 4
M	S-	Block 5
N	S-	Extinction
O	S1	

MEAN SPC AMPLITUDE S #01

EYE

	1	2	3	4	5	6	7	8	9	10
A	-0.5	9.1	6.7	9.6	6.5	4.3	2.4	-0.9	-1.7	-2.2
B	-4.3	0.4	-4.6	-8.7	-11.6	-14.0	-14.8	-13.5	-15.9	-14.9
D	-5.8	3.9	-1.2	1.4	-1.3	-2.0	-3.8	-5.2	-6.8	-7.0
E	-1.9	4.4	7.7	6.1	5.4	2.3	-1.1	-0.6	-1.5	1.7
F	1.9	6.3	9.1	4.2	1.3	-2.2	-3.6	-2.8	-3.0	-1.2
G	0.8	5.6	8.3	5.1	3.9	2.7	2.0	1.4	2.7	2.3
H	-10.1	-2.5	-1.8	-4.2	-3.8	-7.1	-8.0	-7.7	-9.3	-10.6
I	-1.6	6.3	3.3	3.0	4.1	1.3	0.8	-2.5	-1.6	-1.2
J	-3.4	5.3	1.2	-0.3	-3.1	-1.9	-4.7	-6.9	-8.9	-9.9
K	-3.6	4.0	1.6	-4.4	-5.3	-7.3	-7.1	-8.3	-12.4	-11.9
L	-0.5	9.2	6.8	4.3	0.8	-0.7	2.1	-0.1	-0.8	-0.3
M	0.0	8.5	6.8	4.1	5.9	6.7	6.2	5.7	8.3	6.7
N	-1.5	6.4	4.6	3.4	-1.4	-3.1	-5.6	-5.1	-4.5	-5.0
O	-3.6	0.1	-2.3	-5.4	-6.8	-7.9	-5.2	-5.3	-5.8	-8.0

CZ

A	-4.8	-9.5	-13.6	-8.9	-5.9	-4.9	-1.0	-3.6	-4.1	-3.6
B	-4.9	-8.4	-14.5	-6.4	-7.5	-7.8	-7.6	-7.9	-5.3	-5.2
D	0.7	-6.8	-8.8	-4.2	-3.7	10.2	1.8	2.1	0.6	0.7
E	1.0	-15.7	-23.3	-21.8	-17.0	-11.9	-12.7	-13.2	-16.5	-13.9
F	-3.1	-19.1	-24.1	-20.5	-15.7	-16.0	-14.2	-15.3	-18.3	-20.0
G	-0.6	-14.6	-17.2	-16.0	-11.8	-9.4	-10.9	-11.5	-11.1	-13.9
H	4.1	-10.9	-11.4	-10.1	-10.2	-7.5	-7.6	-10.3	-11.6	-15.1
I	-0.4	-9.8	-11.4	-8.3	-4.9	-1.9	2.2	2.4	1.9	2.9
J	-2.2	-12.2	-16.2	-16.1	-13.4	-10.4	-10.4	-10.3	-6.4	-6.8
K	1.8	-9.6	-12.3	-9.4	-10.4	-10.9	-9.4	-9.8	-5.5	-5.2
L	7.1	12.6	7.8	10.3	6.9	10.6	11.4	13.2	12.0	11.2
M	5.4	7.1	5.2	7.7	9.5	8.3	7.5	8.5	9.6	10.7
N	0.9	-12.3	-14.2	-7.6	-3.5	-1.5	2.8	1.1	2.2	-0.4
O	2.1	-14.4	-13.7	-10.7	-9.3	-9.6	-6.9	-7.0	-5.7	-4.3

OZ

A	7.1	3.5	-2.5	-1.9	1.0	1.1	3.7	1.5	3.8	-0.3
B	2.3	-2.4	-7.0	-2.7	-2.6	-1.4	-2.0	-5.8	-7.9	-10.3
D	7.2	0.3	-1.4	-0.4	0.2	3.6	4.4	2.9	2.0	2.8
E	13.1	6.1	-1.3	-1.0	2.0	3.7	2.8	2.1	-1.1	-4.5
F	5.2	1.1	-5.0	-1.7	1.5	2.0	0.4	-2.2	-4.9	-9.9
G	8.0	5.8	0.2	-0.2	2.6	4.3	4.5	3.6	-0.6	-2.5
H	10.4	7.6	2.5	3.4	4.8	5.9	5.9	4.7	3.6	-2.4
I	2.5	-2.3	-5.6	-2.7	-1.9	-0.2	2.6	1.5	-0.8	-0.2
J	6.7	1.0	1.3	0.8	0.9	1.7	1.6	2.4	0.7	0.4
K	6.4	-0.5	-2.5	0.3	-2.0	0.5	1.4	-2.3	2.2	1.8
L	4.7	-0.3	-3.5	-3.6	0.0	0.1	-2.0	-4.8	-1.8	-2.4
M	6.5	2.5	1.4	2.8	1.8	-2.6	-1.1	0.5	-1.9	-3.2
N	8.1	0.6	-4.5	-0.7	-0.6	0.1	3.3	1.5	1.8	-0.6
O	7.3	2.2	-3.0	-1.3	0.8	2.8	1.9	0.6	1.0	1.0

C3

A	-0.2	-8.7	-11.3	-9.6	-7.4	-5.5	-1.2	-3.3	-4.3	-4.5
B	-1.5	-6.3	-10.9	-5.5	-6.6	-5.7	-6.1	-6.0	-5.3	-7.3
D	2.8	-4.0	-3.3	-1.5	0.4	1.9	1.9	1.4	-0.4	-0.2
E	3.0	-11.4	-14.3	-14.1	-10.5	-6.3	-6.3	-7.7	-10.5	-8.0
F	-1.0	-12.8	-16.1	-14.6	-11.3	-11.2	-9.8	-12.1	-13.8	-14.0
G	0.0	-11.6	-13.6	-13.4	-10.0	-7.5	-9.4	-11.9	-11.1	-13.2
H	3.6	-8.2	-8.9	-7.6	-7.9	-5.9	-5.2	-5.6	-6.1	-8.8
I	1.2	-7.3	-8.8	-6.0	-5.0	-2.3	0.3	2.0	-0.1	0.9
J	-0.6	-10.5	-12.5	-11.3	-8.9	-7.3	-8.7	-9.4	-8.4	-8.9
K	1.1	-8.9	-10.6	-17.6	-8.1	-8.7	-8.2	-9.8	-6.8	-7.6
L	-0.1	-11.1	-11.6	-9.9	-5.8	-3.4	-2.0	-3.5	-1.5	-1.6
M	0.0	-10.0	-6.6	-3.3	0.1	1.3	2.9	4.8	5.2	3.3
N	1.5	-8.2	-8.3	-4.4	-2.8	0.8	2.1	1.6	1.9	0.1
O	2.0	-10.6	-9.9	-6.8	-5.9	-6.4	-5.8	-5.6	-5.5	-4.1

C4

A	0.9	-2.7	-7.2	-6.7	-4.8	-6.0	-0.8	-3.8	-4.9	-3.6
B	0.0	-1.8	-10.5	-6.6	-6.3	-6.2	-6.8	-6.8	-8.0	-7.6
D	2.7	-1.6	-4.1	-2.1	-1.1	0.3	-0.1	-0.2	-0.1	-0.4
E	4.2	-4.8	-9.7	-8.9	-4.8	-3.1	-5.2	-6.0	-9.4	-8.0
F	-0.9	-10.7	-16.8	-13.8	-9.3	-11.6	-10.7	-13.7	-15.4	-16.6
G	0.1	-8.7	-10.1	-10.9	-7.4	-6.6	-8.5	-10.3	-9.9	-12.4
H	6.0	-6.0	-5.6	-5.6	-7.4	-4.0	-5.6	-6.3	-8.4	-11.7
I	3.2	-4.9	-8.3	-5.9	-4.1	-2.1	0.7	-0.2	-1.5	-0.3
J	0.7	-8.7	-12.6	-11.3	-11.2	-8.7	-10.6	-9.5	-6.8	-7.8
K	3.9	-3.9	-8.1	-6.6	-8.2	-9.1	-6.4	-8.1	-5.4	-5.9
L	0.0	-11.9	-14.3	-12.6	-6.2	-5.1	-5.2	-6.9	-2.9	-2.6
M	1.0	-8.8	-8.1	-4.0	-0.6	-0.5	1.9	3.4	5.2	3.5
N	2.8	-0.9	-8.2	-1.9	3.5	1.3	0.3	3.1	4.1	2.2
O	2.8	-0.8	0.2	-0.3	0.4	0.0	-0.9	-0.5	1.0	2.0

MEAN SPC AMPLITUDE S #0Z

EYE

	1	2	3	4	5	6	7	8	9	10
A	-1.8	0.2	-0.6	-3.0	-4.7	-5.8	-5.9	-5.4	-5.6	-3.1
B	-1.8	1.9	-1.1	-3.8	-2.3	-2.6	-2.8	-4.8	4.1	-2.2
D	-4.0	-4.6	-2.9	-3.8	-6.4	-5.4	-6.8	-8.3	-8.6	-8.9
E	-5.4	-5.9	-3.4	-5.5	-4.1	-3.8	-4.5	-5.1	-6.1	-6.5
F	-3.5	-3.1	3.1	4.6	5.8	4.0	2.9	1.4	2.0	0.7
G	-1.7	-0.7	4.7	7.2	5.0	4.3	4.8	5.3	3.9	5.0
H	0.9	-3.3	-0.1	0.7	1.9	6.0	10.1	9.7	10.8	11.3
I	-1.2	-2.4	-0.7	-2.9	-2.5	-5.8	-3.6	-4.6	-5.8	-4.1
J	-3.9	-4.4	-1.6	-4.9	-7.3	-6.5	-5.0	-7.5	-8.1	-11.5
K	-2.4	-2.5	-5.3	-8.3	-8.4	-6.8	-7.7	-7.2	-7.1	-9.7
L	-4.3	-5.3	-5.1	-5.3	-0.3	-4.4	-5.4	-5.8	-5.3	-3.4
M	-4.5	-5.4	-8.2	-9.5	-6.1	-5.3	-5.7	-6.3	-9.3	-8.7
N	-2.3	-5.8	-5.6	-8.8	-8.1	-6.9	-7.7	-7.0	-10.6	-12.8
O	-2.8	-1.0	1.1	0.3	-2.1	-1.3	-6.3	-4.6	-6.3	-4.0

CZ

A	-6.0	-11.6	-9.6	-5.9	-6.9	-6.5	-1.9	3.9	0.9	-0.5
B	-2.6	-6.7	-1.5	3.6	-2.0	4.4	0.8	3.1	7.6	2.1
D	-0.6	-7.3	-8.8	-4.8	-2.0	0.7	0.2	1.4	-0.7	-0.1
E	-0.5	-5.0	-8.2	-11.1	-7.0	-3.2	-1.8	-3.0	-2.9	0.6
F	-8.3	-18.3	-23.4	-21.8	-19.9	-17.9	-17.6	-18.4	-18.6	-17.4
G	-2.7	-16.4	-18.0	-16.0	-12.0	-8.4	-9.7	-11.8	-13.0	-15.1
H	-2.0	-6.9	-10.8	-10.2	-9.9	-7.8	-8.1	-10.4	-7.8	-9.8
I	0.2	-9.4	-8.2	-3.7	-1.7	0.1	0.1	-0.2	0.8	-0.7
J	-5.8	-13.4	-16.1	-13.3	-10.0	-8.6	-9.5	-7.0	-5.2	-9.6
K	-5.7	-12.7	-6.8	-4.8	-4.3	-3.7	-2.3	1.3	0.1	-0.5
L	-1.7	-8.1	-2.6	1.1	1.9	3.0	2.5	4.1	2.1	2.2
M	-5.6	-13.2	-10.6	-7.8	-4.0	-2.3	-0.3	-2.9	-1.9	-2.2
N	-1.5	-8.1	-5.3	-6.2	-4.3	1.4	-0.3	-1.0	-3.2	-1.9
O	-3.7	-11.0	-10.3	-7.6	-2.5	3.2	1.6	4.2	2.0	0.5

OZ

A	3.0	3.3	3.2	2.2	3.9	3.2	2.0	1.7	4.3	-0.4
B	2.4	4.5	7.1	9.0	1.7	4.1	3.4	7.3	5.9	4.0
D	5.3	4.7	3.4	0.1	2.3	3.1	2.4	3.9	1.2	3.8
E	5.0	8.5	0.3	1.3	0.6	2.5	3.0	2.0	1.3	3.1
F	2.6	6.5	-1.2	-4.6	-5.8	-4.8	-5.6	-6.4	-6.1	-5.9
G	0.5	5.6	2.0	-2.9	-1.6	-2.2	-2.0	-6.4	-8.0	-9.7
H	0.1	8.0	-1.9	-3.3	-3.6	-6.4	-8.4	-8.2	-9.1	-11.0
I	0.1	4.1	3.1	2.9	1.2	4.7	2.4	0.5	1.3	0.0
J	0.1	4.3	-4.0	-3.0	-2.6	-2.8	-4.6	-2.1	-1.0	-0.4
K	2.1	5.4	5.2	3.5	2.4	1.9	-0.8	1.8	-0.8	3.3
L	2.9	8.1	4.9	1.6	1.9	1.2	1.7	0.8	-2.2	0.4
M	1.2	2.8	1.6	-0.6	-1.2	-2.8	-1.9	-2.3	-1.7	-2.2
N	3.1	5.7	6.0	1.2	0.6	2.6	2.6	1.9	-0.5	3.9
O	1.3	4.6	1.0	2.9	2.3	2.9	2.8	6.2	2.2	-0.2

C3

A	-6.4	-11.5	-7.7	-6.8	-8.6	-7.8	-4.9	0.1	-2.0	-2.8
B	-2.5	-4.6	0.1	4.0	-0.8	4.3	2.4	3.3	8.4	5.0
D	-1.2	-7.8	-8.0	-4.9	-3.9	-2.3	-1.8	-0.9	-3.9	-2.0
E	-1.8	-5.6	-6.7	-9.4	-6.5	-3.9	-3.1	-3.8	-3.2	0.5
F	-7.0	-17.7	-19.6	-18.0	-16.7	-15.1	-15.0	-15.5	-15.8	-14.4
G	-3.4	-17.1	-17.2	-15.7	-12.4	-9.3	-10.3	-10.9	-10.8	-12.4
H	-2.4	-9.0	-9.7	-9.0	-8.7	-7.3	-8.2	-10.1	-8.2	-9.6
I	-0.6	-10.1	-7.2	-2.6	-1.3	0.1	-1.3	0.1	0.7	0.3
J	-5.6	-12.9	-12.2	-11.0	-9.0	-7.7	-9.9	-5.4	-4.7	-9.8
K	-5.9	-13.6	-6.1	-5.7	-4.8	-5.8	-4.9	-2.1	-2.7	-2.7
L	-2.2	-10.8	-2.9	0.1	0.3	-0.3	-1.1	1.3	0.0	0.0
M	-4.9	-13.7	-7.9	-6.0	-3.7	-3.1	-0.4	-2.2	0.1	-1.5
N	-1.7	-9.2	-6.7	-9.1	-8.2	-4.2	-5.2	-4.3	-5.6	-2.9
O	-4.0	-10.9	-10.8	-9.1	-5.2	-0.3	-1.2	-0.2	-1.8	-3.3

C4

A	0.8	-4.7	-6.0	-1.9	-1.9	0.8	-0.5	1.4	1.6	2.3
B	-1.4	-6.1	-7.5	-5.2	-0.8	0.5	1.3	3.5	0.2	2.1
D	0.5	-4.6	-6.5	-8.8	-5.9	-3.0	-3.0	-2.8	-0.5	0.8
E	-5.1	-13.6	-16.7	-15.4	-14.2	-13.2	-12.7	-13.4	-12.7	-12.1
F	-1.0	-13.1	-14.2	-12.6	-10.5	-7.8	-9.0	-11.3	-11.6	-13.3
G	0.4	-7.7	-6.9	-6.8	-5.0	-1.7	-1.1	-2.3	0.0	1.0
H	-0.2	-3.8	-2.6	0.0	-0.4	-0.8	-1.5	2.4	2.0	-1.3
I	-4.6	-12.0	-11.3	-9.5	-8.9	-6.4	-8.2	-5.2	-5.0	-6.4
J	-2.5	-7.7	-3.5	1.4	0.3	0.8	2.1	3.2	3.4	1.8
K	-2.0	-6.9	-2.8	0.1	2.2	1.2	0.2	1.4	1.0	0.6
L	-3.2	-10.2	-8.8	-9.9	-7.0	-3.9	-2.2	-4.6	-5.6	-4.0
M	-0.6	-7.7	-6.8	-4.5	-2.5	-0.1	-1.0	0.2	-1.4	-1.5
N	-1.9	-7.4	-9.2	-7.5	-5.6	-2.5	-0.2	3.0	0.5	2.2
O	-1.5	-1.5	2.0	5.2	2.3	4.7	4.0	4.9	7.2	6.0

MEAN SPC AMPLITUDE S #03

EYE

	1	2	3	4	5	6	7	8	9	10
A	-6.7	-14.4	-7.2	-3.6	-5.7	-8.8	-10.6	-14.6	-11.6	-8.9
B	-5.0	-12.2	-3.1	0.9	2.6	7.3	3.5	-0.7	3.2	3.2
D	-0.3	-5.6	-6.6	3.6	1.4	4.2	7.7	9.8	9.4	7.3
E	-1.0	-8.6	-5.5	0.9	0.8	1.1	0.4	-2.3	1.8	1.5
F	-3.5	-13.6	-9.2	-7.6	-4.4	0.9	-0.8	-0.3	-4.2	-3.9
G	1.5	-2.7	5.3	5.9	7.4	6.5	5.9	1.5	1.3	-3.6
H	0.6	-3.4	-0.1	10.5	9.7	10.9	13.9	16.1	15.0	17.5
I	-1.3	-6.5	-0.7	0.0	2.3	3.3	-0.9	0.7	0.9	-1.9
J	2.4	-3.4	1.0	2.4	3.2	5.5	7.8	9.1	7.4	6.0
K	-1.3	-10.5	-12.8	-10.0	0.0	2.7	2.4	2.5	1.5	3.1
L	-7.1	-7.4	-5.5	-2.2	-3.3	1.0	-0.3	-2.4	-1.4	-1.5
M	5.6	-3.1	-8.6	1.2	8.6	13.6	11.8	10.8	13.7	14.6
N	7.0	6.3	10.8	10.4	11.9	17.2	18.1	5.7	12.1	10.8
O	-5.5	-9.8	-6.7	2.0	-0.5	-5.8	-1.7	1.1	-1.4	-0.9

CZ

A	4.0	0.3	-7.5	-6.3	-5.8	-9.4	-6.4	-5.3	-3.7	-5.8
B	2.4	-4.4	-10.7	-14.1	-6.8	-3.5	-6.0	-5.3	-8.6	-7.7
D	9.8	-5.1	-6.7	-8.0	-8.7	-5.8	-3.4	-2.8	-1.6	-0.8
E	3.4	5.2	-1.4	-1.2	-1.5	-0.9	-3.0	-2.4	-3.1	-1.8
F	7.4	3.7	-2.6	-4.1	-6.2	-4.8	-4.7	-3.8	-3.9	-8.3
G	2.9	6.7	-0.2	0.7	-2.2	-6.5	-4.7	0.1	2.5	5.1
H	1.6	6.6	0.3	-1.5	-2.5	-4.4	-3.5	4.9	6.0	6.8
I	5.3	3.1	-2.4	-6.7	-7.3	-5.6	-5.2	-3.6	-6.2	-6.2
J	2.4	3.3	-7.5	-11.8	-12.4	-7.6	-4.8	-4.9	-6.0	-2.1
K	1.5	2.4	-2.3	-5.8	-1.7	-2.1	-4.4	0.2	2.5	1.1
L	-0.4	-4.6	-10.8	-13.2	-10.4	-9.6	-10.9	-8.2	-10.2	-11.2
M	-3.2	-1.2	-8.7	-13.3	-10.9	-11.0	-8.1	-3.1	-3.3	-5.1
N	3.9	4.4	-5.4	-1.4	3.7	-0.7	-2.3	1.6	-0.1	2.8
O	3.7	5.8	-5.6	-9.0	-3.3	0.4	-3.6	1.6	0.7	2.4

OZ

A	7.1	11.8	6.6	0.9	3.5	1.6	3.4	3.5	2.8	1.5
B	5.2	8.9	-0.7	1.0	0.0	-0.7	2.6	2.7	-1.7	-4.8
D	6.4	4.0	1.5	-0.9	-1.1	0.9	0.0	1.5	3.8	2.5
E	4.9	10.8	7.6	2.9	2.5	1.8	0.4	-0.4	-1.2	-0.0
F	3.7	8.3	4.3	0.7	-2.2	-0.7	-2.7	-0.3	-2.0	-5.4
G	1.6	31.5	5.2	2.6	0.2	-2.4	-3.8	-2.4	0.2	1.7
H	5.6	12.9	12.9	8.0	4.8	-0.6	-1.6	1.3	3.5	-0.2
I	6.3	12.0	5.9	4.7	3.4	3.8	2.1	3.5	0.6	0.7
J	3.6	10.8	5.8	2.0	4.6	1.7	2.1	0.8	-2.7	-0.3
K	4.8	11.7	9.9	2.5	0.0	2.3	0.5	3.5	4.3	3.3
L	6.9	9.1	5.8	2.5	0.5	0.1	-2.0	0.8	-3.8	-2.5
M	0.8	6.9	5.9	1.3	-0.2	1.5	-2.2	-1.5	-3.3	-5.0
N	5.8	14.2	5.1	3.1	4.8	1.9	-0.6	0.0	-0.2	-2.6
O	1.6	7.2	2.2	-2.9	-3.9	-1.0	-3.2	-3.9	-4.7	-2.7

C3

A	-0.6	0.9	-4.6	-4.8	-4.7	-5.2	-3.7	-3.5	-2.5	-3.5
B	-0.5	-1.7	-5.5	-8.3	-5.3	-1.6	-3.8	-2.2	-3.1	-6.5
D	5.9	1.9	0.8	-3.0	-1.3	-1.8	-0.2	-0.8	-0.2	1.6
E	0.5	4.4	-1.2	-2.4	-3.6	-3.6	-4.9	-4.6	-7.7	-5.2
F	3.5	2.9	-1.5	-1.6	-4.5	-5.9	-7.7	-5.0	-3.9	-5.3
G	1.8	5.6	1.4	3.5	1.6	-3.8	-3.9	-1.6	0.2	4.0
H	-1.7	2.7	0.2	2.3	2.4	1.0	1.7	3.9	4.9	6.7
I	2.3	3.6	-0.4	-4.5	-6.1	-4.8	-4.8	-3.4	-5.3	-5.3
J	1.3	4.7	-2.7	-4.8	-8.4	-3.4	-1.9	-2.2	-1.8	0.5
K	1.2	7.9	4.3	-0.6	2.2	2.5	2.0	4.1	10.1	2.6
L	0.0	0.5	-4.4	-7.7	-7.1	-9.3	-9.7	-4.8	-7.7	-9.1
M	-2.6	2.2	-0.1	-3.9	-3.2	-3.7	-1.5	3.1	1.3	0.8
N	1.2	3.8	-2.4	-0.7	0.2	-3.7	-6.8	-2.3	-5.6	-2.1
O	0.7	6.5	-2.4	-6.1	-2.3	0.0	-2.7	-2.0	-4.9	-3.9

C4

A	0.4	-1.8	-3.7	-2.9	-1.9	-5.3	-3.3	-3.8	-1.3	-3.2
B	-1.4	-5.7	-6.3	-9.9	-5.1	-2.2	-4.2	-3.7	-5.7	-5.0
D	7.3	-5.8	-7.2	-5.1	-6.3	-3.0	-0.4	1.8	3.7	4.7
E	0.7	1.0	-0.9	-0.3	0.1	1.5	0.0	0.4	0.7	-0.5
F	5.0	2.3	-1.5	-2.7	-3.9	-2.2	-3.6	-1.6	-2.3	-6.4
G	-1.8	3.2	-1.3	-1.1	-1.5	-0.8	-0.2	4.6	5.7	8.2
H	-1.7	1.4	0.0	-3.3	-4.0	-4.9	-5.1	0.2	0.6	2.3
I	2.8	1.8	0.7	-2.8	-2.8	-0.2	-0.9	-0.3	-2.0	-1.0
J	-0.3	-0.6	-3.6	-5.7	-5.9	-1.6	0.7	1.9	2.1	2.2
K	-0.2	1.9	2.2	-0.6	2.5	3.4	0.2	2.2	3.0	3.4
L	-0.3	-4.4	-8.9	-10.2	-7.0	-5.7	-5.8	-5.9	-6.5	-7.4
M	-3.9	-3.7	-8.5	-11.7	-9.9	-7.6	-6.5	-2.9	-5.3	-4.3
N	2.7	3.9	-2.9	-0.1	4.0	2.8	2.5	4.0	4.9	7.8
O	1.6	5.9	-2.8	-6.1	0.2	3.7	3.1	6.7	5.4	8.8

MEAN SPC AMPLITUDE S #04

EYE

	1	2	3	4	5	6	7	8	9	10
A	-8.8	-4.5	1.1	-1.0	-0.5	5.1	4.0	5.9	9.0	8.5
B	-8.4	-7.0	-5.8	-8.11	-1.5	-11.0	-11.4	-8.7	-9.8	-9.8
D	-4.4	-2.4	-1.5	-3.5	-3.9	-5.0	-2.7	-1.9	-3.0	-3.4
E	-7.3	-3.6	-6.0	-6.0	-4.0	-4.1	-7.1	-8.0	-7.9	-5.2
F	-4.8	-1.6	2.9	3.6	0.3	0.0	-2.2	-4.1	-4.3	-4.5
G	-4.8	-1.5	-2.3	-5.7	-5.0	-9.8	-11.7	-7.1	-13.8	-14.6
H	-5.4	-6.6	-4.5	-4.2	-2.0	-0.6	-1.4	-2.1	-4.0	-4.2
I	-4.3	-3.0	-4.8	-2.7	-1.7	-3.8	-3.2	-1.2	-1.6	-6.7
J	-7.1	-7.2	-9.7	-10.6	-12.3	-9.0	-14.0	-16.5	-12.9	-9.9
K	-3.5	-1.8	-4.0	-2.2	-1.8	-2.6	-3.4	-6.6	-6.2	-5.3
L	-6.6	-6.8	-8.2	-7.5	-9.8	-9.5	-9.2	-12.3	-16.0	-18.6
M	-3.9	-4.3	-4.6	-4.1	-4.9	-1.6	-5.7	-1.9	-0.8	-2.7
N	-4.1	-8.0	-7.2	-5.4	-5.0	-2.6	0.2	-2.2	5.8	10.5
O	-5.6	-5.8	-5.0	-1.6	-6.7	-6.5	-8.4	-10.3	-9.8	-11.3

CZ

A	3.4	1.4	-2.4	1.4	-3.2	-0.5	0.3	0.6	3.8	6.2
B	2.2	-1.7	-6.6	-2.6	-1.5	-2.0	-6.9	-7.1	-7.2	-12.4
D	-4.4	-6.9	-9.5	-9.4	-6.5	-5.6	-6.8	-7.7	-12.2	-13.0
E	0.1	-6.1	-7.4	-8.1	-7.1	-4.6	-5.7	-9.3	-5.0	-6.4
F	-7.0	-13.7	-13.0	-8.8	-6.5	-5.0	-5.0	-7.3	-7.2	-5.4
G	-5.3	-12.7	-7.8	-5.9	-4.1	-3.1	-3.2	-4.8	-6.0	-9.3
H	-4.8	-5.7	-8.2	-5.7	-5.0	-0.8	-1.4	-5.1	-0.8	0.4
I	0.6	-7.1	-12.7	-10.3	-10.1	-11.4	-12.2	-11.0	-12.9	-13.3
J	-0.6	-4.3	-5.9	-3.2	-5.1	-5.7	-6.1	-2.8	-4.8	-3.5
K	-0.4	-10.4	-9.0	-4.2	-2.7	1.9	1.1	3.5	2.5	2.2
L	-3.8	-9.7	-10.0	-6.6	-2.8	0.3	4.2	2.8	-0.2	2.9
M	1.1	-4.6	1.1	0.8	4.4	7.6	8.9	5.4	6.8	8.1
N	-6.5	-13.9	-5.5	-2.7	-3.7	-7.6	-11.1	-10.4	-11.9	-9.8
O	-3.4	-7.4	-4.0	-4.1	-4.2	-4.3	-0.5	-1.8	1.1	-0.8

OZ

A	7.0	8.9	4.0	6.6	4.5	0.9	-0.6	3.2	1.0	1.5
B	4.1	8.0	5.6	7.7	7.0	4.7	3.2	3.7	4.3	4.6
D	2.7	2.7	1.1	1.0	3.5	4.6	5.5	5.1	4.2	6.1
E	5.8	5.8	2.9	3.2	2.7	2.1	1.6	2.3	2.8	2.3
F	6.5	5.8	4.6	1.6	3.1	2.5	4.8	3.7	4.8	4.9
G	2.5	4.7	3.6	3.3	1.5	2.9	1.7	1.5	1.3	0.6
H	0.4	4.0	1.1	1.0	1.8	1.9	1.3	0.0	1.3	-0.9
I	4.9	7.2	5.9	2.6	1.7	2.3	0.9	2.1	1.9	6.2
J	4.2	3.0	1.6	1.8	2.1	-1.5	-0.5	1.3	0.7	-0.8
K	1.7	2.8	1.0	1.6	1.2	2.4	-0.5	-0.1	0.5	-1.2
L	3.6	3.0	4.2	5.4	5.1	7.0	3.4	5.0	3.0	6.2
M	2.5	2.4	1.0	1.0	3.4	2.7	8.3	6.3	3.5	3.0
N	-0.9	2.9	1.8	2.0	1.0	0.1	-1.9	1.1	1.5	0.6
O	3.1	3.6	3.7	1.0	2.8	1.1	0.4	4.6	5.0	5.5

C3

A	3.8	0.0	-3.5	-0.7	-3.8	-5.0	-7.4	-6.5	-7.0	-7.5
B	2.9	-2.8	-6.0	-3.0	-2.7	-3.5	-7.8	-6.5	-5.2	-9.2
D	-1.6	-3.9	-5.5	-3.3	-0.6	0.5	1.2	0.2	-2.4	-2.5
E	0.8	-5.8	-6.4	-8.1	-6.8	-5.3	-6.2	-10.0	-7.4	-8.2
F	-4.5	-11.6	-13.3	-9.0	-8.4	-7.7	-8.8	-10.7	-11.7	-10.0
G	-3.1	-8.2	-5.5	-5.3	-4.0	-3.9	-3.9	-5.6	-5.1	-7.6
H	-2.7	-5.9	-7.5	-5.2	-5.3	-2.5	-4.1	-5.8	-3.4	-2.2
I	1.7	-5.4	-7.6	-5.6	-5.0	-5.5	-6.1	-4.2	-6.0	-5.8
J	1.5	-4.8	-5.3	-4.4	-5.4	-5.4	-5.5	-2.8	-4.3	-2.5
K	-0.3	-9.7	-8.5	-6.2	-6.1	-4.1	-4.6	-4.2	-6.2	-6.4
L	-0.1	-4.4	-5.4	-2.7	-0.6	-0.3	2.8	3.1	-0.2	1.8
M	1.5	-2.8	0.2	-0.5	1.9	4.3	5.7	2.3	2.1	2.6
N	-3.9	-9.3	-5.3	-4.5	-5.0	-6.4	-7.1	-5.4	-6.6	-3.8
O	-3.3	-7.3	-6.4	-6.6	-5.7	-8.2	-6.4	-9.0	-7.3	-8.8

C4

A	0.6	-0.4	-4.4	0.0	-3.3	-2.7	-2.0	-1.5	0.6	-1.0
B	1.7	-0.1	-5.1	-1.9	-0.9	-1.7	-4.3	-2.4	-0.3	-3.0
D	-2.0	-1.5	-4.5	-2.6	-0.1	1.6	2.7	2.4	0.3	0.3
E	0.3	-3.2	-3.2	-3.8	-3.3	-2.3	-2.9	-6.3	-2.8	-4.0
F	-4.5	-6.8	-9.3	-6.8	-5.7	-4.8	-5.4	-6.9	-5.8	-6.2
G	-2.5	-3.8	-1.1	-2.0	-0.2	1.2	-1.2	-1.3	0.3	-3.7
H	-4.0	-4.9	-7.6	-4.3	-5.9	-1.9	-3.1	-5.4	-4.6	-1.8
I	0.0	-1.9	-5.2	-3.4	-2.2	-3.6	-3.5	-1.0	-2.7	-1.9
J	0.0	-4.0	-5.0	-3.2	-4.4	-3.7	-3.5	0.4	-0.9	1.9
K	-1.5	-8.4	-8.1	-5.7	-6.3	-4.7	-6.2	-5.3	-6.3	-4.8
L	-0.5	-2.0	-4.1	-2.2	0.2	2.1	4.3	4.4	2.7	5.7
M	0.0	-2.3	-0.1	-0.2	2.3	5.3	5.7	4.2	3.9	2.7
N	-4.2	-7.6	-3.6	-2.1	-2.9	-4.3	-6.1	-4.5	-3.7	-2.9
O	-2.9	-4.2	-5.4	-4.2	-5.4	-4.4	-1.8	-3.1	-2.8	-4.0

MEAN SPC AMPLITUDE S #05

EYE

	1	2	3	4	5	6	7	8	9	10
A	-4.1	-2.2	-2.1	-2.6	0.7	-1.7	-4.5	-3.1	-5.9	-6.9
B	-4.3	-4.9	-2.5	-3.0	-4.6	-5.3	-1.8	-2.6	1.0	1.1
D	-5.2	-7.6	-7.5	-11.1	-10.5	-11.2	-14.7	-15.2	-14.1	-18.2
E	-3.8	-6.9	-6.1	-7.6	-8.1	-7.6	-7.9	-7.5	-10.9	-11.8
F	-4.0	-6.9	-7.2	-8.1	-8.0	-9.2	-9.3	-10.1	-11.0	-12.0
G	-2.3	-3.8	-3.3	-3.0	-4.7	-4.1	-3.9	-4.0	-6.1	-5.7
H	-3.7	-5.7	-6.1	-6.2	-7.7	-8.6	-10.8	-12.0	-16.0	-17.1
I	-6.1	-7.4	-8.3	-10.5	-12.6	-14.0	-14.0	-15.3	-17.7	-16.3
J	-6.3	-7.9	-8.8	-6.0	-6.7	-9.8	-10.0	-14.3	-14.5	-14.8
K	-4.1	-8.9	-6.2	-7.3	-7.2	-5.9	-6.8	-7.2	-7.0	-10.9
L	-4.2	-4.5	-4.4	-2.8	-1.1	-2.7	-2.8	-2.8	-8.4	-5.4
M	-2.1	-1.7	-3.4	-3.2	-3.9	-4.5	-5.1	-3.9	-4.2	-9.4
N	-2.9	-8.2	-5.5	-4.9	-2.9	-1.8	-3.3	-4.1	-7.4	-8.2
O	-4.1	-9.1	-10.0	-9.6	-9.7	-11.3	-10.2	-12.2	-13.6	-12.9

CZ

A	-6.3	-6.8	-4.7	-0.4	-2.8	-1.3	-1.4	1.7	1.1	-1.6
B	1.6	-5.3	-5.0	0.1	-5.3	-3.6	-5.3	-4.1	-4.2	-7.6
D	-1.2	-11.7	-10.9	-10.8	-12.1	-6.7	-4.3	-2.8	-3.2	-2.9
E	3.2	-6.3	-5.3	-4.8	-4.8	-7.0	-4.1	-4.8	-3.3	-2.5
F	0.6	-8.8	-7.0	-4.1	-2.1	-2.1	-2.5	-2.1	-2.4	-3.4
G	-0.3	-6.3	-5.3	-4.5	-3.9	-2.6	-2.0	-1.3	-2.9	-2.2
H	4.0	-5.0	-1.7	-1.6	-2.0	-2.2	0.4	-1.3	-0.3	-0.3
I	0.6	-5.4	-4.6	-4.9	-4.6	-1.4	-2.6	-0.9	1.4	1.6
J	0.2	-4.9	-7.3	-4.6	-1.0	-2.1	-2.2	-0.2	-1.1	0.3
K	0.6	-6.1	-5.3	-5.3	-7.1	-6.0	-6.4	-4.0	-6.3	-3.4
L	0.2	-5.6	-5.5	-5.6	-5.3	-6.2	-3.6	0.1	0.3	-0.2
M	0.3	-3.3	-4.9	-5.9	-5.2	-5.4	-4.0	-4.2	-0.1	0.9
N	0.4	-6.4	-4.2	-2.9	-2.4	0.2	-1.9	-5.3	-6.4	-6.5
O	0.8	-6.2	-3.3	-5.7	-3.4	-3.4	-2.6	-3.9	-3.4	-1.8

OZ

A	-0.3	3.8	3.7	4.2	0.4	1.3	3.4	4.7	5.8	6.4
B	3.8	6.0	5.9	6.9	4.3	7.1	5.6	6.1	5.5	6.2
D	1.4	1.7	1.9	2.0	0.3	3.4	5.2	4.5	2.9	4.2
E	1.2	0.1	-1.0	-2.6	-2.1	-3.2	-0.6	-2.6	-2.7	-2.0
F	2.0	1.9	2.9	3.7	3.5	2.4	2.1	1.1	-0.4	-2.3
G	2.4	3.6	3.4	0.5	1.6	1.4	0.7	2.2	1.9	1.6
H	1.7	1.1	1.4	1.6	2.1	1.9	4.3	2.7	6.6	4.5
I	2.7	3.6	4.1	2.3	2.3	4.3	2.2	5.1	5.0	4.3
J	1.8	4.7	0.9	1.0	2.2	1.8	-0.1	0.8	0.0	-1.7
K	1.7	5.3	3.3	3.6	2.0	2.1	1.9	0.9	-1.0	-0.3
L	1.5	1.0	0.1	-1.8	-3.6	-3.7	-1.9	-1.5	1.6	0.6
M	0.2	1.2	-2.1	-2.8	-2.0	-3.5	-1.9	-1.7	-1.9	-1.5
N	-0.1	3.1	0.7	0.6	-2.5	-0.3	-1.3	-6.1	-5.7	-3.8
O	-0.6	0.7	2.0	-1.3	-2.1	-2.1	-2.5	-2.4	-1.5	-0.8

C3

A	-5.9	-5.3	-4.1	-0.5	-2.1	-1.6	-0.9	1.6	1.2	-1.2
B	-0.7	-4.6	-4.7	0.2	-4.3	-3.1	-4.4	-3.4	-2.6	-3.7
D	-2.2	-8.8	-8.3	-8.3	-8.5	-4.7	-2.3	-1.0	-0.7	-0.8
E	0.7	-5.2	-4.8	-4.5	-4.4	-5.4	-3.1	-3.4	-1.5	-0.9
F	-0.5	-6.5	-5.3	-2.9	-1.0	-1.4	-1.4	-1.6	-1.6	-2.7
G	-0.9	-5.3	-4.8	-3.4	-2.2	-1.3	-0.9	-0.7	-2.1	-1.2
H	2.5	-3.2	-1.3	-1.6	-2.4	-2.4	0.0	-1.8	-1.1	-2.1
I	-0.4	-4.1	-3.6	-4.5	-3.5	-0.4	-1.4	-0.4	1.8	3.2
J	-0.9	-3.6	-6.1	-3.3	-0.5	-1.8	-1.9	-0.4	-0.2	1.5
K	-0.6	-4.2	-4.0	-3.3	-3.9	-3.0	-2.8	-0.7	-3.0	-0.5
L	-1.4	-3.2	-4.0	-4.3	-3.8	-4.0	-1.9	0.5	0.6	-0.5
M	-1.5	-3.2	-4.8	-5.5	-4.2	-4.9	-3.8	-3.7	-0.4	0.5
N	-2.1	-4.8	-3.7	-3.1	-1.8	0.6	-0.9	-3.8	-4.5	-3.8
O	-0.5	-4.6	-2.4	-3.4	-1.4	-0.9	-1.6	-3.9	-0.5	1.6

C4

A	-4.6	-3.8	-2.1	-0.2	-0.3	0.2	-0.1	3.0	2.0	-0.6
B	-0.7	-4.2	-3.8	-0.1	-4.3	-2.7	-4.6	-3.2	-3.4	-5.3
D	-1.3	-8.4	-7.4	-8.8	-9.5	-6.1	-4.4	-3.7	-2.6	-3.3
E	0.9	-5.9	-4.9	-4.8	-4.7	-6.7	-3.8	-4.4	-3.4	-2.7
F	0.3	-5.5	-4.6	-1.6	0.2	-0.1	-0.6	0.1	0.0	-1.0
G	-0.9	-5.3	-4.9	-3.6	-3.0	-1.7	-1.4	-0.9	-2.3	-1.0
H	3.0	-4.5	-2.2	-2.6	-3.2	-3.6	-1.5	-3.2	-1.8	-2.6
I	-0.4	-3.7	-3.0	-4.5	-4.2	-1.2	-1.8	-0.3	2.0	4.3
J	-0.8	-2.9	-4.4	-2.8	-0.3	-2.3	-1.7	-0.5	-0.2	1.0
K	0.5	-4.4	-2.9	-3.5	-5.1	-3.3	-4.2	-2.6	-5.0	-2.2
L	-0.6	-4.9	-4.8	-5.2	-3.7	-4.6	-3.2	-0.3	0.8	1.1
M	0.5	-2.5	-4.1	-5.5	-4.3	-5.4	-4.7	-3.9	0.0	1.1
N	0.4	-5.7	-4.1	-3.9	-2.7	-0.3	-1.0	-3.9	-5.3	-4.0
O	0.0	-6.2	-4.3	-6.6	-4.3	-4.2	-3.0	-4.1	-4.2	-2.1

MEAN SPC AMPLITUDE S #06

EYE

	1	2	3	4	5	6	7	8	9	10
A	-1.2	-0.4	4.9	2.5	3.8	4.7	4.0	1.9	2.1	2.6
B	-2.1	-1.3	-2.7	0.5	-0.9	0.1	-3.7	-7.1	-5.4	-5.1
D	-3.5	-1.6	0.2	-0.1	3.8	3.0	2.4	2.2	4.8	4.2
E	0.7	2.8	3.0	4.5	5.7	5.6	4.5	2.9	3.9	4.4
F	-1.8	-0.1	0.2	-0.2	-2.0	-0.7	-0.9	-0.7	-0.8	-1.4
G	-2.8	-3.6	0.2	-1.4	-1.5	-2.6	-3.2	-4.6	-4.8	-4.6
H	-4.8	-3.8	-2.3	0.0	0.5	1.5	4.8	5.1	6.2	5.6
I	1.3	0.6	0.3	-0.6	-1.8	-0.5	-1.0	-2.0	-0.2	-0.3
J	1.6	3.8	4.2	0.5	3.4	-0.6	1.7	2.7	3.2	1.5
K	0.8	1.1	-0.2	0.1	-2.0	-1.9	-3.4	-4.9	-3.4	-4.0
L	-0.7	3.7	6.1	3.6	0.9	1.0	2.3	2.7	3.2	2.7
M	-0.5	1.9	0.3	-0.4	-2.2	-3.6	-3.2	-1.7	-0.7	-1.3
N	5.6	6.6	5.9	9.0	6.9	6.2	4.1	4.8	4.6	5.3
O	-2.9	-2.5	-2.3	-0.7	-2.6	-2.2	-1.3	-0.9	-0.9	-1.0

CZ

A	-10.5	-13.1	-13.9	-14.2	-8.9	-6.2	-4.1	-2.8	-5.5	-11.0
B	-2.4	-11.1	-12.6	-8.8	-5.7	-4.3	-7.0	-5.8	-6.7	-6.3
D	-7.1	-12.3	-11.4	-8.9	-7.5	-5.1	-2.7	-2.6	-3.7	-4.2
E	-3.5	-10.0	-7.0	-1.5	-0.6	2.0	1.7	1.8	3.3	3.0
F	-2.9	-6.4	-4.3	-0.8	2.4	5.0	4.6	4.6	7.4	7.7
G	-5.1	-6.4	-7.6	-7.7	-7.4	-10.1	-6.0	-3.8	-4.8	-3.2
H	-1.8	-7.7	-12.8	-14.2	-12.4	-13.3	-15.6	-18.4	-19.2	-18.5
I	-9.3	-13.8	-14.1	-10.7	-8.6	-4.5	-2.9	-0.7	-1.4	-2.1
J	-5.4	-9.4	-8.6	-4.3	-2.2	-5.0	-1.3	-0.2	-0.1	-1.6
K	-7.5	-9.7	-5.1	-3.3	-3.7	-4.9	-2.0	1.1	0.2	-2.1
L	-3.2	-7.6	-7.3	-3.1	-0.6	-4.4	-5.4	-4.6	-5.7	-3.7
M	-3.8	-3.8	-7.4	-4.3	-3.3	-3.6	-3.0	-1.9	-3.6	-1.4
N	-3.6	-11.2	-7.3	-6.5	-5.2	-3.7	-5.3	-3.5	-1.4	-3.3
O	-1.1	-6.5	-10.0	-12.5	-12.5	-9.1	-6.2	-3.1	-3.9	-7.4

OZ

A	0.2	-0.2	-4.9	-4.3	-2.9	-2.0	-1.7	-1.9	-3.7	-6.3
B	1.7	-1.2	-0.8	-0.2	3.2	1.7	1.5	3.4	0.2	-1.0
D	2.9	2.7	2.9	3.8	5.2	3.8	3.7	3.4	2.9	1.3
E	-1.0	-2.2	-0.3	2.4	1.5	4.2	4.4	3.8	3.5	1.3
F	-0.2	1.0	-0.4	0.6	1.5	2.4	3.1	3.1	3.1	4.0
G	-0.8	4.9	-0.3	0.9	1.0	-0.8	-0.2	2.8	1.3	1.6
H	1.8	5.5	2.3	1.7	2.6	4.1	-0.3	-0.4	-2.2	-2.9
I	-3.5	-2.7	-4.4	-3.1	-0.2	0.3	0.8	2.2	0.2	-1.5
J	-1.6	-1.9	-3.0	-0.5	0.6	1.8	2.4	2.3	1.4	2.3
K	-2.3	-1.9	0.5	-0.1	0.8	0.2	1.1	1.8	0.7	3.4
L	-1.4	-0.7	-3.5	-1.6	1.6	0.4	-0.7	-2.0	-2.6	-3.5
M	-1.0	-0.3	-4.4	-1.8	-1.9	-2.9	-2.5	-3.3	-4.4	-2.9
N	1.0	1.3	4.6	1.8	0.2	3.8	2.0	2.6	2.6	1.9
O	2.8	3.2	0.4	-2.3	1.1	-0.9	1.3	2.8	2.6	0.5

C3

A	-5.5	-7.7	-10.4	-11.7	-9.2	-7.9	-5.9	-5.1	-7.2	-11.6
B	-0.7	-9.3	-11.8	-9.2	-7.0	-6.5	-8.4	-7.4	-8.0	-7.7
D	-3.7	-8.2	-8.6	-6.6	-5.7	-3.8	-2.4	-2.9	-3.6	-3.9
E	-1.0	-6.3	-5.0	-0.7	0.5	1.7	1.6	1.2	2.0	1.4
F	-1.5	-4.8	-3.7	-1.6	0.3	2.2	1.9	1.8	3.4	4.1
F	-2.7	-2.8	-3.6	-4.3	-3.6	-5.5	-1.9	-0.6	-2.2	0.2
H	-1.1	-3.2	-4.7	-6.1	-3.9	-3.5	-5.5	-7.7	-7.7	-6.9
I	-5.7	-10.7	-11.0	-8.9	-7.4	-4.3	-2.6	-1.8	-2.6	-2.1
J	-3.0	-6.0	-6.4	-2.3	-0.6	-2.5	-0.5	0.1	0.6	-0.9
K	-5.2	-7.5	-4.8	-3.7	-4.0	-5.5	-2.7	-0.1	-2.1	-3.3
L	-0.7	-4.1	-5.0	-2.9	-1.3	-4.1	-4.5	-3.8	-4.2	-3.0
M	-3.1	-3.5	-6.8	-5.6	-4.8	-5.9	-4.7	-3.4	-5.2	-3.6
N	-3.1	-10.4	-7.8	-8.2	-6.3	-5.9	-6.9	-5.7	-4.5	-4.7
O	-0.9	-5.1	-8.7	-11.9	-10.3	-8.1	-6.8	-4.7	-5.9	-7.2

C4

A	-4.6	-7.4	-8.3	-10.2	-7.4	-5.3	-4.3	-4.7	-6.9	-10.5
B	1.3	-8.0	-10.3	-8.9	-7.3	-5.9	-8.0	-7.5	-8.0	-8.4
D	-4.7	-7.8	-8.1	-5.9	-4.6	-3.0	-2.4	-1.5	-2.0	-1.8
E	-1.4	-5.6	-3.9	0.2	1.1	2.3	1.6	1.9	3.0	2.3
F	-1.2	-3.1	-3.0	-1.3	-0.2	1.7	1.3	1.5	4.1	3.7
G	-3.0	-3.5	-2.8	-3.3	-3.3	-5.4	-3.5	-2.2	-2.2	-0.9
H	-1.0	-4.5	-6.6	-8.0	-5.7	-6.3	-7.2	-9.2	-10.6	-9.9
I	-6.3	-10.5	-10.9	-8.5	-6.5	-3.9	-2.9	-1.8	-3.2	-3.5
J	-0.6	-3.4	-3.3	2.0	1.5	-0.6	2.6	3.2	2.8	0.9
K	-4.6	-5.7	-4.0	-3.3	-4.4	-5.1	-2.5	-0.3	-1.0	-3.4
L	-1.2	-3.9	-4.7	-3.6	-2.2	-5.6	-5.1	-4.5	-5.3	-4.4
M	-2.7	-2.0	-6.1	-4.4	-4.1	-4.8	-3.5	-2.2	-3.9	-2.7
N	-1.2	-5.0	-3.5	-3.7	-3.0	-3.0	-5.0	-3.0	-1.3	-2.4
O	-1.3	-4.5	-7.0	-8.7	-8.9	-6.9	-4.8	-3.2	-4.6	-7.3

APPENDIX B

SPC SEGMENTS ENTERED (REMOVED) INTO SWDA RESULTING IN A SIGNIFICANT (p .05) U-STATISTIC

SPC SEGMENTS S 001

SEGMENTS

EYE

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	*									
S-								*	*	
PSD	*			*	*					
ACQ 01										
02		*	*		(*)					
03										
04										
05	*								*	
EXT										

Cz

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	*			*						*
S-			*		*		*	*		
PSD	*							*		*
ACQ 01										
02	*		*		*	*		*	(*)	*
03	*		*			*		*	*	
04	*									*
05			*							*
EXT		*	*				*			

Oz

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	*	*			*					*
S-									*	
PSD	*	*	*						*	*
ACQ 01	*		*							
02	(*)	*	*	*		*			*	*
03					*			*		*
04		*			*			*	*	*
05				*		*				
EXT										

C3

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	*			*	*	*		*	*	*
S-								*		
PSD										
ACQ 01										*
02										
03	*		*	*		*	(*)	*	*	
04	*									*
05		*					*			(*)
EXT				*			*			

C4

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	*	*	*	*	*				*	*
S-		*		*	*			*		
PSD	*		*		*	*		*	*	
ACQ 01										
02				*			*	*	*	
03			*					*	*	
04			*							*
05			*						*	
EXT										

SPC SEGMENTS S #02

SEGMENTS

EYE

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•			•	•	•				•
S-										
PSD										
ACQ 01				•	•	•			•	(•)
02										
03		•		(•)			•			•
04		•		•	•	•				•
05	•	•		•					•	
EXT	•	•		(•)			•			•

Cz

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•	•	(•)	•		•				•
S-	•	•	•				•	•		
PSD						•				
ACQ 01										
02		•	•	•		•			•	•
03		•	•	(•)				•	•	
04			•				•	•		
05		•								
EXT										

Oz

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•	•	•		•		•			•
S-		•	•			•	•		•	•
PSD										
ACQ 01				•				•	•	
02	•	•				•				
03		•	•	•	(•)		•			(•)
04								•		
05	•	•						•		(•)
EXT	•			•			•	•	•	•

C3

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2		•		•		•				•
S-	•	•				•				
PSD						•				
ACQ 01										
02		•	•	•		•			•	•
03		•	•	•			•	•	•	
04			•			•				•
05	•	•	•				(•)	•		
EXT										

C4

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•	•		•		(•)	•	•		•
S-					•		•		•	
PSD										
ACQ 01		•		•				(•)	•	•
02				•	•					
03					•					
04										
05										
EXT	•	•	(•)	•				•		

SPC SEGMENTS S #03

SEGMENTS

EYE

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2										•
S-										
PSD										
ACQ 01		•		•						
02										
03										
04										
05		•								
EXT	•							•		

Cz

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•				•					•
S-										
PSD	•	•								
ACQ 01	•				•			•	•	
02		•	•	•		•		•	•	
03	•			•				•		•
04		(•)		•		•	•	•		•
05										
EXT			•			•				

Oz

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2										
S-										
PSD										
ACQ 01					•		•		•	•
02										
03	•									•
04										
05				(•)				•	•	•
EXT					•	•	•			•

C3

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2										
S-									•	
PSD		•			•		•	•	•	•
ACQ 01										
02	•									•
03			•	•	•	(•)	•	•	•	•
04		•		•				•	•	•
05	•		(•)		•					•
EXT						•				

C4

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•	•			•					•
S-	•		•							
PSD	•	•	•	•	•	•	(•)			•
ACQ 01	•	•				•			•	
02	•				•					•
03	•								•	
04				•						
05										
EXT	•			•				•	•	•

SPC SEGMENTS S 004

SEGMENTS

EYE

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2										
S-					•					•
PSD										
ACQ 01										
02										
03										
04										
05										
EXT	•	•		(•)	•	•	•		•	(•)

Cz

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•							•	•	
S-		•	•				•			
PSD										
ACQ 01			•			•				•
02										
03	•		•				•	•		
04										
05		•	•			•		•		•
EXT			•				•		(•)	

Oz

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2										
S-		•		•		•	•		•	•
PSD										
ACQ 01	•	(•)	•	•	•		•	•		•
02			•							
03	•			•					•	•
04	•		•	•		•	•	•		
05	•					•			•	•
EXT										

C3

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•	•						•		•
S-	•	•	•				•	•		
PSD										
ACQ 01	•	•						•		
02			•	•	•	•	•			•
03	•	•						•		
04										
05		•	•	•						
EXT										

C4

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•		•					•	•	•
S-		•	•				•			•
PSD										
ACQ 01										
02							•		•	•
03										
04	•	•	•		•		•		•	(•)
05		•	•		•			•		•
EXT	•		•	(•)	•				•	

SPC SEGMENTS S #05

SEGMENTS

EYE

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2										
S-	•	•	•		•	•		•	•	
PSD						•		•	•	
ACQ 01										
02				•		•				•
03		•								
04										
05						•		•	•	•
EXT										

Cz

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•	•			•	•				
S-										
PSD	•							•		
ACQ 01		•	(•)	•	(•)		•		•	
02			•		•					
03										
04										
05	•		•	(•)						
EXT										

Oz

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2			•		•		•	•	•	
S-						•				•
PSD	•		(•)			•			•	•
ACQ 01	•					•		•	•	•
02										
03										
04										
05								•	•	
EXT				•	(•)	•	•		•	

C3

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•		•		•	•		•		
S-										
PSD	•	•			•				(•)	
ACQ 01			•							
02										
03										
04										
05	•	•		•					•	
EXT										

C4

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2			•		•	•				
S-										
PSD									•	
ACQ 01			•				•			•
02										
03					•					•
04										
05	•								•	
EXT										

SPC SEGMENTS S #06

SEGMENTS

EYE

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	(*)	•	•	•	•			•	•	
S-										
PSD										
ACQ 01	(*)			•	•		•		•	
02			•					•		
03									•	
04	•	•		•	•	•		•		
05	(*)	•					•	•		
EXT			•	•						

Cz

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•	•				•		•	•	
S-		•			•			•		
PSD	•	•	•	•	•	•				•
ACQ 01										
02		•		•						
03	•	•	•	•	•	•				•
04										
05	•									•
EXT		•	•	•				•	•	

Oz

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•	•	•						•	
S-										
PSD	•		•						•	
ACQ 01	•							•		
02										
03										
04	•	•			•			•		
05			•	•		•	•		•	
EXT							•			

C3

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•	•				•		•	•	
S-		•			•				(*)	
PSD		(*)		•						•
ACQ 01										
02										
03	•					•				•
04			•							
05						•	•	•		
EXT			•		•					

C4

	1	2	3	4	5	6	7	8	9	10
ACQ S1-S2	•	•							•	
S-	•	•	•	•		•	(*)			
PSD	•	•		•	•				•	
ACQ 01										
02										
03	•				•	•				
04										
05	•						•	•		•
EXT		•						•		

APPENDIX C

MEAN PERCENT POWER OBTAINED FOR EACH SUBJECT

Mean pecent power obtained for each subject in each frequency band of the four epochs depicted in Figure 2.

Letters A through O represent the following conditions:

	Stimulus	Condition
A	S-	Pseudoconditioning
B	S1	
		Acquisition
D	S1-S2	Block 1
E	S1-S2	Block 2
F	S1-S2	Block 3
G	S1-S2	Block 4
H	S1-S2	Block 5
I	S-	Block 1
J	S-	Block 2
K	S-	Block 3
L	S-	Block 4
M	S-	Block 5
N	S-	Extinction
O	S1	

MEAN PERCENT POWER S #01

CZ

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	52.4	18.5	14.6	14.5	51.5	20.3	13.7	14.5	46.3	15.0	23.2	15.5	38.6	20.4	28.8	12.2
B	29.5	16.4	35.7	18.4	50.9	18.3	16.3	14.5	59.1	12.6	17.7	10.6	41.7	21.7	24.9	11.7
D	54.1	12.9	16.8	16.1	43.0	21.7	21.8	13.5	37.1	20.9	28.9	13.1	41.1	16.7	23.1	19.1
E	37.5	16.2	33.7	12.7	47.7	17.6	18.8	15.9	45.5	20.6	18.1	15.8	43.6	24.7	19.3	12.3
F	30.8	19.9	35.3	14.0	47.1	16.0	20.4	16.5	43.5	17.3	22.9	16.4	45.9	20.0	23.5	10.6
G	36.9	17.3	32.4	13.3	46.4	18.7	21.5	13.4	34.7	18.4	30.4	16.5	45.2	19.6	22.5	12.7
H	39.6	16.6	27.8	16.0	43.5	16.5	19.0	21.0	43.9	22.4	20.4	13.3	50.1	17.3	17.6	15.0
I	42.4	15.5	28.9	13.2	30.0	15.4	35.4	19.2	39.1	20.0	28.7	12.2	47.0	17.5	24.1	11.4
J	46.6	16.6	23.5	13.3	35.3	16.2	31.4	17.1	37.7	13.4	32.6	16.3	42.0	15.1	32.1	10.8
K	39.1	14.9	30.7	15.2	43.8	17.7	15.8	22.7	43.2	18.7	22.8	15.2	45.7	16.6	26.2	11.6
L	36.0	18.4	34.0	11.5	37.7	14.6	28.5	19.2	39.5	13.1	32.9	14.5	35.6	19.0	32.1	13.2
M	41.9	18.1	26.8	13.2	42.7	17.2	26.6	13.5	34.3	16.4	37.1	12.2	32.9	14.1	37.3	15.7
N	40.2	18.3	30.5	11.0	29.5	19.3	31.8	19.3	37.2	18.5	31.7	12.6	35.7	22.7	28.7	12.9
O	28.0	19.7	41.4	10.9	53.1	20.0	15.9	11.1	33.8	23.7	27.6	14.9	34.7	31.3	19.1	14.9

OZ

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	37.1	12.8	39.3	10.9	22.9	10.4	57.7	9.1	27.5	11.0	47.5	14.0	24.7	15.4	43.3	16.6
B	21.2	12.5	58.3	8.0	30.6	9.0	47.7	12.7	32.5	11.2	44.4	11.9	28.4	13.6	47.4	10.6
D	23.8	16.8	47.5	12.0	34.1	9.2	43.6	13.1	30.3	10.5	47.3	12.0	22.1	8.9	54.8	14.2
E	25.3	12.2	51.2	11.3	34.9	8.1	43.0	14.0	33.0	14.6	37.9	14.5	29.1	16.2	37.1	17.6
F	14.6	13.9	63.1	8.4	33.0	13.0	40.9	13.1	29.0	10.0	41.5	19.6	35.3	10.7	39.6	14.5
G	21.1	9.7	61.0	8.2	29.8	10.8	49.6	9.8	24.3	8.8	54.7	12.1	28.0	11.2	45.0	15.9
H	20.3	12.2	57.2	10.3	31.6	8.5	43.7	16.2	29.8	10.9	48.1	11.2	35.5	15.0	35.8	13.7
I	30.3	11.9	45.1	12.8	24.7	10.9	50.6	13.8	25.6	15.6	42.9	15.9	30.9	12.1	46.3	10.7
J	27.0	10.9	52.1	10.0	17.7	11.0	59.4	11.9	18.2	11.0	57.6	13.3	21.3	13.4	55.5	9.8
K	23.3	709	59.0	9.8	28.9	7.1	49.6	14.4	19.4	12.0	57.5	11.1	22.4	12.2	57.1	8.3
L	24.9	12.2	53.2	9.7	23.5	10.9	55.5	10.2	17.5	10.6	61.2	10.7	20.0	10.3	61.4	8.3
M	36.0	9.0	46.0	8.9	22.5	12.3	53.2	12.1	15.1	9.5	67.0	8.4	18.1	14.1	58.6	9.2
N	20.4	12.8	56.9	9.9	21.9	13.2	54.1	10.8	23.1	11.6	55.7	9.6	19.9	12.2	59.2	8.7
O	9.5	13.0	72.7	4.8	30.9	10.8	48.9	9.4	28.6	10.6	50.4	10.4	20.6	13.0	53.5	12.9

C3

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	49.3	20.1	16.7	14.0	37.4	19.7	26.6	16.3	33.0	16.8	34.3	16.0	34.2	23.5	30.9	11.6
B	31.9	13.2	36.9	18.0	42.0	15.7	28.7	13.7	58.6	11.2	19.4	10.8	34.3	21.2	30.0	14.8
D	51.9	11.7	23.3	13.1	49.4	19.5	17.3	13.7	40.2	18.2	29.9	11.8	45.8	12.9	22.3	19.0
E	36.0	16.4	34.2	13.4	47.3	17.4	19.0	16.3	48.0	17.2	21.1	13.7	39.9	24.4	19.6	16.2
F	30.3	17.0	41.5	11.2	46.6	17.7	19.3	16.3	39.6	16.9	23.1	20.5	44.1	18.9	24.5	12.5
G	33.5	13.2	41.8	11.5	49.6	15.5	19.3	15.6	39.4	15.9	27.5	17.2	46.3	14.2	24.8	14.9
H	41.1	14.9	30.7	13.3	47.2	12.5	19.9	20.5	43.3	19.3	23.2	14.2	50.5	14.4	21.0	14.1
I	37.3	18.4	28.6	15.7	31.9	18.4	29.9	19.7	40.8	17.2	28.8	13.2	44.7	16.0	26.3	13.0
J	39.7	16.4	29.9	14.0	40.9	16.5	24.4	18.2	32.2	17.8	38.6	11.4	38.8	15.1	36.2	9.9
K	38.5	15.6	32.4	13.4	32.7	16.4	29.4	21.4	40.3	15.9	29.8	14.0	41.9	16.3	29.0	12.8
L	43.6	13.8	33.4	9.2	38.0	13.8	29.9	18.3	32.7	12.9	43.6	10.8	35.4	14.9	37.8	11.9
M	44.0	18.1	26.0	11.9	41.0	13.8	32.4	12.7	36.1	22.0	28.8	13.2	34.5	13.7	35.3	16.5
N	41.1	18.5	29.3	11.1	31.0	23.3	30.5	15.2	33.3	19.3	33.1	14.3	28.4	19.3	39.5	12.9
O	24.7	18.0	46.5	10.8	53.4	13.7	19.1	13.8	38.1	16.0	29.4	16.5	34.8	25.1	25.3	14.8

C4

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	44.1	17.7	26.4	11.8	43.7	18.4	23.6	14.3	39.7	13.5	30.0	16.7	36.2	17.9	34.3	11.6
B	25.4	16.7	37.8	20.0	35.4	19.0	29.8	15.8	48.8	8.1	32.7	10.5	39.5	18.7	28.8	13.0
D	48.3	12.3	23.1	16.2	44.4	16.4	23.1	16.0	38.0	17.4	30.7	13.9	31.8	17.4	29.6	21.2
E	33.4	13.6	41.1	11.8	47.3	15.7	19.3	17.7	46.7	14.2	22.1	17.1	43.2	16.6	24.0	16.2
F	32.0	17.7	35.1	15.1	45.3	12.5	24.5	17.8	39.9	14.0	25.2	20.9	43.7	20.0	21.9	14.4
G	31.7	13.3	42.2	12.8	48.3	17.1	20.6	13.9	40.4	18.3	24.8	16.5	47.3	19.3	20.5	13.0
H	33.5	14.9	37.1	14.5	43.1	15.1	22.2	19.6	44.9	19.7	20.3	15.1	48.4	14.1	21.8	15.7
I	35.7	15.7	34.6	14.0	31.4	15.1	34.6	18.9	35.9	16.7	31.2	16.1	42.4	18.2	22.4	17.0
J	46.3	11.2	28.7	13.8	37.5	11.5	37.1	13.9	35.6	13.5	36.1	14.8	38.5	15.1	32.1	14.3
K	33.4	10.4	40.4	15.8	36.8	11.8	32.7	18.7	27.9	16.8	39.6	15.7	41.2	12.4	32.6	13.8
L	28.6	16.7	40.6	14.2	30.4	14.0	39.8	15.8	34.3	10.4	42.2	13.1	37.3	15.6	34.4	12.6
M	37.0	12.2	36.0	14.8	37.8	13.4	37.0	11.8	30.0	12.1	44.2	13.7	27.8	15.4	40.8	16.1
N	35.2	18.7	28.8	17.3	38.8	19.0	25.7	16.5	45.5	15.6	26.1	12.8	36.1	18.4	33.2	12.3
O	36.3	16.0	26.9	20.8	44.5	18.3	19.7	17.6	37.8	19.7	21.1	21.4	36.8	20.6	21.1	19.5

T3

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	46.4	20.1	15.4	18.1	30.5	16.9	25.1	27.5	29.9	16.4	32.9	20.8	37.9	19.0	27.9	15.2
B	31.9	9.4	35.2	23.5	32.7	15.2	29.6	22.4	60.2	7.3	18.2	14.3	28.8	22.2	26.9	22.0
D	37.6	16.8	28.4	17.3	36.8	18.3	20.9	24.0	32.1	15.8	30.1	22.1	33.6	14.9	26.7	24.9
E	36.1	13.8	30.9	19.1	36.8	13.6	25.3	24.2	37.8	16.5	22.9	22.9	26.8	21.9	23.3	28.1
F	32.3	15.4	37.7	14.7	38.6	14.7	22.3	24.4	38.5	16.0	22.7	22.9	35.4	17.2	25.9	21.5
G	32.6	12.1	40.2	15.2	37.8	15.9	24.1	22.2	27.7	15.6	29.1	27.6	31.7	17.4	27.1	23.8
H	35.0	15.6	31.6	17.8	32.5	10.6	32.3	24.6	33.2	12.6	33.3	20.9	34.4	18.3	27.8	19.6
I	30.9	19.8	29.5	19.7	26.2	16.5	30.7	26.6	32.0	15.5	29.3	23.2	42.0	12.7	26.2	19.2
J	31.7	13.9	35.5	18.9	35.5	14.4	26.5	23.6	28.6	18.0	34.5	18.9	34.4	13.8	36.3	15.5
K	33.2	18.2	34.4	14.1	31.6	14.5	28.2	25.6	31.5	15.7	33.9	18.9	37.8	14.0	29.9	18.3
L	36.9	15.6	33.4	14.1	33.2	12.7	31.5	22.6	33.8	12.6	37.8	15.8	30.9	14.9	38.3	15.9
M	42.5	21.3	23.1	13.2	29.4	12.6	36.6	21.4	27.6	19.7	32.2	20.5	25.3	16.5	41.5	16.7
N	35.4	17.2	31.6	15.8	28.6	23.1	29.3	19.0	29.3	16.6	37.4	16.6	23.7	14.7	44.9	16.6
O	26.4	15.1	40.9	17.5	38.9	16.2	24.0	20.9	32.8	16.4	30.7	20.2	34.2	18.8	28.3	18.7

T4

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	36.5	19.0	27.0	17.4	42.8	14.1	23.7	19.5	34.1	14.4	27.7	23.8	37.7	20.2	28.0	14.1
B	33.9	12.3	31.9	21.9	29.2	18.7	36.5	15.6	41.6	11.1	35.7	11.5	32.0	18.4	28.3	21.4
D	38.0	16.5	23.8	21.7	39.4	18.0	24.6	21.0	36.6	18.4	25.0	20.0	32.6	19.7	25.7	21.9
E	34.5	12.5	35.1	17.9	41.9	16.3	24.4	17.4	44.2	15.0	22.6	18.1	38.1	16.8	26.1	18.9
F	30.1	21.1	33.3	15.6	40.3	14.0	25.2	20.5	40.4	13.8	22.1	23.7	40.4	23.6	18.2	17.8
G	32.2	15.7	36.7	15.4	46.3	15.5	20.7	17.5	40.6	15.7	23.4	20.3	43.6	18.1	19.1	19.2
H	33.5	14.7	36.2	15.6	37.2	14.0	26.1	22.7	38.1	17.8	25.5	18.5	43.3	16.8	20.5	19.5
I	38.5	15.8	29.3	16.4	30.0	11.3	33.8	24.9	37.1	16.5	28.5	17.9	46.4	16.7	17.5	19.4
J	40.8	12.5	28.7	18.0	31.1	15.4	36.9	16.6	40.0	11.4	29.2	19.6	35.2	14.1	34.7	16.0
K	31.7	10.0	36.9	21.3	32.9	11.6	35.3	20.1	26.6	18.2	36.3	18.8	35.2	14.0	34.7	16.1
L	34.6	12.6	33.6	19.1	28.3	15.9	34.8	21.1	37.2	11.4	34.1	17.4	34.5	17.0	35.2	13.3
M	35.0	15.3	31.6	18.1	30.8	14.6	39.1	15.6	33.9	13.2	37.0	16.0	27.4	14.7	39.0	18.8
N	35.6	18.4	34.1	11.8	33.1	17.7	30.1	19.2	40.6	18.0	30.5	10.9	29.2	19.4	35.5	16.0
O	26.1	18.0	37.3	18.6	44.0	17.4	25.5	13.1	37.4	21.5	25.2	16.0	45.3	20.1	21.5	13.1

MEAN PERCENT POWER S #02

CZ

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	35.7	32.4	18.8	13.2	55.9	24.5	9.1	10.8	62.0	15.5	11.5	11.0	46.1	23.7	13.4	16.8
B	36.7	31.1	18.7	11.5	48.7	25.1	14.0	12.2	50.1	22.1	13.2	14.5	66.2	15.9	9.1	8.7
D	45.6	26.7	14.2	13.5	44.3	31.3	14.5	9.9	46.0	26.5	17.0	10.5	56.2	21.1	12.7	9.9
E	46.5	27.9	14.8	10.8	51.5	27.6	13.5	7.4	50.2	27.7	13.7	8.4	54.9	22.1	15.2	7.8
F	47.0	29.5	14.7	8.7	55.4	26.1	10.8	7.7	51.9	24.8	14.3	9.0	48.9	26.6	14.0	10.5
G	52.8	24.1	12.3	10.8	44.7	28.6	15.7	10.9	43.3	28.3	18.2	10.2	47.4	26.0	16.1	10.5
H	57.0	16.4	14.8	11.9	43.3	28.6	15.9	12.2	52.0	21.4	12.0	14.6	44.8	31.0	12.1	12.1
I	48.3	20.9	18.3	12.5	49.1	25.1	15.7	10.1	54.3	20.0	14.7	11.0	49.9	22.3	15.2	12.6
J	52.8	21.0	17.7	8.5	53.5	27.4	10.9	8.3	47.6	26.1	17.1	9.1	48.5	32.2	10.7	8.6
K	46.2	27.0	16.5	10.2	57.5	20.8	10.8	11.0	51.7	24.1	14.3	9.9	49.6	21.5	16.7	12.3
L	45.6	25.9	16.2	12.2	54.7	19.6	13.8	11.8	47.3	27.8	14.1	10.9	50.1	18.9	16.7	14.3
M	40.9	23.9	14.3	20.9	52.5	16.7	16.8	14.0	47.4	20.9	15.4	16.3	43.3	25.9	15.9	14.9
N	51.5	22.9	15.2	10.3	49.8	22.5	12.9	14.8	42.9	23.1	20.3	13.7	46.1	18.3	19.3	16.3
O	44.4	19.3	23.6	12.7	51.6	19.6	15.1	13.7	46.3	27.5	16.4	9.8	46.6	24.5	16.4	12.5

OZ

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	69.5	6.6	12.4	11.6	53.8	21.0	13.7	11.5	44.9	14.9	18.7	21.5	51.6	14.6	14.4	19.4
B	43.8	20.7	19.2	16.3	68.4	11.2	9.4	11.0	50.0	9.1	25.1	15.8	53.9	12.9	19.6	13.6
D	49.7	12.7	20.9	16.7	53.0	17.2	15.9	14.0	62.6	10.4	14.7	12.4	65.3	11.3	11.2	12.2
E	55.8	13.3	18.1	12.9	57.1	16.6	12.2	14.1	60.0	12.4	15.4	12.2	54.0	17.1	14.8	14.2
F	59.1	12.1	17.4	11.4	63.8	13.1	12.8	10.3	57.1	18.6	11.8	12.4	61.1	15.8	11.9	11.3
G	49.1	15.6	20.7	14.5	56.1	12.8	17.1	14.0	50.4	14.0	22.0	13.7	43.4	18.6	18.9	19.2
H	40.0	13.3	24.4	22.3	41.8	18.6	20.6	19.1	46.1	14.7	21.0	18.2	38.9	17.7	18.2	25.2
I	56.1	12.5	18.5	12.9	64.5	10.6	14.0	11.0	63.0	13.6	12.6	10.7	49.2	14.4	22.4	14.1
J	49.6	14.8	19.3	16.4	55.8	17.1	14.2	12.8	56.4	13.9	15.3	14.4	58.5	14.9	13.7	13.0
K	53.9	9.4	18.9	17.8	57.0	14.4	14.9	13.6	51.8	21.4	15.3	11.6	57.4	15.6	12.8	14.2
L	47.1	18.0	17.1	17.8	55.1	14.1	15.3	15.5	47.6	16.7	17.7	18.0	54.1	11.4	16.9	17.6
M	41.2	13.4	22.8	22.7	49.7	14.5	18.1	17.7	47.5	12.9	20.9	18.7	41.2	14.1	24.5	19.9
N	55.9	11.1	16.2	16.8	49.7	13.8	16.5	20.0	32.0	17.4	29.2	21.5	48.7	13.0	21.7	16.5
O	39.6	15.1	26.0	19.4	52.9	10.5	16.0	20.5	43.2	16.9	23.1	16.9	47.3	14.2	21.8	16.7

C3

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	45.5	24.1	16.3	14.0	56.9	21.7	11.4	9.9	62.3	14.3	10.0	13.4	50.6	21.6	10.6	17.3
B	42.1	24.5	19.9	13.4	48.5	23.7	15.9	11.8	48.4	17.5	17.6	16.5	66.4	16.6	8.3	8.8
D	50.1	23.2	12.6	14.1	47.0	26.3	15.0	11.6	45.3	25.2	18.8	10.7	55.5	21.0	12.3	11.2
E	50.3	25.4	13.2	11.1	55.8	21.6	14.2	8.4	48.2	28.2	13.5	10.0	55.5	21.1	14.7	8.7
F	48.3	22.2	17.8	11.6	59.8	21.0	10.0	9.2	53.2	22.3	14.9	9.5	53.4	25.1	10.8	10.6
G	53.0	20.5	15.0	11.4	48.2	23.7	15.6	12.5	43.1	24.8	18.4	13.7	47.7	24.0	15.8	12.5
H	58.5	13.6	12.2	15.7	42.3	25.7	14.0	15.0	50.7	21.5	11.3	16.5	47.9	26.0	10.9	15.3
I	49.4	20.2	17.8	12.6	52.7	21.5	15.0	10.8	54.5	18.4	16.3	10.8	50.8	21.2	15.3	12.6
J	60.0	15.4	15.0	9.6	54.0	23.6	13.1	6.3	50.4	23.3	16.3	10.1	56.1	22.7	11.7	9.5
K	44.7	25.1	18.3	11.7	52.3	18.6	16.9	12.3	49.2	24.7	15.0	11.1	54.9	18.6	15.7	10.7
L	52.2	18.1	17.2	12.6	51.9	18.6	16.1	13.4	44.8	25.6	15.9	13.8	44.7	20.9	20.4	14.0
M	38.9	21.6	17.3	22.2	51.1	15.1	17.9	15.8	48.0	17.5	16.2	18.3	46.6	19.2	16.4	17.8
N	54.6	18.2	13.6	13.6	50.4	19.8	12.8	17.0	45.7	19.2	19.3	15.8	44.5	17.2	19.1	19.1
O	42.2	16.2	25.8	15.7	54.5	15.8	15.0	14.7	50.5	21.9	16.4	11.2	50.0	20.6	15.4	14.4

C4

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	35.2	27.9	18.0	18.9	53.9	17.7	12.7	15.7	54.1	12.7	12.8	20.4	50.6	17.4	13.4	18.6
B	41.2	22.6	18.7	17.5	54.2	16.1	12.7	17.0	51.0	16.0	11.7	21.3	70.3	11.7	7.2	10.8
D	47.1	18.4	15.2	19.2	40.6	27.3	13.4	18.7	46.2	18.5	16.7	18.6	53.3	18.1	11.7	16.8
E	43.7	25.0	14.9	16.3	55.5	22.6	12.5	9.4	48.9	25.4	13.6	12.2	57.4	16.4	14.3	12.0
F	47.5	22.6	16.1	13.8	55.1	20.0	11.5	13.5	49.4	23.7	13.4	13.5	49.5	20.9	14.7	14.9
G	52.4	17.7	13.3	16.6	50.1	21.6	15.2	13.1	44.4	22.1	20.6	12.9	50.4	19.8	16.7	13.1
H	53.2	14.5	12.5	19.9	41.3	21.7	18.1	18.9	45.0	19.9	14.0	21.1	43.2	21.6	15.3	19.9
I	44.9	18.5	16.9	19.8	48.2	18.9	15.8	17.2	51.8	16.5	14.8	17.0	47.2	16.5	17.4	18.9
J	48.5	19.4	20.0	12.2	55.8	19.9	13.2	11.2	42.5	23.4	18.5	15.6	48.0	28.7	10.6	12.8
K	43.5	22.5	15.6	18.4	58.5	18.1	9.6	13.7	55.5	15.7	15.8	13.1	51.3	16.5	17.5	14.8
L	48.5	19.4	20.0	12.2	55.8	19.9	13.2	11.2	42.5	23.4	18.5	15.6	48.0	28.7	10.6	12.8
M	39.3	17.0	13.5	30.1	45.5	14.4	19.7	20.4	40.5	19.6	15.8	24.1	43.9	19.5	14.2	22.5
N	49.1	19.4	17.0	14.4	42.7	18.5	14.9	24.0	37.7	18.8	19.1	24.3	46.8	13.2	18.2	21.7
O	42.0	15.8	21.2	21.0	49.5	16.1	14.1	20.3	48.6	22.1	15.3	13.9	46.9	16.7	18.1	18.2

T3

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	46.6	16.5	15.2	21.8	47.5	20.4	15.0	17.1	42.5	16.6	16.5	24.6	43.9	18.8	11.3	26.1
B	33.3	26.9	20.6	19.2	41.8	19.6	21.0	17.5	38.6	17.1	19.2	25.0	45.7	18.2	15.4	20.6
D	49.3	17.4	14.5	18.8	41.4	21.8	17.6	19.1	40.0	19.5	20.9	19.6	45.1	19.2	16.4	19.3
E	46.2	17.5	15.8	20.5	47.4	16.1	16.2	20.3	47.0	20.6	12.6	19.7	51.0	17.1	15.4	16.5
F	41.8	20.4	17.7	20.1	49.9	14.2	16.4	19.4	45.0	18.5	16.3	20.2	42.1	21.8	17.3	18.7
G	48.8	17.3	15.2	18.8	38.9	20.0	19.2	22.0	35.5	21.5	18.6	24.4	42.4	18.1	17.7	21.8
H	42.6	12.4	15.5	29.6	33.2	17.7	16.5	32.6	37.1	20.6	14.1	28.2	41.1	17.8	13.8	27.3
I	44.3	18.3	17.9	19.5	39.1	22.8	19.0	19.1	45.6	21.3	16.3	16.8	42.9	19.8	16.7	20.6
J	51.1	12.9	17.9	18.0	52.2	13.0	13.8	21.	38.5	19.7	17.9	23.9	46.3	15.7	17.1	21.[illegible]
K	42.3	20.0	16.7	21.0	50.6	16.8	16.0	16.6	42.3	21.0	18.6	18.1	47.8	18.1	17.0	17.1
L	48.1	16.2	15.9	19.8	35.6	19.6	21.4	23.4	33.4	20.5	22.2	24.0	34.5	20.5	19.4	25.6
M	38.3	13.9	15.7	32.1	38.0	15.4	21.5	25.2	39.6	14.9	16.2	29.3	42.4	13.6	16.5	27.5
N	37.6	20.5	16.1	25.7	40.7	20.3	12.8	26.2	36.1	15.7	21.8	26.5	37.0	17.0	19.3	26.7
O	34.7	12.6	27.2	25.5	44.1	11.6	19.6	24.8	47.6	17.2	14.4	20.7	36.6	14.9	18.7	29.8

T4

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	34.0	21.3	14.6	30.0	35.8	12.6	13.1	38.6	41.3	12.6	12.7	33.3	29.9	14.3	16.9	39.0
B	32.1	17.6	19.3	31.0	39.7	8.5	17.8	34.0	39.1	15.8	11.7	33.5	47.6	13.6	8.7	30.0
D	31.2	13.5	17.2	38.1	35.5	16.9	16.9	30.6	36.0	16.4	15.9	31.6	42.9	14.0	13.9	29.1
E	35.8	16.6	15.4	32.1	47.0	16.1	13.4	23.5	40.1	17.2	13.7	28.9	40.0	14.5	17.4	28.0
F	35.3	19.0	14.3	31.4	43.3	16.8	12.9	27.0	36.3	17.0	16.2	30.4	36.1	17.3	17.3	29.3
G	38.8	13.0	22.2	26.0	45.6	12.5	16.4	25.5	36.7	17.4	19.4	26.4	42.3	11.8	17.6	28.3
H	34.0	12.4	15.7	38.0	33.8	13.3	19.3	33.6	35.5	13.2	18.3	33.0	38.2	10.9	12.7	38.1
I	29.9	16.2	22.7	31.2	33.2	14.4	17.0	35.4	33.3	16.4	17.3	33.0	35.8	14.2	17.1	32.9
J	36.7	15.3	21.0	27.0	39.0	15.9	15.2	29.9	29.1	19.4	18.9	32.6	32.6	15.8	21.2	30.4
K	37.9	14.3	14.1	33.6	38.9	19.8	17.0	24.3	38.0	15.1	18.8	28.2	42.7	13.3	16.5	27.5
L	39.4	17.6	13.7	29.4	34.5	18.3	19.6	27.6	34.6	19.5	17.7	28.3	39.4	11.1	17.7	31.8
M	33.8	15.2	18.3	32.6	34.0	11.7	24.2	30.1	32.1	16.6	17.4	33.9	31.3	15.1	18.6	35.0
N	31.8	14.2	22.6	31.4	30.9	15.5	20.4	33.3	25.6	17.7	22.5	34.3	33.0	11.5	25.3	30.2
O	29.9	12.8	26.9	30.3	33.2	18.3	17.5	30.9	36.0	17.9	19.4	26.6	42.7	11.0	13.9	32.5

MEAN PERCENT POWER S #03

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
CZ																
A	58.0	20.5	12.6	8.9	52.1	21.3	17.6	9.0	51.3	22.8	15.8	10.2	56.0	21.3	14.0	8.7
B	58.4	13.2	17.6	10.9	62.0	16.0	13.7	8.3	56.0	24.4	12.7	6.9	48.3	21.8	21.7	8.3
D	56.6	18.2	14.1	11.2	46.4	24.3	18.5	10.8	45.6	24.2	20.1	10.1	43.8	25.9	19.0	11.3
E	55.2	17.5	18.6	8.7	53.8	15.9	19.9	10.4	45.8	20.1	24.3	9.8	52.3	16.7	22.0	9.1
F	56.3	15.3	18.1	10.3	38.4	20.5	29.3	11.8	47.2	17.7	21.2	13.9	54.0	12.2	25.3	8.5
G	36.6	20.9	31.8	10.8	48.5	19.8	22.7	9.1	54.6	16.2	21.8	7.2	47.5	20.4	23.3	8.7
H	53.7	10.2	27.2	8.9	52.5	8.9	29.2	9.5	43.7	27.7	17.6	11.0	54.2	14.0	20.4	11.5
I	48.7	23.7	19.5	8.2	47.2	16.5	26.9	9.6	49.9	17.8	24.1	8.1	54.2	19.3	19.1	7.4
J	44.8	18.7	26.2	10.3	59.3	16.5	16.7	7.4	44.9	22.3	20.9	11.9	55.0	18.2	18.3	8.5
K	61.6	19.1	10.0	9.3	58.9	20.2	14.5	6.4	54.7	19.6	17.1	8.7	51.1	16.9	21.7	10.3
L	48.7	13.6	27.1	10.7	48.6	19.8	21.3	10.3	55.6	19.4	18.0	6.9	44.2	16.4	26.1	13.3
M	53.0	13.1	22.9	11.1	51.3	14.2	27.3	7.2	49.7	22.5	20.2	7.7	49.0	18.5	23.0	9.5
N	59.6	18.2	16.1	6.1	52.6	25.3	13.9	8.2	53.3	17.8	19.0	10.0	45.9	25.6	20.6	7.9
O	50.2	19.7	19.4	10.7	41.7	26.8	21.2	10.3	59.7	19.6	13.2	7.4	51.6	26.2	12.2	8.1
OZ																
A	62.5	5.0	21.1	11.4	45.3	9.1	34.9	10.8	55.3	11.8	20.9	12.0	60.6	10.2	17.2	12.0
B	60.4	6.9	25.0	7.8	44.6	9.3	34.8	11.3	58.8	7.8	25.8	7.6	51.1	16.5	23.2	9.2
D	64.1	7.3	19.0	9.5	51.1	14.6	23.1	11.2	44.2	10.0	30.6	15.2	59.5	7.7	23.9	8.8
E	35.8	8.8	16.2	9.3	54.0	7.4	27.3	11.4	55.0	8.7	24.3	12.0	52.5	12.0	24.3	11.2
F	61.8	7.8	21.6	8.9	49.5	8.2	30.2	12.1	58.0	9.0	20.0	12.9	51.4	10.9	28.0	9.8
G	57.0	11.2	22.2	9.5	37.8	7.6	42.9	11.7	61.4	8.9	20.7	9.0	58.3	9.5	20.9	11.2
H	40.7	5.6	41.4	12.3	46.3	9.0	34.3	10.3	38.1	11.1	45.9	5.0	60.9	7.5	24.2	7.5
I	49.8	10.7	27.4	12.1	42.6	5.6	40.4	11.4	52.7	9.8	27.4	10.1	47.5	11.7	30.1	10.6
J	54.3	8.2	26.5	11.0	66.7	5.8	17.1	10.5	50.7	8.3	29.8	11.2	58.0	10.0	21.0	11.1
K	56.4	9.5	21.5	12.7	60.0	9.1	20.2	11.1	57.0	8.0	23.4	11.7	61.6	8.8	20.5	9.1
L	40.7	11.8	32.9	14.6	45.2	10.8	33.7	10.2	46.1	11.2	34.3	11.5	42.2	8.6	37.7	11.6
M	54.9	7.1	26.3	11.8	52.2	7.2	26.4	14.2	56.3	9.7	25.8	8.3	40.0	13.1	34.8	12.1
N	47.8	15.1	29.0	8.1	45.8	11.6	32.3	10.3	47.8	12.4	27.8	12.0	52.2	10.4	27.3	10.2
O	42.6	13.4	29.4	14.6	54.7	9.5	24.6	11.1	58.7	8.5	20.7	12.0	54.4	11.9	22.5	11.2
C3																
A	58.4	17.2	14.9	9.5	58.7	15.9	15.2	10.1	48.7	21.0	17.3	13.0	57.2	17.8	14.1	10.9
B	58.0	12.1	16.6	13.4	59.3	15.3	13.5	11.9	62.0	17.8	11.3	9.0	52.4	21.3	15.5	10.9
D	48.9	21.6	15.0	14.6	61.9	16.3	11.7	10.0	56.7	19.1	14.4	9.8	40.0	26.9	20.9	12.2
E	58.8	16.0	14.2	11.0	56.7	10.0	20.4	12.9	55.8	16.3	18.4	9.5	54.4	17.9	17.7	9.9
F	56.5	16.9	16.4	10.2	38.5	17.4	30.0	14.1	55.5	12.6	18.8	13.1	46.2	17.0	25.0	11.9
G	38.3	21.0	26.8	14.0	51.8	19.2	18.7	10.3	63.5	12.2	15.5	8.8	55.4	19.0	15.9	9.7
H	67.1	5.4	17.1	10.4	55.6	7.5	26.5	10.3	47.0	24.4	17.1	11.5	57.3	13.6	16.8	12.3
I	51.4	21.2	16.7	10.7	48.7	15.2	25.4	10.7	53.7	14.9	20.9	10.5	54.4	17.5	18.1	10.0
J	53.1	16.5	18.9	11.4	59.3	14.6	16.5	9.6	38.4	25.0	22.3	14.3	62.5	15.0	12.7	9.8
K	58.7	17.6	13.4	10.3	65.7	14.1	12.5	7.7	59.1	14.3	16.8	9.8	56.9	12.7	18.2	12.3
L	51.5	14.9	23.0	10.6	53.3	17.7	17.8	11.2	59.3	15.6	17.3	7.8	50.6	14.8	21.8	12.9
M	58.8	12.0	15.6	13.5	59.9	14.9	17.6	7.7	50.7	21.7	15.8	11.8	54.0	15.7	18.7	11.7
N	61.5	18.1	12.3	8.1	55.7	20.8	14.3	9.3	60.3	11.8	17.0	10.9	53.1	20.5	17.7	8.7
O	56.6	17.5	14.6	11.3	46.6	22.8	18.6	12.1	64.0	16.5	11.1	8.5	51.2	24.2	13.0	11.6
C4																
A	65.9	11.6	13.1	9.4	55.3	16.7	19.1	8.9	49.2	21.1	17.8	11.9	49.6	25.7	12.4	12.3
B	60.4	13.0	16.3	10.3	65.0	13.9	12.0	9.1	57.4	18.9	15.5	8.2	56.0	21.0	15.2	7.6
D	49.0	22.2	18.4	10.4	47.7	24.1	17.4	10.8	53.0	19.6	16.7	10.7	41.6	20.4	24.5	13.6
E	57.5	13.3	20.7	8.6	58.2	13.3	19.4	9.1	47.4	21.0	21.5	9.8	57.0	10.6	22.7	9.8
F	60.7	12.5	17.2	9.6	37.2	21.0	30.1	11.7	53.2	13.7	20.7	12.4	49.4	15.5	27.2	7.9
G	40.5	16.8	31.4	11.3	44.8	14.1	30.2	10.9	45.0	24.2	21.8	9.0	57.5	14.8	18.1	9.6
H	51.6	17.0	21.2	10.1	42.3	12.8	31.2	13.6	36.0	34.3	17.4	12.3	46.3	12.6	22.3	18.9
I	55.0	18.3	17.9	8.8	50.5	15.3	25.1	9.1	53.9	15.6	22.0	8.4	55.0	17.5	18.6	8.9
J	41.2	18.8	26.8	13.0	64.3	9.4	18.2	8.1	47.3	15.2	24.9	12.7	53.5	17.0	18.3	11.2
K	56.4	23.0	10.9	9.8	61.0	17.6	13.9	7.6	61.2	13.4	17.1	8.3	50.4	15.9	21.6	12.1
L	52.9	10.1	25.0	12.1	54.0	16.7	17.5	11.9	58.5	15.2	18.7	7.7	48.8	13.8	26.6	10.8
M	51.5	13.9	22.2	12.3	43.4	20.0	27.3	9.3	53.6	16.6	20.9	8.9	48.6	18.5	21.5	11.3
N	63.6	13.3	15.4	7.8	58.6	19.7	14.5	7.2	48.6	21.1	20.4	10.0	42.5	25.8	22.8	8.9
O	50.2	21.4	17.5	10.9	48.8	23.1	17.2	11.0	61.0	17.0	14.5	7.5	55.1	20.0	16.0	8.9
T3																
A	43.9	13.3	13.8	29.0	47.5	9.9	12.6	30.0	39.1	15.7	15.6	29.7	44.8	14.6	11.4	29.3
B	35.5	15.3	14.1	35.1	43.0	12.2	12.1	32.8	38.6	12.9	11.6	37.0	40.2	18.1	12.4	29.4
D	30.8	19.8	18.5	30.9	58.1	11.9	9.6	20.5	38.5	10.0	18.8	32.7	34.9	21.0	13.1	31.0
E	40.3	15.2	11.7	32.8	41.5	11.4	15.3	31.8	47.3	12.4	14.8	25.6	46.9	16.0	14.3	22.7
F	37.1	15.1	20.8	27.0	35.4	15.1	23.5	26.0	47.0	15.3	15.5	22.1	39.7	16.7	17.9	25.7
G	34.5	12.7	21.5	31.2	39.5	19.2	16.9	24.3	42.3	9.5	13.6	34.6	46.7	17.9	11.1	24.2
H	60.9	4.0	8.4	26.7	41.5	7.8	20.8	29.8	36.7	17.7	20.0	25.6	39.1	14.3	14.2	32.4
I	40.9	14.6	17.7	26.8	42.8	15.6	19.5	22.1	48.6	13.1	15.7	22.6	40.1	13.9	17.8	28.2
J	45.0	14.9	18.2	21.8	49.0	12.2	12.9	26.0	36.0	18.2	18.2	27.7	44.6	17.6	11.9	25.9
K	41.8	18.5	14.2	25.5	50.4	13.6	11.7	24.4	44.0	14.8	13.0	28.2	38.7	10.3	18.9	32.2
L	36.8	12.2	20.3	30.7	43.8	9.4	15.5	31.3	42.4	12.4	16.4	28.8	31.1	11.8	21.2	35.9
M	47.0	9.5	12.3	31.2	52.1	8.5	14.2	25.3	30.7	15.0	17.6	36.8	35.0	8.3	18.9	37.9
N	34.6	13.3	17.2	34.8	41.3	13.4	10.3	35.0	36.8	11.2	14.0	38.1	48.2	10.8	12.0	29.1
O	39.3	10.4	15.4	34.9	34.0	15.2	12.2	38.6	35.5	13.1	10.2	41.2	38.0	13.3	12.0	36.7
T4																
A	42.1	12.6	14.5	31.0	46.9	12.8	17.4	22.9	45.0	10.5	15.9	28.6	32.0	23.4	17.1	27.6
B	51.0	8.3	15.2	25.6	40.2	13.9	13.0	32.9	35.1	14.8	18.0	31.9	51.4	14.4	12.1	22.1
D	44.4	17.0	23.4	15.2	50.6	21.8	15.8	11.8	50.6	14.5	17.6	17.2	32.4	19.6	24.4	23.6
E	48.4	12.0	17.0	22.7	44.6	12.5	22.0	20.9	40.7	20.4	20.0	18.8	49.2	7.4	19.8	23.6
F	54.2	12.5	20.0	13.3	36.0	21.7	27.9	14.4	49.7	12.7	25.2	12.5	45.1	19.3	24.4	11.3
G	34.2	15.9	26.9	23.0	45.9	10.2	23.8	20.1	32.2	24.3	19.5	24.0	56.4	10.7	13.2	19.7
H	37.5	17.0	25.8	19.6	35.8	11.5	29.3	23.5	29.7	28.5	15.0	26.7	36.7	14.0	23.0	26.1
I	43.6	21.9	18.1	16.4	44.4	16.8	24.5	14.3	44.5	13.5	23.6	18.4	41.2	19.5	23.5	15.8
J	37.5	18.4	24.3	19.8	55.2	11.4	21.1	12.3	43.6	13.0	22.0	21.4	50.8	18.4	14.1	16.6
K	52.9	18.7	13.5	14.9	58.1	11.7	18.4	11.8	52.1	18.1	13.3	16.5	47.9	11.8	20.2	20.2
L	39.4	11.4	24.5	24.8	35.8	15.0	20.6	28.6	47.5	14.0	17.3	21.2	41.3	11.1	24.6	23.1
M	44.5	20.6	18.4	16.5	40.0	21.7	21.1	17.2	44.6	15.9	21.4	18.2	44.2	14.6	19.0	22.3
N	38.6	13.6	23.1	24.7	54.1	12.5	13.4	20.0	26.1	18.1	21.1	34.7	45.7	13.0	19.7	21.6
O	30.7	16.4	14.9	38.0	30.3	13.5	21.3	34.9	40.9	15.1	13.6	30.4	33.4	12.0	16.6	38.0

MEAN PERCENT POWER S #04

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
CZ																
A	58.2	13.0	16.2	12.6	52.4	18.7	17.9	11.0	47.1	20.3	17.1	15.5	55.1	10.5	21.8	12.6
B	48.9	15.3	19.2	16.7	50.2	18.3	16.7	14.7	50.4	15.6	19.6	14.4	41.8	16.5	25.0	16.8
D	43.3	20.0	22.5	14.1	48.7	16.8	17.5	17.0	42.4	19.2	21.5	16.9	46.8	14.2	24.4	14.7
E	47.4	17.4	24.2	11.0	48.0	15.1	24.0	13.0	46.6	15.0	26.8	11.4	41.8	15.8	30.9	11.6
F	38.2	17.2	31.9	12.7	45.4	18.5	22.0	14.1	38.7	17.9	27.8	15.6	44.6	19.9	19.2	16.3
G	38.7	19.5	27.3	14.4	36.1	17.9	28.8	17.1	28.5	23.7	33.4	14.4	49.5	19.4	18.2	12.9
H	34.8	17.8	32.5	14.9	36.0	20.7	22.6	20.7	46.1	17.3	23.6	13.0	42.9	21.1	22.3	13.6
I	48.8	11.6	24.9	14.7	48.9	13.5	21.1	16.5	46.9	17.8	25.2	10.2	51.4	12.6	23.9	12.0
J	50.2	13.8	22.7	13.3	45.0	18.1	23.2	13.6	41.8	12.4	31.4	14.5	42.3	14.0	29.1	14.6
K	47.6	15.7	25.6	11.1	47.8	18.6	20.0	13.6	39.8	15.2	28.1	16.9	42.8	14.8	28.0	14.4
L	50.9	15.7	16.4	17.0	47.7	13.0	24.2	15.0	45.7	13.4	26.8	14.0	50.4	16.4	23.0	10.3
M	45.4	17.5	24.5	12.6	48.3	15.4	22.3	13.9	50.3	13.2	20.1	16.3	34.4	13.5	36.6	15.6
N	47.9	13.5	19.2	19.4	35.2	13.8	31.6	19.4	31.8	12.5	41.7	14.0	38.6	15.3	25.8	20.3
O	29.4	15.3	39.5	15.7	42.1	15.2	26.9	15.8	37.4	19.1	27.9	15.6	44.5	18.4	22.1	15.0
OZ																
A	69.6	11.0	11.3	8.2	56.7	8.1	22.1	13.0	36.8	23.5	17.6	22.1	56.7	12.4	20.2	10.7
B	52.6	10.2	18.3	18.9	40.3	24.6	20.3	14.8	51.5	9.9	21.3	17.3	47.9	9.0	27.5	15.6
D	49.5	14.2	25.0	11.4	40.0	13.2	28.9	17.9	48.1	15.5	21.4	15.	43.0	13.8	27.0	16.2
E	38.4	15.2	33.4	12.9	43.0	14.0	30.5	12.6	41.8	17.6	27.4	13.2	42.8	12.5	32.7	11.9
F	37.9	12.0	35.3	14.9	46.6	14.1	24.5	14.8	40.9	18.2	25.6	15.3	53.8	13.0	20.5	12.8
G	37.0	16.2	28.3	18.6	35.6	19.3	31.0	14.2	42.1	10.8	30.7	16.4	41.6	17.8	28.7	12.0
H	41.6	11.6	34.8	12.0	47.9	15.1	18.5	18.5	42.6	17.5	29.5	10.4	50.1	17.8	20.5	11.7
I	44.3	14.6	27.9	13.2	48.2	12.6	23.4	15.8	36.9	16.0	31.5	15.6	43.7	16.2	30.3	9.9
J	38.2	15.6	31.7	14.5	50.4	11.5	26.9	11.2	39.1	15.3	33.0	12.6	36.2	14.4	37.5	11.9
K	32.7	16.2	34.2	16.8	42.2	13.8	29.6	14.3	30.2	18.2	36.1	15.5	41.3	9.8	38.6	10.3
L	42.4	14.4	29.5	13.7	35.2	20.7	29.2	14.9	38.2	5.0	32.3	14.5	43.9	14.3	26.2	15.5
M	44.1	11.9	30.9	13.2	40.0	14.4	29.5	16.1	49.6	14.8	24.3	11.3	37.5	10.2	37.6	14.6
N	43.5	10.2	28.6	17.7	37.1	11.3	37.4	14.1	30.9	19.8	36.1	13.3	53.7	18.0	15.2	13.1
O	30.1	15.5	45.2	9.1	43.4	15.4	24.9	16.3	35.8	12.0	37.1	15.1	35.9	12.6	40.5	11.1
C3																
A	63.3	8.0	16.1	12.7	55.0	12.6	18.6	13.7	49.6	20.7	14.1	15.6	54.2	9.8	21.4	14.6
B	50.4	12.2	18.5	19.0	46.7	15.2	20.2	17.9	51.9	13.6	18.7	15.8	46.2	9.6	25.2	19.0
D	44.9	15.3	25.5	14.3	47.8	14.4	20.8	17.0	43.3	17.2	21.8	17.8	38.9	13.9	30.3	16.9
E	41.0	12.2	34.5	12.3	45.4	12.0	25.1	17.5	47.4	15.6	25.7	11.4	38.9	15.2	31.7	14.3
F	38.8	14.0	33.4	13.9	45.7	15.4	24.0	15.0	46.0	14.0	25.2	14.8	46.1	16.3	20.2	17.5
G	37.7	21.9	25.7	14.7	34.3	14.6	30.0	21.1	27.8	20.6	33.8	17.8	57.1	17.3	15.3	10.3
H	34.6	16.0	36.6	12.9	38.0	16.7	26.2	19.1	42.9	12.1	31.8	13.1	42.6	17.1	24.5	15.9
I	40.8	12.7	27.9	18.6	46.9	9.3	25.2	18.6	47.3	12.6	27.7	12.4	45.2	9.1	28.0	17.7
J	51.3	8.0	25.2	15.5	39.3	21.0	23.3	16.3	40.8	13.2	31.5	14.5	42.1	10.3	33.6	13.9
K	45.8	12.1	30.7	11.4	47.7	16.3	23.1	12.9	38.8	16.4	29.6	15.2	36.8	10.1	38.9	14.2
L	53.5	14.5	15.9	16.1	41.8	15.6	27.7	14.7	51.4	13.5	23.6	11.5	54.0	13.7	20.9	11.4
M	45.2	15.8	25.4	13.7	46.5	12.5	27.2	13.8	44.7	11.4	29.5	14.5	29.0	8.6	46.9	15.5
N	40.7	11.4	22.6	25.3	27.0	11.0	41.1	20.9	30.6	8.8	44.6	16.0	37.1	12.8	25.2	24.9
O	27.5	12.0	46.7	13.8	41.1	15.8	29.7	13.4	36.6	15.8	31.3	16.3	45.5	10.1	27.2	17.2
C4																
A	56.6	12.2	13.1	18.2	59.6	9.5	16.2	14.6	44.1	15.4	26.9	13.5	53.7	7.8	24.1	14.4
B	48.6	13.8	19.3	18.4	38.4	24.1	18.3	19.2	47.5	11.2	24.7	16.6	40.6	17.4	23.4	18.6
D	43.0	14.4	25.1	17.5	43.5	13.1	21.0	22.5	37.0	19.9	23.9	19.2	46.2	11.4	27.0	15.5
E	39.5	13.4	31.4	15.8	46.7	10.1	29.0	14.2	44.1	12.8	31.6	11.6	36.3	15.9	34.1	13.7
F	38.5	14.2	32.9	14.5	42.7	15.0	24.7	17.5	41.9	12.7	30.3	15.2	43.9	17.9	23.2	15.0
G	41.9	13.2	26.7	18.2	24.9	13.7	38.6	22.8	36.3	13.8	31.2	18.8	50.1	14.1	20.8	15.0
H	42.0	12.9	29.3	15.9	40.0	14.2	23.2	22.6	44.0	13.2	28.1	14.8	47.1	13.8	21.5	17.6
I	39.0	12.5	31.0	17.5	48.3	12.0	21.6	18.0	40.9	15.4	30.8	12.9	44.6	9.9	30.5	14.9
J	51.9	10.7	20.0	17.3	40.5	17.2	25.8	16.6	44.3	11.0	29.7	14.9	41.5	13.2	29.9	15.4
K	42.6	16.8	28.7	11.9	43.9	12.6	28.0	15.5	30.6	12.3	39.6	17.5	38.2	12.8	30.1	18.9
L	49.6	14.1	18.5	17.7	44.9	11.4	26.3	17.4	42.6	13.1	26.5	17.9	49.1	15.3	22.7	12.9
M	42.9	15.7	25.6	15.9	42.0	16.1	27.1	14.9	50.1	11.0	22.8	16.2	32.2	9.5	37.2	21.2
N	40.1	12.4	26.0	21.5	31.4	16.0	33.7	19.0	27.3	14.1	40.6	18.0	47.6	11.0	20.9	20.5
O	30.4	10.9	38.5	20.1	41.6	14.4	25.2	18.9	31.6	14.2	32.4	21.9	41.2	12.7	29.0	17.1
T3																
A	45.5	20.3	15.2	19.0	51.1	11.2	18.7	19.0	46.2	19.1	9.8	24.9	56.6	15.1	12.5	15.8
B	37.4	12.2	18.0	32.4	38.8	13.1	17.0	31.1	41.3	18.0	18.2	22.5	34.3	16.2	23.2	26.2
D	39.9	14.9	27.5	17.7	34.8	13.6	23.5	28.1	42.9	14.6	20.7	21.9	38.7	11.6	25.8	23.8
E	30.7	13.6	33.7	21.9	35.8	13.4	24.0	26.7	38.0	17.1	22.0	23.0	41.1	15.5	22.3	21.1
F	44.2	12.2	25.9	17.6	41.7	13.2	23.2	21.9	46.2	15.4	21.1	17.3	38.6	15.1	25.3	20.9
G	36.0	21.1	24.9	18.1	35.6	17.0	26.8	20.6	39.2	13.9	28.4	18.5	53.9	18.6	15.2	12.2
H	34.1	12.5	35.7	17.7	36.2	17.4	21.3	25.1	34.9	16.2	25.2	23.6	35.5	18.6	25.7	20.3
I	29.8	16.3	26.8	27.1	46.5	10.4	23.7	19.5	45.3	11.7	24.3	18.7	42.9	9.9	23.0	24.2
J	34.0	9.9	23.2	32.8	33.4	16.6	23.2	26.8	39.8	9.8	25.5	24.9	40.4	9.1	27.5	23.0
K	38.6	14.9	30.5	15.0	46.3	11.4	22.8	19.4	32.6	19.1	29.0	19.3	31.0	10.2	38.7	20.1
L	39.5	14.4	24.9	21.2	35.3	15.1	23.3	26.3	44.6	17.6	21.1	16.7	46.2	17.6	20.2	16.0
M	35.6	16.5	23.5	24.4	39.4	13.0	25.5	22.1	39.1	13.1	27.3	20.5	31.1	10.8	35.1	23.0
N	35.1	12.8	15.5	36.7	28.1	9.1	33.4	29.4	30.3	9.6	28.3	31.8	38.8	9.2	12.6	39.5
O	26.3	12.6	30.9	30.1	31.4	13.5	30.1	24.9	36.9	9.4	27.5	26.2	38.3	15.5	24.9	21.2
T4																
A	39.6	11.3	28.7	20.4	56.6	9.6	10.5	23.4	47.9	11.3	27.1	13.6	42.2	18.2	21.5	18.1
B	41.8	18.4	19.4	20.3	39.3	21.3	17.2	22.2	44.2	10.5	27.6	17.8	40.4	18.7	16.7	24.3
D	42.2	14.8	27.7	16.5	39.8	10.2	32.2	17.7	38.7	14.9	31.0	15.4	34.6	13.9	31.1	20.4
E	41.1	14.7	27.7	16.5	39.8	10.2	32.2	17.7	38.7	14.9	31.0	15.4	34.6	13.9	31.1	20.4
F	39.6	13.4	31.1	16.0	40.8	14.3	25.6	19.3	35.8	13.9	31.5	18.9	35.2	20.1	27.5	17.2
G	43.6	10.3	26.2	19.9	29.7	12.2	34.3	23.8	44.0	15.9	27.9	12.3	45.7	13.4	27.0	13.9
H	35.8	16.7	26.5	21.0	46.0	10.2	23.9	19.9	34.4	15.8	27.3	22.4	42.5	11.1	25.2	21.1
I	33.4	12.8	27.9	26.0	52.3	11.7	19.5	16.5	37.7	15.4	29.4	17.4	41.0	12.7	30.0	16.3
J	42.8	13.0	22.8	21.5	38.6	14.4	27.5	19.5	42.2	14.2	25.6	18.0	42.7	11.3	29.7	16.2
K	40.1	15.3	28.7	15.9	43.1	13.3	26.9	16.7	27.2	13.6	42.3	16.9	43.7	10.1	28.2	18.1
L	28.4	19.8	31.6	20.3	42.5	18.6	22.9	16.0	39.5	12.2	29.2	19.1	35.3	20.2	25.7	18.8
M	36.4	15.9	27.9	19.8	34.8	19.5	26.4	19.3	41.5	8.8	32.1	17.6	37.3	11.2	32.6	18.8
N	40.0	15.2	21.6	23.3	35.7	20.0	23.2	21.1	23.6	14.6	39.6	22.3	45.2	13.9	16.0	24.9
O	30.9	11.6	27.8	29.7	41.8	15.5	22.7	20.	26.6	12.2	37.5	23.7	25.9	14.3	39.5	20.3

MEAN PERCENT POWER S #05

CZ

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
A	45.3	30.5	16.6	7.6	52.0	25.3	14.2	8.5	60.1	18.6	14.1	7.2	59.0	16.7	17.0	7.4
B	48.8	24.5	18.6	8.1	64.1	17.7	11.8	6.4	56.7	20.7	15.3	7.3	50.4	23.9	17.3	8.4
D	52.1	23.3	16.5	8.1	58.7	20.9	12.8	7.5	49.3	23.7	18.9	8.2	51.9	25.9	14.9	7.3
E	52.1	25.5	15.6	6.8	53.5	23.8	16.1	6.6	46.2	28.0	16.9	8.7	55.5	24.4	14.3	5.8
F	47.9	26.4	16.5	9.1	49.2	30.3	12.0	8.5	50.5	21.7	19.7	8.2	46.1	27.1	18.2	8.6
G	59.6	16.0	17.2	7.2	59.2	21.0	12.5	7.3	45.7	29.9	17.1	7.3	54.4	22.4	16.6	6.5
H	53.9	22.1	15.8	8.2	49.7	28.3	14.9	6.9	56.3	17.5	19.5	6.7	53.1	20.7	18.4	7.8
I	46.4	28.4	16.4	8.8	45.1	28.2	18.5	8.2	50.1	29.3	13.0	7.6	45.9	32.7	12.9	8.5
J	51.9	24.0	15.7	8.4	53.1	23.9	14.7	8.3	50.6	23.3	17.3	8.8	44.4	30.7	16.4	8.4
K	49.0	21.9	21.0	8.1	51.4	27.6	12.6	8.4	60.4	18.4	13.0	8.2	53.2	27.0	12.9	6.9
L	57.2	23.7	12.3	6.8	42.4	29.7	19.4	8.5	47.3	26.4	19.4	6.9	49.6	21.7	18.1	10.5
M	45.4	27.6	17.6	9.3	50.4	25.2	16.0	8.3	44.3	30.1	18.6	7.0	59.0	25.7	10.3	5.1
N	53.0	23.3	15.5	8.1	56.7	22.2	13.6	7.5	59.7	18.4	14.0	7.8	47.5	25.8	19.6	7.3
O	53.2	20.7	15.9	10.1	49.6	23.4	17.8	9.2	46.7	25.2	18.7	9.4	46.6	23.7	22.0	7.6
								DZ								
A	61.8	16.4	13.1	8.6	54.4	21.7	15.8	8.1	54.1	22.0	14.2	9.7	55.0	22.7	14.5	7.9
B	50.4	28.3	15.0	6.3	61.9	15.8	14.1	8.1	64.4	12.9	13.5	9.1	55.9	18.7	16.1	9.4
D	53.3	20.6	16.5	9.6	54.0	18.3	17.3	10.4	56.7	15.8	19.0	8.5	58.1	17.8	15.9	8.2
E	47.9	23.1	19.8	9.3	53.9	23.3	14.4	8.5	56.3	21.1	14.4	8.3	59.1	18.2	15.9	6.9
F	47.8	23.3	19.1	10.9	60.8	18.0	12.1	9.2	57.3	19.2	15.4	8.1	49.4	23.1	19.2	8.4
G	63.9	13.8	15.6	6.7	57.0	21.3	13.5	8.2	55.1	20.9	15.6	8.4	51.7	26.0	16.1	6.2
H	51.9	26.9	14.1	7.1	47.7	24.0	20.6	7.7	62.9	13.3	14.2	9.6	60.0	18.5	15.3	6.2
I	53.3	17.1	19.1	10.4	55.8	22.2	13.2	8.7	53.4	21.4	15.4	9.8	54.9	25.8	11.2	8.1
J	54.4	23.3	14.5	7.9	48.8	24.6	16.2	10.5	51.9	23.7	15.5	9.0	50.2	28.0	13.3	8.5
K	47.1	21.6	18.5	12.7	53.7	22.0	12.4	11.9	53.0	18.0	18.7	10.4	54.4	23.3	12.7	9.6
L	66.5	16.8	9.9	6.8	49.3	23.1	18.6	8.7	55.3	17.2	19.6	7.9	63.7	15.3	15.1	5.9
M	58.8	16.4	16.0	8.8	51.0	24.2	16.8	7.9	59.5	18.6	15.7	6.2	55.7	24.1	14.4	5.8
N	52.7	20.0	18.7	8.7	61.4	16.9	14.8	7.0	52.2	22.5	16.9	8.5	50.8	21.3	19.4	8.6
O	55.4	21.4	15.2	8.0	46.0	21.6	22.4	10.1	59.7	15.9	17.7	6.8	55.6	16.9	20.4	7.1
								C3								
A	48.6	29.2	14.0	8.2	54.6	19.8	16.0	9.7	59.0	18.7	15.5	6.8	55.6	16.2	21.7	6.4
B	52.2	23.2	16.6	8.1	64.0	18.0	10.7	7.2	50.3	21.3	20.5	7.9	55.3	17.6	19.3	7.7
D	50.7	18.1	21.7	9.6	56.4	20.8	13.3	9.5	49.9	21.8	18.7	9.6	48.5	22.8	18.2	10.4
E	49.7	23.1	19.3	7.9	52.2	24.2	15.1	8.4	49.3	21.8	20.0	9.0	54.7	21.7	16.8	6.8
F	45.0	24.8	19.8	10.4	47.6	25.3	15.9	11.2	53.4	18.1	18.7	9.8	43.7	22.2	24.4	9.4
G	58.6	15.4	19.1	6.9	57.3	20.5	14.0	8.2	47.0	23.3	20.8	8.9	55.4	19.9	17.7	6.9
H	55.0	23.7	13.5	7.9	50.3	25.3	16.9	7.6	51.6	20.0	21.0	7.3	51.3	21.3	19.9	7.5
I	42.3	25.6	19.9	12.2	49.3	21.0	18.6	11.1	51.0	25.8	14.2	8.7	46.1	26.5	16.5	10.9
J	47.4	23.3	18.3	11.0	51.7	22.5	15.6	10.1	50.6	24.5	15.9	8.9	44.3	30.1	15.6	9.9
K	51.5	19.8	18.1	10.6	44.1	27.5	18.3	10.2	57.8	16.7	15.4	10.1	60.9	20.2	12.1	6.8
L	58.4	19.9	14.3	7.4	44.2	24.1	22.0	9.8	53.2	23.5	15.4	8.0	52.0	18.9	18.5	10.5
M	45.9	24.2	19.7	10.2	52.9	19.6	18.2	9.3	46.2	27.7	17.9	8.2	55.5	24.7	14.5	5.2
N	51.3	21.2	17.4	10.1	46.6	21.0	23.7	8.7	59.5	14.8	16.7	9.0	47.0	22.0	22.4	8.6
O	51.5	15.8	22.2	10.5	49.1	22.1	18.4	10.4	51.8	21.6	16.5	10.2	43.8	22.1	25.1	9.0
								C4								
A	51.9	25.2	13.8	9.1	55.8	19.6	13.7	10.9	61.3	18.1	12.7	7.9	57.4	16.8	15.2	10.6
B	45.7	26.3	19.9	8.1	63.5	16.3	13.2	7.0	54.0	20.8	15.9	9.3	55.0	16.2	20.1	8.7
D	52.1	20.4	16.1	11.3	55.9	20.6	14.5	9.0	51.9	18.2	18.7	11.2	52.1	21.3	17.6	8.9
E	51.8	17.8	20.1	10.3	49.9	21.6	18.3	10.2	48.6	22.6	17.8	10.9	57.3	17.6	17.5	7.7
F	42.0	23.4	21.8	12.9	50.8	22.2	16.1	11.0	49.8	17.5	20.6	12.0	45.9	23.2	21.0	10.0
G	59.5	12.2	17.7	10.6	56.3	21.4	12.4	9.9	46.2	24.8	18.1	10.9	48.6	21.2	19.2	11.0
H	55.5	17.5	17.2	9.7	50.6	28.1	11.8	9.5	56.1	18.0	17.7	8.2	47.3	23.0	16.9	12.8
I	40.9	27.9	19.1	12.1	43.8	24.8	19.9	11.6	56.2	21.0	13.4	9.4	45.8	25.7	16.0	12.6
J	47.9	22.6	17.7	11.8	52.0	20.8	15.8	11.3	47.5	23.1	17.3	12.1	44.7	24.0	20.4	10.8
K	51.6	18.8	20.0	9.7	50.7	24.5	12.8	11.9	55.9	15.3	17.9	10.9	52.2	22.2	14.1	11.5
L	53.8	19.3	15.0	12.0	47.5	20.6	19.3	12.6	48.5	23.7	18.0	9.8	51.1	17.7	18.1	13.1
M	39.4	28.2	18.5	13.9	47.6	22.8	18.6	11.1	45.1	24.7	20.2	10.0	58.1	22.1	11.8	8.1
N	50.5	17.9	16.6	15.0	37.8	23.0	21.2	18.1	49.5	16.5	19.2	14.8	41.7	17.5	24.5	16.4
O	49.7	16.9	15.5	17.9	48.8	16.5	17.5	17.2	43.7	18.3	21.9	16.1	46.7	21.8	20.3	11.2
								T3								
A	46.3	24.6	16.5	12.6	48.9	19.9	18.0	13.2	51.2	21.8	16.5	10.5	54.3	17.4	16.1	12.2
B	45.0	16.5	14.2	24.2	45.5	19.5	13.5	21.5	40.2	24.4	14.3	21.2	50.8	17.3	14.3	17.7
D	32.4	10.4	16.3	41.0	34.9	17.2	14.0	33.9	34.8	12.5	17.7	35.0	31.4	17.2	16.0	35.4
E	30.3	20.0	15.5	34.2	30.4	16.9	16.4	36.4	32.6	13.3	18.2	35.9	32.8	16.9	21.3	28.9
F	32.9	13.3	19.3	34.5	35.3	14.9	17.0	32.8	30.5	16.0	13.8	39.7	33.9	15.9	16.8	33.4
G	35.5	14.4	17.9	32.2	31.8	17.8	15.1	35.3	34.6	15.0	18.2	32.[illegible]	35.6	16.6	18.2	29.6
H	32.5	17.8	15.8	33.9	37.9	16.3	22.0	23.8	41.5	13.7	20.9	23.9	37.1	15.4	21.0	26.5
I	28.7	17.4	20.1	33.8	37.7	13.8	16.7	31.7	30.6	20.0	18.6	30.7	33.7	16.5	15.0	34.8
J	29.5	18.9	16.3	35.4	32.7	14.4	17.7	35.2	33.8	17.9	13.8	34.6	35.6	18.1	13.0	33.2
K	34.0	14.6	17.1	34.4	24.3	19.5	17.1	39.1	37.4	13.4	17.5	31.7	41.3	15.2	15.8	27.7
L	35.0	15.7	14.1	35.3	29.5	16.6	17.8	36.2	32.7	17.5	19.4	30.4	34.9	17.6	17.2	30.3
M	34.9	16.1	18.9	30.1	33.4	19.8	20.5	26.3	35.2	24.5	16.3	24.0	38.5	22.9	16.5	22.1
N	28.2	11.7	17.0	43.1	23.0	17.5	13.2	46.3	28.9	14.1	17.3	39.7	33.6	14.8	19.6	32.1
O	30.0	11.9	16.7	41.5	33.9	16.6	15.1	34.3	31.3	12.2	17.1	39.4	28.0	14.6	18.0	39.4
								T4								
A	40.4	29.4	15.9	14.3	42.9	19.9	20.2	17.0	55.7	21.5	12.6	10.2	47.0	20.9	20.6	11.6
B	38.9	29.4	17.3	14.4	47.6	26.8	14.3	11.4	41.6	28.1	16.9	13.4	52.1	16.8	17.1	14.[illegible]
D	41.4	16.1	21.5	21.1	43.2	20.2	18.1	18.5	38.0	16.6	24.7	20.7	40.8	19.1	21.7	18.4
E	43.0	16.3	22.4	18.3	36.2	26.2	18.5	19.1	34.0	21.6	24.0	20.4	43.0	14.0	23.8	19.2
F	35.6	20.9	23.9	19.6	41.4	17.2	20.9	20.5	44.5	18.2	19.0	18.3	37.8	22.2	21.7	18.3
G	45.7	15.3	21.5	17.6	45.0	18.7	17.5	18.7	38.1	19.1	22.1	20.7	37.9	20.1	21.5	20.5
H	35.6	20.6	22.1	21.6	40.9	20.5	20.3	18.4	45.1	17.8	20.6	16.6	33.2	30.6	17.0	19.2
I	34.7	26.7	19.0	19.5	40.4	23.0	18.2	18.4	43.5	23.7	15.3	17.6	36.0	21.1	21.1	21.7
J	39.8	19.0	19.9	21.4	38.9	22.6	17.5	21.1	38.0	20.0	21.6	20.4	35.9	23.2	19.9	21.0
K	46.5	19.5	18.7	15.3	42.5	18.8	16.9	21.8	42.6	16.8	20.9	19.8	40.5	20.2	20.4	18.9
L	37.0	19.4	20.5	23.1	23.7	19.0	19.7	17.6	36.0	23.0	21.8	19.2	41.7	20.4	21.5	16.4
M	35.2	29.9	16.1	18.8	36.3	21.0	20.3	22.4	33.2	23.3	23.1	20.4	47.8	17.6	19.0	15.6
N	36.8	15.5	26.3	21.4	31.0	27.1	14.5	27.3	27.9	15.6	27.2	29.2	31.3	14.1	26.1	28.5
O	39.7	16.4	18.3	25.5	42.9	17.1	18.9	21.[illegible]	30.4	19.2	26.3	24.1	42.1	20.3	18.3	19.4

MEAN PERCENT POWER S #06

	BASE				EPOCH 1				EPOCH 2				EPOCH 3			
	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30	1-4	5-7	8-12	13-30
CZ																
A	50.2	15.4	23.3	11.1	48.2	24.3	15.0	12.4	58.1	17.8	15.3	8.8	46.3	21.2	22.0	10.4
B	53.3	20.8	16.2	9.7	57.6	16.9	16.5	8.9	53.5	11.1	26.0	9.5	46.1	13.9	28.0	12.0
D	52.0	21.5	16.4	10.0	54.9	17.0	17.5	10.5	54.5	18.0	17.5	10.0	50.9	15.7	21.8	11.6
E	42.7	21.1	22.6	13.6	50.7	19.9	18.0	11.5	51.3	16.0	22.6	10.0	48.4	15.6	22.3	13.6
F	50.1	15.7	24.8	9.4	52.7	14.9	20.8	11.6	33.2	18.4	34.9	13.4	41.2	15.4	32.7	10.6
G	37.9	21.8	31.2	9.1	48.6	20.2	20.5	10.7	36.2	23.1	30.7	9.9	35.2	15.1	41.1	8.6
H	37.9	18.7	33.8	9.6	57.3	17.8	15.1	9.8	47.3	22.6	16.6	13.6	51.8	17.9	16.3	13.9
I	46.0	19.9	24.4	9.7	60.4	14.3	15.0	10.3	37.1	22.5	28.6	11.8	50.1	15.9	23.8	10.2
J	41.4	20.8	26.9	10.9	54.5	15.6	19.7	10.2	48.0	18.4	22.5	11.1	50.4	12.1	23.7	13.8
K	43.1	17.0	26.7	13.2	48.6	18.8	20.5	12.0	48.4	19.4	19.2	13.1	38.9	15.1	34.8	11.3
L	44.5	17.1	28.4	10.0	53.4	18.8	16.9	10.9	40.1	21.8	27.4	10.7	37.9	17.7	33.3	11.1
M	36.2	15.6	36.5	11.7	40.2	14.0	35.2	10.5	35.7	15.8	39.9	8.6	38.7	13.9	37.5	10.
N	50.4	11.8	28.7	9.1	46.6	17.2	22.9	13.3	37.2	13.5	39.6	9.7	35.9	13.2	40.3	10.5
O	39.7	16.7	36.0	7.7	47.0	18.5	18.7	15.9	46.7	15.4	23.6	14.4	48.5	16.8	21.5	13.1
OZ																
A	53.4	9.3	27.1	10.1	51.7	9.2	22.1	17.0	60.6	15.8	15.8	7.9	53.6	15.0	21.0	10.4
B	61.5	9.0	18.1	11.4	54.3	15.2	19.6	11.0	50.5	9.8	28.9	10.8	48.5	11.5	27.6	12.4
D	53.6	16.7	19.4	10.2	63.3	8.7	19.2	8.9	64.5	11.5	18.4	7.5	55.6	9.8	27.3	7.3
E	55.6	10.9	24.5	9.0	49.6	16.2	23.1	11.1	51.6	14.9	26.5	7.0	45.2	16.2	28.4	10.2
F	38.0	13.7	39.7	8.6	44.7	14.3	27.1	13.9	38.8	11.7	40.9	8.6	32.5	14.3	43.5	9.7
G	41.1	11.8	37.3	9.8	54.4	10.8	25.3	9.6	43.3	7.6	40.2	8.9	32.8	11.8	49.3	6.0
H	29.7	11.1	51.2	7.9	47.3	17.0	21.9	13.8	61.9	11.8	15.1	11.3	53.2	15.8	15.1	15.9
I	47.7	12.6	30.1	9.6	53.3	10.3	23.9	12.4	44.2	15.9	29.7	10.1	44.7	14.9	26.3	14.1
J	37.6	14.4	35.4	12.6	51.7	11.6	25.0	11.6	43.9	12.9	34.7	8.5	44.0	14.6	29.9	11.5
K	57.2	11.3	23.9	7.6	43.7	18.5	26.1	11.8	34.7	17.4	36.7	11.2	44.8	12.8	34.6	7.9
L	44.2	14.5	31.5	9.7	54.8	13.6	23.4	8.1	41.8	13.2	36.4	8.7	38.3	9.9	43.9	8.0
M	38.5	12.5	39.4	9.5	26.0	12.3	51.8	9.9	28.4	9.8	55.4	6.3	37.5	11.8	42.6	8.2
N	33.8	10.1	49.3	6.8	45.2	10.1	35.1	9.5	30.3	15.6	44.2	9.8	29.7	7.8	52.8	9.7
O	27.1	8.0	55.8	9.1	49.5	14.1	23.1	13.4	43.8	17.9	26.3	12.0	53.0	12.3	21.0	13.7
C3																
A	48.1	17.9	22.7	11.3	48.8	22.8	15.0	13.5	63.5	14.6	13.1	8.8	50.1	18.0	20.9	10.9
B	53.8	20.8	15.6	9.8	55.4	16.8	16.9	10.9	56.9	11.0	21.7	10.4	44.6	12.7	29.7	13.1
D	52.7	21.6	15.8	9.8	53.4	16.8	18.5	11.2	54.5	18.6	17.0	9.9	48.6	14.0	23.7	13.6
E	43.0	16.9	24.6	15.5	52.4	19.1	15.7	12.9	51.0	13.6	23.0	10.4	46.4	15.4	23.8	14.4
F	47.0	16.0	26.1	11.0	52.9	13.3	21.7	12.1	34.2	18.1	34.6	13.1	37.1	13.6	36.0	13.2
G	40.5	16.7	32.5	10.4	54.3	15.5	18.6	11.6	38.6	20.0	30.1	11.2	36.3	13.1	40.7	10.0
H	35.9	17.0	34.1	12.9	60.3	14.3	13.7	11.7	50.4	18.9	16.4	14.3	54.1	17.4	13.8	14.7
I	48.3	16.7	24.2	10.9	59.9	14.7	14.9	10.5	46.3	18.4	23.8	11.5	55.2	11.9	20.6	12.2
J	45.7	18.4	24.7	11.2	54.9	16.5	18.1	10.6	51.0	14.3	22.5	12.1	52.6	12.2	21.5	13.7
K	44.6	14.4	25.0	16.0	50.3	17.1	16.6	16.0	50.6	16.9	19.8	12.9	38.6	16.6	31.7	13.1
L	44.7	15.5	28.8	11.0	51.4	17.1	19.7	11.8	38.8	20.9	28.8	11.4	38.4	17.8	32.3	11.5
M	39.0	13.0	34.4	13.6	40.2	12.0	37.1	10.7	38.3	12.4	39.8	9.5	36.9	13.2	38.9	10.9
N	43.9	10.9	33.5	11.7	48.2	12.4	24.0	15.5	39.4	12.0	36.8	11.9	32.4	12.5	40.2	14.9
O	38.7	14.8	36.9	9.7	48.4	17.6	18.4	15.6	49.0	13.4	23.2	14.4	50.6	13.8	20.3	15.3
C4																
A	52.9	14.1	20.4	12.6	51.6	19.8	15.1	13.5	59.7	16.7	13.2	10.4	40.3	23.2	23.2	13.3
B	51.8	19.6	15.4	13.2	54.8	17.7	16.8	10.7	52.2	8.5	27.0	12.4	50.5	13.8	23.0	12.7
D	51.5	20.7	15.1	12.7	55.3	15.0	17.2	12.6	53.9	18.5	17.2	10.4	49.1	16.6	20.6	13.6
E	41.5	17.9	24.9	15.7	53.5	14.7	19.3	12.5	51.3	16.3	22.0	10.4	45.5	15.2	25.0	14.2
F	51.4	15.6	21.5	11.4	53.2	14.9	19.4	12.6	37.1	17.6	29.4	15.9	37.9	16.6	31.7	13.9
G	37.4	19.2	32.1	11.4	45.6	20.2	22.7	11.6	36.2	21.5	30.3	12.0	37.3	18.0	35.4	9.3
H	40.2	15.4	34.3	10.2	57.0	17.1	13.7	12.2	46.2	21.4	15.7	16.7	51.1	18.4	14.7	15.8
I	46 6	18.0	23.0	12.5	64.0	11.8	13.2	11.0	37.9	20.0	27.5	14.7	51.3	14.8	22.9	10.9
J	47.2	16.7	25.5	11.7	52.7	12.8	23.1	11.4	46.1	16.7	24.0	13.2	47.3	13.9	24.6	14.2
K	41.7	18.0	25.2	15.1	51.5	17.0	19.2	12.4	42.7	17.6	23.7	16.1	38.3	15.4	35.2	11.1
L	44.7	18.6	25.4	11.3	56.1	16.8	15.0	12.1	41.1	18.2	27.9	12.7	36.5	16.3	34.6	12.5
M	36.0	14.1	35.4	14.5	44.4	12.2	31.3	12.1	35.9	13.8	40.3	10.0	38.3	13.0	36.9	11.8
N	47.9	14.8	26.9	10.4	47.9	17.3	20.8	14.0	37.9	14.0	35.7	12.4	36.4	12.4	36.9	14.3
O	36.4	15.8	37.3	10.5	48.8	15.1	17.6	18.5	43.8	14.6	24.8	16.9	53.2	12.6	20.8	13.3
T3																
A	34.0	17.7	16.7	31.5	33.9	13.0	15.5	37.5	36.6	9.5	15.4	38.4	26.7	11.6	20.8	41.0
B	30.9	17.8	18.9	32.4	29.6	14.6	21.1	34.8	37.1	12.9	20.8	29.3	23.8	16.2	27.7	32.2
D	36.4	19.9	21.0	22.7	32.7	16.0	23.5	27.8	35.3	16.8	20.4	27.5	35.7	14.6	23.3	26.3
E	37.1	15.1	27.4	20.4	45.0	19.5	15.5	19.1	40.5	17.9	25.0	16.5	35.4	15.2	29.1	20.4
F	36.5	19.5	26.3	17.8	38.6	16.5	24.6	20.2	27.0	19.4	34.0	19.7	31.2	17.1	32.5	19.1
G	31.1	18.0	36.1	14.8	45.5	16.5	18.6	19.4	35.5	16.7	30.2	17.7	26.5	17.3	41.1	15.1
H	37.3	16.6	28.3	17.8	43.8	16.6	16.9	22.7	37.6	17.1	20.5	24.8	43.0	15.8	16.2	24.9
I	40.7	13.5	22.2	23.6	39.3	16.1	19.8	24.7	39.1	17.3	21.3	22.4	41.0	14.0	20.5	24.5
J	39.0	18.6	25.2	17.3	40.4	20.5	20.5	18.6	44.0	13.7	23.4	19.0	45.3	13.9	20.3	20.5
K	34.3	15.3	26.7	23.7	41.0	14.1	21.9	23.0	43.2	15.9	21.3	19.7	35.2	17.1	27.6	20.1
L	41.5	16.1	25.0	17.4	35.7	16.8	26.2	21.3	33.1	20.9	29.0	17.1	32.9	19.5	30.5	17.1
M	33.9	13.6	35.1	17.3	33.2	12.0	36.8	18.0	34.5	14.2	34.2	17.2	26.5	17.7	40.5	15.2
N	37.7	10.4	30.2	21.8	32.2	12.0	22.9	32.9	28.4	10.4	33.7	27.6	22.4	14.1	32.9	30.6
O	24.8	12.2	34.0	29.1	31.9	17.3	21.9	29.0	32.4	15.9	22.0	29.7	27.3	16.	21.2	35.6
T4																
A	43.1	17.1	16.3	23.5	49.5	13.6	17.5	19.4	48.5	20.1	13.0	8.4	32.8	21.4	22.0	23.8
B	37.8	24.9	16.6	20.7	40.8	15.4	21.9	22.0	49.0	11.2	21.4	18.3	43.5	14.0	25.7	16.8
D	43.0	21.1	15.3	20.7	39.9	20.9	22.6	16.6	49.0	21.1	18.1	11.8	36.9	22.4	22.8	17.9
E	32.3	21.2	29.3	17.3	42.6	16.2	24.1	17.2	43.1	18.8	24.0	14.1	31.9	17.2	31.5	19.4
F	38.9	19.3	26.8	15.0	42.8	19.5	21.3	16.4	33.9	19.6	30.4	16.1	26.7	22.6	33.7	16.9
G	34.9	15.7	36.0	13.3	42.5	17.0	24.8	15.8	32.2	22.0	31.6	14.2	33.3	20.0	34.3	12.4
H	36.1	16.7	32.8	14.4	44.4	19.1	19.1	17.4	35.4	24.2	19.6	20.8	35.0	2 .0	23.4	22.0
I	38.4	21.1	24.5	16.0	52.5	16.2	18.1	13.2	36.9	22.0	24.7	16.5	40.3	19.8	24.0	16.0
J	43.4	18.5	23.9	14.3	38.5	15.5	29.8	16.3	38.0	18.3	28.7	14.9	43.9	15.9	24.8	15.4
K	38.4	17.3	27.2	17.0	41.1	18.0	22.2	18.6	38.5	19.9	23.8	17.9	37.0	17.7	33.5	11.8
L	35.9	21.6	27.7	14.8	49.6	18.0	15.4	16.9	41.0	17.2	27.6	14.3	37.2	15.4	32.8	14.5
M	35.0	14.3	33.5	17.1	41.1	11.6	31.7	15.6	36.3	15.2	32.7	15.9	30.6	14.9	38.1	16.5
N	35.7	23.0	26.5	14.8	42.3	17.8	22.0	17.9	28.4	20.6	33.1	18.0	30.9	13.7	34.5	20.9
O	25.7	17.4	44.8	12.1	32.2	17.6	24.5	25.7	33.3	18.9	26.0	21.8	45.6	16.3	20.2	17.9

APPENDIX D

BEEG VARIABLES ENTERED (REMOVED) INTO SWDA RESULTING IN A SIGNIFICANT ($p < .05$) U-STATISTIC

S1-S2 and S- indicate comparisons within each over acquisition. All other comparisons are between S1 and S- trials in each condition.

BLEG S #01

Cz

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2												
S-												
PSD		•										
ACQ 01						•				•		•
02	•				•	•			•	•		
03												
04												
05								•	•	•		
EXT	•				•						•	•

Oz

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2		•		•	•				•	•	•	
S-						•		•				
PSD										•	•	•
ACQ 01						•				•		•
02	•				•	•			•	•		
03												
04												
05								•	•	•		
EXT												

C3

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2						•					•	
S-												
PSD		•			•				•	•		•
ACQ 01	•							•	•		•	
02								•	•		•	•
03			•							•	•	
04				•			•	•		•	•	•
05		•	•				•				•	•
EXT	•								•	•		

C4

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2												
S-												
PSD												
ACQ 01												
02		•				•	•				•	•
03	•							•	•			
04							•	•	•			
05				•				•		•	•	•
EXT									•		•	

T3

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2												
S-												
PSD		•								•		•
ACQ 01	•					•						
02						•						•
03												
04					•				•		•	
05	•				•	•	•		•	•		
EXT	•								•			

T4

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2												
S-					•			•	•	•		•
PSD											•	•
ACQ 01	•			•				•		•		
02		•					•				•	
03	•	•							•		•	
04	(•)				•		•		•		•	
05	•		•							•	•	
EXT			•		•					•	•	•

BFEG S #02

Cz

		1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
		5	9	13	6	10	14	7	11	15	8	12	16
ACQ	S1-S2	●							●		●	●	●
	S-	●			●	●	●	●				●	●
PSD		●		●	●	●	●		●		●		●
ACQ	01												
	02												
	03									●	●	●	
	04			●		●							●
	05		●		●					●			●
EXT		●						●	●	●			●

Oz

		1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
		5	9	13	6	10	14	7	11	15	8	12	16
ACQ	S1-S2	●	●	●	●	●			●		●		●
	S-									●	●	●	●
PSD					●	●			●				
ACQ	01					●				●		●	
	02												
	03				●				●				●
	04	●					●		●			●	
	05												
EXT													

C3

		1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
		5	9	13	6	10	14	7	11	15	8	12	16
ACQ	S1-S2								●	●	●	●	●
	S-					●				●	●	●	●
PSD						●							●
ACQ	01												
	02												
	03							●		●			
	04												
	05		●		●		●		●	●			●
EXT							●					●	●

C4

		1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
		5	9	13	6	10	14	7	11	15	8	12	16
ACQ	S1-S2			●					●		●	●	●
	S-			●		●	●	●			●	●	
PSD				●									
ACQ	01												
	02						●		●		●		
	03												
	04					●	●		●				●
	05												
EXT									●	●		●	

T3

		1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
		5	9	13	6	10	14	7	11	15	8	12	16
ACQ	S1-S2		●		●				●		●		●
	S-	●	●	●			●				●	●	
PSD													
ACQ	01												
	02												
	03												
	04												
	05						●				●		
EXT		●	(●)	●	●			●				●	

T4

		1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
		5	9	13	6	10	14	7	11	15	8	12	16
ACQ	S1-S2							●					
	S-			●	●			●			●		
PSD				●	●		●						
ACQ	01												
	02		●							●	●		●
	03												
	04												
	05												
EXT										●		●	

BEEG S #03

Cz

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2												
S-				●							●	●
PSD												●
ACQ 01			●		●				●	●		●
02												
03										●		●
04					●	●	●				●	
05												
EXT			●	●		●		●	(●)	●	●	

Cz

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2												
S-	●	●		●								
PSD						●					●	●
ACQ 01	●			●	●						●	●
02												
03												
04												
05	●		●	●							●	
EXT				●		●				●	●	●

C3

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2				●		●						
S-												
PSD												
ACQ 01												
02		●						●	●			
03	●			●					●			●
04												
05												
EXT				●	●	●	●					

C4

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2	●	●			(●)	●					●	●
S-												
PSD												
ACQ 01			●	●						●		●
02												
03							●					
04	●				●		●					
05												
EXT							●		●	●	●	

T3

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2								●		●	●	●
S-	●	●	●	●					●			
PSD												
ACQ 01							●					
02			●		●	●						
03	●		●					●			●	●
04	●				●	●				●	●	
05							●					
EXT												

T4

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2	●			●	●	●			●		●	
S-				●		●		●		●		
PSD		(●)	●						●			●
ACQ 01												
02												
03												
04												
05												
EXT		●					●					●

BEEG S 004

Cz

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2			●			●			●	●	●	
S-												
PSD		(●)	●	●					●		●	●
ACQ 01											●	
02												
03									●			
04					●			●	●			
05		●			●	●			●	●		
EXT	●	●		●	●	●						

Cz

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2		●						●			●	
S-	●					●						●
PSD			●	●	●	●						
ACQ 01	●					●		●				●
02												
03									●			
04												
05		●				●	●			●		
EXT								●	●	●		

C3

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2		●							●		●	●
S-				●					●	●	●	
PSD												
ACQ 01		●				●						(●)
02				●		●		●			●	
03			●		●	●		●	●			
04	●	●	●			●					●	●
05	●					●			●			
EXT	●		●		●	●	●	●	●			

C4

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2	●				●		●		●		●	
S-			●		●							
PSD	●	●	●	(●)			●			●		●
ACQ 01		●			●				●			●
02		●	●	●	●					●		
03		●									●	●
04	●					●						
05			●		●	●	●			●	●	
EXT												

T3

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2												
S-	●				●	●	●		●			
PSD	●		●		●				●	●		
ACQ 01				●								
02		●			●	●						
03					●				●			
04						●						
05			●		●	●				●	●	
EXT		●		●			●	●	●			

T4

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2			●	●	●	●	●			●	●	
S-	●	●			●							
PSD	●			●		●	●		●		●	
ACQ 01					●		●			●		
02												
03			●	●		●		●				
04		●	●	●	●							●
05				●	●							
EXT	●				●	●			(●)		●	

BEEG 9 #05

Cz

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2					•							
S-	•	•						•	•	•	•	•
PSD						(•)			•			
ACQ 01	•				•			•	•			•
02						•	•					•
03												
04	•					•			•	•		•
05					•				•			•
EXT												

Cz

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2												
S-			•			•	•			•		•
PSD					•							
ACQ 01			•	•					•	•	•	
02						•		•	•			•
03										•		•
04						•	•			•		
05		•		•					•		•	
EXT	•								•	•		•

C3

	1-4 Hz			5-7 Hz			9-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2												•
S-	•	•				•					•	•
PSD												
ACQ 01												
02				•				•	•	•		•
03				(•)		•	•	•	•		•	
04		•					•					•
05	•				•							•
EXT										•	•	

C4

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2												
S-		•									•	•
PSD						•	•					
ACQ 01						•	•		•		•	•
02												•
03												
04							•					
05	•			•		•	•	•			•	•
EXT												

T3

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2												
S-					•							
PSD	•	•	•			•	•					•
ACQ 01					•							
02								•	•		•	•
03						•	•	•	•		•	•
04												
05					•	•						•
EXT			•				•	•		•		•

T4

	1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
	5	9	13	6	10	14	7	11	15	8	12	16
ACQ S1-S2		•				•						
S-												
PSD									•			
ACQ 01	•							•	•			•
02												
03												
04												
05		•				•						•
EXT	•					•	•		•			•

BEEG S #06

Cz

		1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
		5	9	13	6	10	14	7	11	15	8	12	16
ACQ	S1-S2		•						•				•
	S-							•	•				
PSD					•		•		•				
ACQ	01	•	•										
	02												
	03				•				•				
	04												
	05	•	•						•	•		•	
EXT										•			

Oz

		1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
		5	9	13	6	10	14	7	11	15	8	12	16
ACQ	S1-S2	•		•		•						•	•
	S-				•			•				•	•
PSD													
ACQ	01		•			•	•				•		•
	02												
	03												
	04					•					•		
	05		•				•			•			•
EXT				•						•			

C3

		1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
		5	9	13	6	10	14	7	11	15	8	12	16
ACQ	S1-S2		•							•			
	S-			•		•		•			•		
PSD													
ACQ	01												
	02												
	03		•								•	•	
	04												
	05	•	•				•		•	•			
EXT		•		•	•	•	•						

C4

		1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
		5	9	13	6	10	14	7	11	15	8	12	16
ACQ	S1-S2									•		•	•
	S-							•					
PSD					•	•	•				•	•	
ACQ	01	•				•				•			
	02												
	03												
	04												
	05	•		•					•	•		•	•
EXT													

T3

		1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
		5	9	13	6	10	14	7	11	15	8	12	16
ACQ	S1-S2	•	•							•		•	
	S-			•		•		•					•
PSD													
ACQ	01												
	02									•			
	03	•	•	•		•							
	04												
	05		•	•		•		•	(•)	(•)	•		•
EXT													

T4

		1-4 Hz			5-7 Hz			8-12 Hz			13-30 Hz		
		5	9	13	6	10	14	7	11	15	8	12	16
ACQ	S1-S2		•	•								•	•
	S-	•						•		•			
PSD													
ACQ	01	•	•								•		
	02												
	03			•			•					•	
	04							(•)					
	05	•		•	(•)	(•)		•		•		•	•
EXT												•	

APPENDIX E

COMPARISONS OF POST-TONE BEEG EPOCHS TO THE BASE EPOCH.

Only significant mean differences are given (related *t*-test, 2 tail, $p < .05$).

		PSEUDO		ACQUISITION										EXTINCTION	
				01		02		03		04		05			
Cz		S1	S-	S1S2	S-	S1S2	S-	S1S2	S-	S1S2	S-	S1S2	S-	S1	S-
1-4 Hz	1	-19.9	-15.3					-16.2		- 9.5	14.7	-19.4		12.7 10.7 -25.1	
	2	-14.8 -26.3						16.9		13.9					
	3			12.8				-15.0				-13.9	-13.6		
5-7 Hz	1														
	2		9.7							-13.9			- 9.4		
	3	13.8	- 8.6			- 8.5	8.7					-14.7			-11.6
8-12 Hz	1					14.9		14.9	5.7 14.9	11.0	- 7.1	18.7			25.5
	2					15.5			- 7.1			7.4 17.2 17.5	-10.3		
	3					14.3	7.0	12.7			- 5.8	10.2	-10.7 7.4		22.3 17.5
13-30 Hz	1					3.4	2.9						3.8	- 8.3	- 8.2
	2								- 4.0		3.7 - 7.6			- 3.8	
	3								- 3.3 1.9		- 3.7	6.7	4.2		2.3 - 5.5
Oz															
1-4 Hz	1	15.7				10.8		-18.4 12.3 -13.0						- 8.7	-21.4
	2	24.6	-14.0					-14.4	22.4		11.3	-32.1	21.0	23.9	-19.1
	3	18.0		-15.5		-11.2		-20.6 -15.9		12.2		-15.1 -23.5	17.9 15.0		-11.1
5-7 Hz	1	-14.5	9.4 -14.4		8.0 5.0								- 7.8		
	2	- 8.4 - 6.8 - 5.6	15.4	6.3				- 6.5 - 6.3	-12.0	4.3		13.7		-16.1	- 9.9
	3	- 5.2	- 9.6	7.8	- 8.7	- 5.3		3.2	- 6.2	-12.1	7.0		- 6.1		
8-12 Hz	1	-10.9				-11.1		22.2			- 9.0	29.3			20.3 23.8
	2					- 8.1		21.6			- 9.8	36.1	-21.0	-13.0	22.2
	3			9.7		14.1		23.5 14.8	6.1	16.0	- 5.3	21.4 36.1			19.2 34.8
13-30 Hz	1	- 4.9	- 6.8 - 3.5 - 4.7					- 4.7	- 4.6			- 5.9			- 4.6 - 7.2
	2	-14.0						-11.2 2.8		- 3.9			4.7 3.2	- 3.9	- 5.6
	3							- 6.1 2.5		- 7.6 6.6 3.7			3.0		- 8.1

		PSEUDO		ACQUISITION										EXTINCTION	
				01		02		03		04		05			
C3		S1	S-	S1S2	S-	S1S2	S-	S1S2	S-	S1S2	S-	S1S2	S-	S1	S-
1-4 Hz	1							-16.3 -11.5 18.0		-16.1		-24.5			-28.6 -12.3
	2	-16.8						12.8				-14.5			
	3	9.0						-13.8		-12.7 -19.3		-18.2		12.7	-18.0
5-7 Hz	1					6.0	- 8.1 -13.0								
	2	9.8									- 7.7	-19.0			
	3	8.2		7.6		- 8.0							7.1		
8-12 Hz	1					15.2 8.9		22.1 7.8 -13.6 9.4	8.4	22.5		20.4		10.9	27.4
	2	-17.6	-26.7					18.4		14.3	-10.2	17.7	- 3.7	- 5.7	
	3					14.6		16.9 13.2		17.1 10.3		20.3			21.2
13-30 Hz	1									- 9.1			5.4		
	2			6.2		5.0		- 9.2							
	3						4.1			4.4				- 5.5	- 5.7
C4															
1-4 Hz	1	-18.7	-17.8		-17.4		-23.1	23.6		-16.7 17.0		-16.9	9.1	12.7	
	2	-18.8			-15.3			14.4	12.0	13.3				11.5	
	3	16.3					-12.3	-11.7 13.6		-15.6			-18.7	21.1	
5-7 Hz	1	10.1	-10.4												
	2	15.2	11.1							- 5.0 -12.7	6.3			- 7.8	
	3	-14.0				8.7				- 6.0				-12.5	3.3
8-12 Hz	1			9.3		21.8			6.0	21.6		15.0 20.6	- 7.0		
	2					19.0		9.9		17.5		16.9 18.6			
	3					17.2	9.4	13.2 -10.2		21.7		15.3 19.6			
13-30 Hz	1					- 5.9 6.9	5.1							- 9.6	- 8.0
	2					4.2 5.3		- 4.5	- 5.6		4.4		4.4	- 9.9	
	3		2.8						- 7.0				5.8	- 7.3	6.7

		PSEUDO		ACQUISITION										EXTINCTION	
				01		02		03		04		05			
T3		S1	S-	S1S2	S-	S1S2	S-	S1S2	S-	S1S2	S-	S1S2	S-	S1	S-
1-4 Hz	1	15.9			-16.7				9.7						
	2	16.5	-28.3		-15.5	6.7					14.6		16.4		- 9.3
	3				-13.1										
5-7 Hz	1		7.3				- 6.6	6.2				8.7			
	2						4.9			13.3		-13.7			
	3		-12.8												
8-12 Hz	1	- 9.6				10.9		15.3		17.5 16.1		11.4			16.9
	2	-17.5						14.9 5.5			- 6.1	7.8 -11.6			
	3	- 9.4 2.4				11.4		11.8		13.1		12.1	-18.4	-13.4	
13-20 Hz	1			-10.4 - 6.7				- 9.7	-11.5	- 7.0		- 4.9	- 8.2		
	2				8.4			- 8.2	- 4.8	-12.4	4.5		- 7.3 6.1		
	3					- 9.0 10.1		- 6.9				- 7.1	8.0	11.1	8.9
T4															
1-4 Hz	1				-14.1 -18.9			18.1		-14.2 -11.7 14.0					
	2							- 8.9	13.0						
	3			-11.7				-10.3 12.2				- 9.8	-12.6		-19.9
5-7 Hz	1		9.5 13.7			- 9.9		- 9.1						-11.6	-17.9
	2					- 8.5		7.3		- 4.4					
	3					4.5		- 6.8				12.2			-19.2
8-12 Hz	1				6.4		5.8			16.0	12.3	13.7		9.6	
	2							11.2	-13.6	13.3		13.2			
	3				11.7			15.1		17.6		15.8			15.9 24.6
13-30 Hz	1	8.0		-12.4	9.5	8.7	7.4	- 5.0	- 6.4		5.5		- 3.6		9.6 -13.6
	2	6.8		8.8	8.6			- 8.2				5.0 - 6.4			- 9.7
	3			8.9 - 8.4	9.7							- 7.6			9.3 - 5.8

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