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An electrophysiological study of individual human learning.

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AN ELECTROPHYSIOLOGICAL STUDY OF INDIVIDUAL HUMAN LEARNING

by

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ABSTRACT

This study investigated the relationships between the electrophysiological activity in skeletal muscles and individual complex learning. Three experimental tasks of ordered complexity were employed. These were, a No-Learning task of a perceptual-motor nature, a Pair-Learning task of a stimulus-response nature, and a Problem-solving task of a cognitive nature. The electrophysiological activity (physiological responses) was determined by the surface electromyographic technique.

The experimental group consisted of nine male undergraduate, monolingual students. The level of learning was determined over blocks of six trials. The physiological responses were similarly determined.

The results showed an increase in the magnitude of the physiological responses from the no-learning task to the pair-learning task, and from the pair-learning task to the problem-solving task. These increases were shown to be statistically significant. The increases in the magnitude of the physiological responses could not be attributed to physical work as it was identical in the three experimental tasks. The differences in the magnitude of the three physiological responses within subjects was not significant.

The duration of the physiological response of the active arm was found to increase significantly between the no-learning task and both of the two learning tasks. The difference of the physiological

response duration between the two learning tasks was not significant.

The results were discussed in terms of central processes. Further research to broaden the understanding of the relationships between the electrophysiological activity in the periphery and individual complex learning was recommended.

PREFACE

This study began approximately two years ago when the author became increasingly aware that there was more involved in the understanding of learning than merely investigating isolated overt response characteristics. It was felt that a broader and more wholistic understanding of learning could be gained by measuring, in some way, the internal physiological activity of individuals while learning tasks of varying complexity. Thus, with the excellent research facilities available in the department of Psychology, University of Windsor, it was possible to design and conduct a research project studying the electrophysiological activity in skeletal muscles during learning tasks of varying complexity. Aside from the theoretical value of such research in the psychology of human learning, it presents excellent opportunities for research in more applied but essential aspects of human behaviour such as the detection of physiological abnormalities where learning problems are known to exist.

I would like to express my gratitude to Professor A. A. Smith, my director whose suggestions for experimental and apparatus design, and his enduring patience and guidance made this paper a reality. I wish also to express my appreciation to my readers, Professor J. V. Basmajian of Queens University, for his helpful suggestions and for coming to Windsor for the oral examination, and to Professors R. C. Fehr and M. W. Starr for serving on the committee.

I wish to express my gratitude, again, and personal indebtedness to Professors Fehr, Smith and Starr for the excellent training and guidance that I have received during my four years in the department of Psychology, University of Windsor, as a graduate student. Without the understanding and teaching of these truly unique and brilliant men this thesis could not have materialized or been completed.

Finally, I would like to thank Walter Schredel, my friend, who assisted me in so many countless and valuable ways in the technical aspects of the thesis; and Katherine Ladd, my wife, who typed the many drafts of the thesis.

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CHAPTER I

INTRODUCTION

Studies of the electrophysiological activity in skeletal muscles of individual humans while performing various psychological tasks have been reported in the literature since the late 1930s. The general goal of this active area of research has been to determine the quantitative changes in the electrophysiological activity during performance of a specific task and then, to theoretically interpret the electrophysiological activity in terms of central processes; i.e., central nervous system mechanisms and/or activity, underlying the organized performance of the task. The changes in the electrophysiological activity; i.e., the electrical activity of the motor units of the skeletal muscles, have been found to be progressively increasing changes, beginning with the onset of a continuous task and continuing to the termination of the task. In the studies reported these progressive increases have been referred to generally as "physiological gradients". The gradients have been theoretically interpreted, in terms of central processes, as indicating increasing levels of either motivation, attention, activation, awareness, interest, or such during performance of the task. The tasks have been limited, for the most part, to perceptual-motor type behaviour.

Malmo (1965) and Thompson, Lindsley and Eason (1967) have presented excellent reviews of the studies in this area of electrophysiological research in psychology. Basmajian (1965) has presented a review concerned with the underlying anatomical considerations of the electrophysiological activity in the skeletal muscles.

Hodgkin (1964) has presented a definitive explanation of the bio-chemical and the bio-physical mechanisms underlying the electro-physiological activity. Sidowski (1967) has presented a detailed report on the current status of instrumentation and methodology in this area.

An extensive review of the studies in this area of electro-physiological research in psychology has revealed two major contributions from which the investigation undertaken in this thesis has been developed. First, the recent advancements in instrumentation and technical methodology have made the necessary complex and sensitive equipment readily available to any laboratory, specifically the psychology laboratories of the University of Windsor. Secondly, in that the majority of studies reported have been limited generally to one behavioural level; i.e., perceptual-motor tasks, a well developed experimental approach has been established for electro-physological research in psychology.

The result, stemming from these contributions, is that both the necessary equipment was available and a dependable experimental approach has been developed at one behavioural level from which the experimentation in this thesis has been designed for a different and more complex behavioural level. That is, three different experimental tasks were designed to study the electrophysiological activity of the skeletal muscles of individual humans during complex individual learning. Task one was operationally defined as a "no-learning" task; task two was defined as a "pair-learning" task; and task three was

defined as a "problem-solving" task.

The research was of a highly exploratory and empirical nature. The first objective of the research was to determine the relationship between the electrophysiological activity of the forearm extensor muscles and the speech muscles and performance of the three experimental tasks during acquisition. The second objective was to determine the same relationship during over-learning.

A brief historical overview of the science of electrophysiology has been presented in the following section separately from the review of the studies of electrophysiological research in psychology. This has been done to give the reader a general idea of what the electrophysiological activity in skeletal muscles is in this and in other studies.

HISTORICAL OVERVIEW OF ELECTROPHYSIOLOGY

Until 1791 electrophysiological activity of nervous tissue was a highly speculative and little known phenomena. In this year Galvani (1791) published his famous Commentarius with the conclusion that nerves contain an intrinsic form of electricity:

Conjecturæ, & conſectaria nonnulla.

EX hactenus cognitis, exploratiſque ſatis conſtare arbitror, electricitatem animalibus ineſſe, quam liceat nobis cum Bartolonio, aliiſque generali quodam nomine animalem appellare. Hæc, ſin minus omnibus, pleriſque tamen animalium partibus continetur; ſed in muſculis, ac nervis luculentiſſime ſe exhibet. Hujus peculiare nec antea cognitum ingenium eſſe videtur, ut a muſculis ad nervos, vel ab his potius ad illos tendat vehementer, ſubeatque illico vel arcum, vel hominum catenam, vel quæcumque alia deferentia corpora, quæ a nervis ad muſculos breviori, & expeditiori ducant itinere, celerrimeque per eadem ab illis ad hos excurrat.

Ex hoc autem duo maxime profluere videntur, duplicem ſcilicet in his partibus electricitatem eſſe, poſitivam aliam, ut credere eſt, aliam negativam, atque alteram ab altera penitus eſſe natura ſejunctam; ſecus enim æquilibrio habito, nullus motus, excurſus electricitatis nullus, nullum muſcularis contractionis phænomenon. (1)

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(1) From the things that have been ascertained and investigated thus far, I believe it has been sufficiently well established that there is present in animals an electricity which we, together with Bartholonius and others are wont to designate with the general term, "animal". This electricity is present, if not in all, at least in many parts of animals. It is seen most clearly, however, in the muscles and nerves. Its special characteristic, not recognized before, seems to be that it courses strongly from the muscles to the nerves or rather from the latter to the former, and directly enters an arc, a chain of men, or other conducting bodies which lead from the nerves to the muscles by the shortest and most direct course possible, and passes in all haste from one to the other through them.

From this, two facts are particularly evident, namely that

This discovery, using nerve-muscle preparations of sheep and dogs, marked the beginning of the science of electrophysiology. Another 50 years passed before scientists realized that the electrical activity of the nervous system could be used as an inherent sign of its function; instead of, as Galvani had actually demonstrated, that nervous tissue was capable of the conduction of electricity. It was in 1848 that it was finally demonstrated by DuBois-Reymond that activity in a nerve was invariably accompanied by an electrical change and current flow (Brazier, 1961; Zacks, 1964). He had successfully demonstrated, working in peripheral nerves, that an electrical signal is concomitant with the transmission of the nerve impulse, which is still the most important concept for determining the transmission of impulses in nerves. DuBois-Reymond stated that the electrical change was due, possibly, to changes in concentration of chemicals between the inside and outside of the merve membrane. The next major step in electrophysiology was the establishment of similar electrical activity in the brain. The first account of this in the literature was reported by R. Caton of England in 1875 (Brazier, 1961). Caton experimented with the exposed brains of rabbits and monkeys using surface electrodes

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a two-fold electricity is present in these bodily parts, one positive, as one supposes, the other negative, and that each is completely separated from the other by nature: otherwise, if there were a state of equilibrium, no movement, no flow of electricity, and no phenomenon of muscular contraction would take place.
Translated by Margaret Glover Foley. Burnby Library, 1953. Norwalk, Connecticut. Publication No. 10, pp. 132-133.

and a galvanometer to establish the presence of electrical activity.

To account for the invariable electrical activity and current which was demonstrated by DuBois-Reymond, Bernstein presented the "membrane theory" of nervous conduction in 1868 (Zacks, 1964) and in 1902 and 1912 (Hodgkin, 1964). Broadly, Bernstein conceived the resting nerve as being surrounded by a polarized membrane with selective permeability to potassium. It was basically the neutralization of the polarized membrane that was responsible for the electrical current flow. Bernstein's membrane theory was widely accepted without major modification until the early 1950s. Hodgkin and Huxley (1952) have modified Bernstein's theory to show that it was not a neutralization of the polarized membrane potential but a reversal of the potential, from negative to positive, which was responsible for the electrical transmission of the impulse. That is, in the resting state the membrane interior is high in potassium ions and low in sodium ions with respect to the extracellular solution, resulting in a negative potential. Under stimulation the membrane was shown to be more permeable to sodium ions and, as a result, the inside swings momentarily positive, giving a transient "action potential". At the peak of the action potential the inside of the membrane is positive with respect to the extracellular solution. This ionic change has been attributed to a selective ionic permeability quality of the membrane (Hodgkin, 1964).

In terms of the electrophysiological activity of the skeletal muscles it is these action potentials, originating in the motor neuron, that are the basis of the electrophysiological gradients

discussed in the introduction. Specifically, it has been shown that with the activation of the spinal motor neuron the action potential is conducted via the motor nerve axon spreading into the terminal branches of the motor end-plate of the muscle fiber (neuromuscular junction), resulting in the end-plate action potential (Gasser and Erlanger, 1930). It is important to state that the end-plate potential has been found to be a graded response. It has no refractory period, and subsequent excitation before it has decayed will cause summation along the whole length of its electrotonic extension; i.e., a few millimeters (Brazier, 1960). This summative property of the end-plate potential may have accounted, in part, for the physiological gradients obtained in previous research. The end-plate potential, in turn, gives rise to muscle action potentials which are propagated toward both ends of the muscle fibre from the centrally located end-plates.

This electrophysiological activity, in the form of action potentials, between the motor neurons and the muscle fibers is what has been measured in the physiological gradients referred to in the introduction. The physiological gradients have been determined generally by measuring and recording the electrophysiological activity for specific muscles or muscle groups from the surface of the skin. This procedure has been shown to result in a broad survey of the action potentials generated by many motor units within a specific muscle or group of muscles (Basmajian, 1964; J.F. Davis,1959). This procedure of measuring the electrophysiological activity from the surface of the skin has been referred to as "electromyography" and

the actual recordings have been referred to as "electromyograms" (EMGs) in the literature. It is important to realize that the surface EMG is not a direct measure of musculature contraction, although a high correlation has been shown to exist between the electrophysiological activity and the mechanical or muscular events (Bullock, 1959). The EMG has been shown to be, again, a more direct index of motor nerve activity in the form of motor neuron action potentials, as the magnitude of the gross electrophysiological response in the motor unit is a direct function of the amount of central nervous system stimulation imposed upon the individual motor neurons (Bullock, 1959).

The study of the relationship between the electrophysiological activity of skeletal muscles and performance of experimental psychological tasks, employing the surface electromyographic technique, had its beginning with the work of R.C. Davis (1937, 1940). Since that time numerous studies have been reported in the literature. A review of these studies and other electrophysiological studies, pertinent to this thesis, is presented in the following review of the literature.

REVIEW OF THE LITERATURE

The review of the literature is an aggregate review with the emphasis on the empirical results. The appropriate review references and the individual studies have been cited extensively for the reader who is interested in specific details.

The individual studies concerned with the relationships between the electrophysiological activity in skeletal muscles and performance have been generally within the behavioural framework of continuous perceptual-motor tasks; e.g., visual and auditory discrimination, tracking behaviour, mirror tracing, grip pressure, listening and talking. The electrophysiological activity has been determined by recording from the surface of the skin over the muscle or muscles specified. The electrophysiological activity has been measured in terms of quantitative changes in microvolts over time or task performance. The measurements (EMGs) have been generally referred to as "physiological gradients". This term has been used as the quantitative changes in the electrophysiological activity have been shown to be continued and progressively monotonic increases. The gradients have been shown to commence with the onset of the task and continue to the completion of the task, and decrease sharply with task completion. The gradients have been observed often in muscles not actively engaged in the task as well as in those muscles directly engaged in the task.

Time courses of the gradients have depended on the length of the experimental tasks. This has been from 20 to 30 seconds in the

case of some mirror drawing tasks, for example, up to 10 minutes in the case of listening and talking tasks.

In the majority of cases individual studies have yielded the physiological gradients during performance where they have been looked for (Bartoshuk, 1955, a, b; Bartoshuk, 1956; Belanger, 1957; Courts, 1939; Davis, R., 1937; Davis, F., and Malmo, 1951; Davis, J., and Mundl, 1964; Eason, 1960, 1963; Eason and Branks, 1963; Eason and White, 1960, 1961; Elliott, 1964; Freeman, 1940; Harter, Eason and White, 1964; Kennedy and Travis, 1947, 1948; Malmo and Davis, 1956; Malmo and Shagass, 1949; Malmo, Shagass and Davis, 1951; Malmo and Surwillo, 1960; Pinneo, 1961; Ryan, Cottrell and Bitterman, 1950; Schnore, 1959; Shagass and Malmo, 1954; Shaw, 1956; Smith, 1953; Smith, Malmo and Shagass, 1954; Stennett, 1957; Surwillo, 1956; Wallerstein, 1954).

Failure to observe gradients in adults have been relatively uncommon. MacNeilage (1966) has reported that he had observed no gradients during a paced auditory task. He did not attempt to explain his failure to observe gradients. In reference to these results Belanger's (1957) findings appear relevant. Belanger required subjects, in a task requiring a series of rapid visual discriminations, to press a button each time a judgement was made. Under these conditions physiological gradients were obtained. However, when all the subjects had to do was to press the button at the same intervals without making the visual discriminations, physiological gradients were not observed. Malmo (1965) has stated that the failure to observe gradients is due,

perhaps, to the fact that the task may be too simple and, therefore, too low in its demands on the individual. Eason's (1959) failure to have observed gradients appears similar to Belanger's results and may be accounted for by the simplicity of the experimental task.

Elliot (1964) has reported that he failed to obtain gradients in young children during experimental conditions where typical gradients were observed in adults. Elliot concluded that the failure to observe gradients was due primarily to the fact that the children were far less able than the adult subjects to maintain an undivided and persevering attention to the experimental task.

The reviews in this area of research have been presented periodically by Bartoshuk, 1955b; Courts, 1942; Duffy, 1957, 1962; Malmo, 1957, 1959, 1962, 1965; Lazarus, 1966; Meyer, 1953; Thompson, Lindsley and Eason, 1966; Woodworth and Schlosberg, 1954. These reviews as well as the individual studies have pointed out that in general as performance proceeds, physiological gradients are observed. The gradients have shown a continued monotonic increase from the onset to the end of the task and fall off sharply with task completion. Typical gradients are shown in Figure 1.

In relating the physiological gradients to performance, as a rule, these two variables have been found to be positively related. That is, as performance increases, the gradients have been found to increase. Several studies have shown a negative relationship; e.g., Eason, 1963; Davis, R., 1940. This negative relationship has been accounted for in either of two ways. First, if the

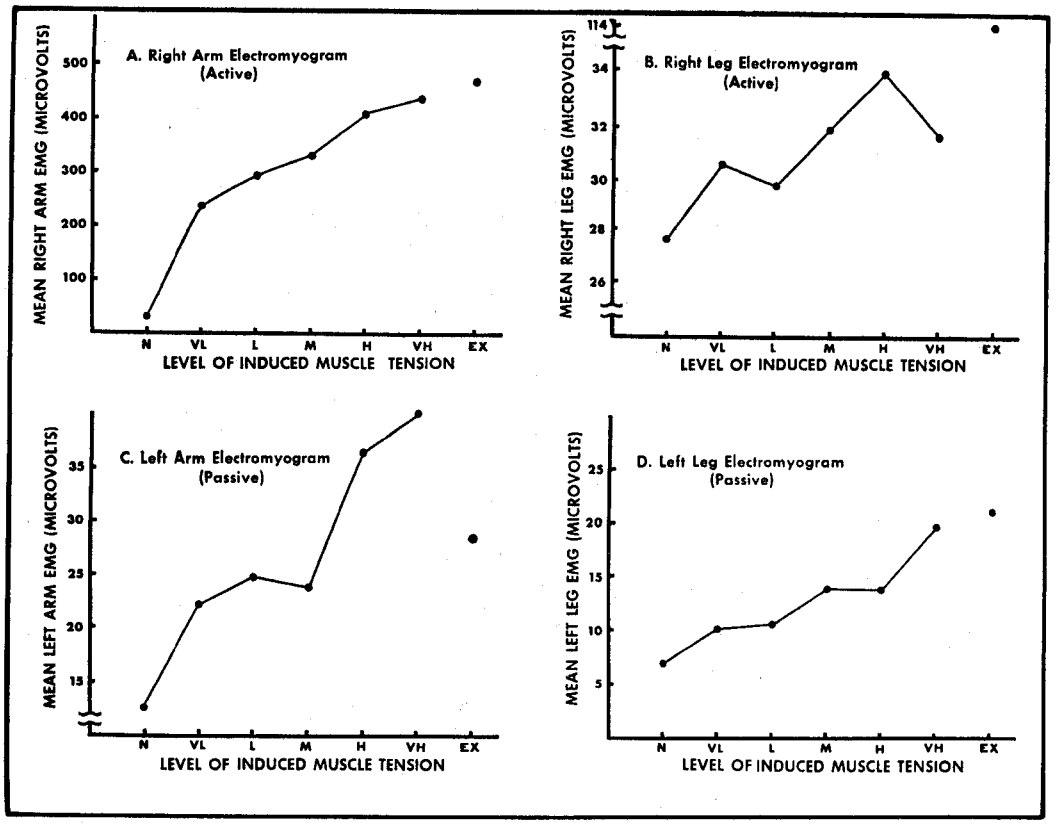


Figure 1. Muscle tension of active limbs (used in tracking or in squeezing on the dynamometer) and passive limbs (not used in any way, merely resting) as a function of induced muscle tension. Baseline intervals are as follows: No tension (*N*), very light tension (*VL*), light tension (*L*), heavy tension (*H*), very heavy tension (*VH*). The last unconnected point on each curve is for the "exertion" condition in which the majority of subjects exerted their maximum pull on the dynamometer during a period at the end of the experiment when they were not tracking. [Data from Pinneo, 1961, courtesy of the *Journal of Experimental Psychology*.]

increases in the physiological gradients were produced by factors extraneous to the task, this could account for a negative relationship. Second, a negative relationship could be expected if the individual was performing at maximum skill level at the beginning of the task. In such case, no further improvement could occur and there may actually be a decrement in performance which, in turn, could result in a decreasing gradient during performance. Evidence that such decrements do occur under these conditions was reported by Eason (1963).

Various suggestions have been offered in terms of central processes as to what is indicated by the relationship between the physiological gradients and performance. The first formal statement concerning the relationship in terms of central processes was given by Smith (1953). Smith's hypothesis was stated as follows:

> ... the observed increase in muscle tension during drawing reflects the developing organization of a central neural process, which controls and "anticipates" the overt activity, and is yet relatively independent of immediate sensory stimulation (1953, pp. 34-35).

In the majority of studies following Smith's there was a definite trend away from discussing the relationship between the physiological gradients and performance directly in terms of central processes. Instead, the interpretations were discussed in more specific behavioural and physiological terms such as motivation and activation. These interpretations are discussed subsequently. The current trend in the discussion of the relationship between physiological gradients and performance is, again, in terms of central processes directly. This thinking has been reflected currently in Malmo's (1965) hypothesis

developed from an extensive review of the literature:

> Again, the evidence indicates that the rising gradients do not signify increasing motivation, degree of interest, or the like, during the course of the behavioural sequence. Instead, the indications are that this increasing "tonic" background is somehow part of the whole physiological activity seemingly required for sustaining a relatively even level of attention from the beginning to the end of the task..(1965, p. 231).

In terms of specific qualities of behaviour Bartoshuk (1955 a,b,; 1956) has discussed the relationship between physiological gradients and performance in terms of motivation. His hypothesis was that the gradients are a direct function of strength of motivation to perform a given task. The motivational hypothesis has been used by Elliot (1964), MacNeilage (1966), Surwillo (1956), Wallerstein (1954) and others. Other specific qualities of behaviour referred to have included interest, attention and such. These qualities are generally subsumed under the general heading of motivation.

The specific physiological quality that has been referred to is activation or arousal (Duffy, 1962; Eason, 1963; Malmo, 1962; Pinneo, 1951; Schnore, 1959; Stennet, 1957 and others). The activation hypothesis has stated generally that the gradients reflect the relative amount of effort or activity exerted during the performance of various perceptual-motor tasks. It has been suggested that activation is mediated chiefly through the ascending reticular activating system (Magoun, 1964; Malmo, 1962).

At the present stage of empirical knowledge in this area of psycho-physiological research the empirical results and the hypotheses should be considered as limited and tentative.

This statement is made in view of the fact that the research has been limited generally to perceptual-motor tasks and the empirical relationships observed during acquisition only. It is important, therefore, that this type of research be extended both in terms of more complex behaviour and in terms of over-learning, or active participation in the experimental task beyond acquisition.

It is felt that such research would result in a more definitive understanding of the empirical relationship between the electrophysiological activity in the skeletal muscles and performance. It is the purpose of the present research to accomplish this. Three experiments were designed to study the relationships between the electrophysiological activity in the skeletal muscles and performance during complex learning.

The first experiment, a "no-learning" task, was designed to determine the relationship between the physiological activity and performance in terms of physical work. The physical work in the no-learning and the two learning tasks was identical. The two learning tasks were defined as complex learning tasks. Complex learning is defined as learning where mediation could be inferred. The first learning task was of a stimulus-response nature and is referred to as the "pair-learning" task. The second learning task was of a cognitive nature and is referred to as the "problem-solving" task.

The research was of an highly exploratory nature with the emphasis on establishing the empirical relationships between the electrophysiological activity in specific skeletal muscles and complex learning during both acquisition and over-learning.

CHAPTER II

METHODOLOGY AND PROCEDURE

Subjects

The subjects were nine male undergraduate students enrolled in the introductory psychology courses at the University of Windsor. The age range of the subjects was limited to between 19 and 21 years. This precaution was taken to minimize possible variations in the electrophysiological recordings which could have been attributed to chronological age factors. All subjects were english speaking monolinguals since it has been determined in previous investigations by the writer and others that monolinguals learn more rapidly than bilinguals in the type of experimental learning procedure employed.

The nine subjects were randomly assigned to three different experimental learning tasks: a no-learning task, a pair-learning task, and a problem-solving task. Three subjects each were assigned to the three tasks. A total of 30 subjects were used to complete the experimentation. The first eight subjects used were discarded because of an improvement in preparing the skin for electrode placement. The improvement was a lowered skin resistance which, in turn, resulted in clearer electrophysiological recordings. The additional loss of 13 subjects was due to either too high a skin resistance for clear electrophysiological recordings, refusal to participate, or to apparatus failure during experimentation.

The subjects participated on an individual basis. That is, one subject was run each day of experimentation. The order of participation was random regardless of which one of the three experi-

mental tasks the subject participated in. The starting time for each experimental session was between 3:00 p.m. and 3:30 p.m. This time variable was controlled in order to minimize variability in the individual electrophysiological activity which could be attributed to temporal variations in fatigue and skin resistance. Experimental time was approximately two hours for each of the three subjects participating in the no-learning task. Experimental time was approximately three hours for each of the three subjects participating in either the pair-learning task or the problem-solving task.

All subjects were naive as to the nature of the experiment and the apparatus previous to participation. The subjects were not reimbursed for participating in the experiment and were free to refuse. Each subject was contacted one day in advance of participation.

Apparatus

Experimental

The General Learning Apparatus (GLA) of the department of Psychology, University of Windsor was used. The apparatus consisted of six isolated individual panels and a master console from which all panels were automatically operated. The GLA has been operationally and physically described in detail elsewhere (Cervin, Smith and Kabisch, 1966). Of the six panels A through F, panel B was used. A diagrammatic representation of panel B as it appeared to each subject in the no-learning task is presented in Figure 2. The six orange lights and the six response buttons numbered 1 through 6 were used in this task. The onset, duration time and offset for each orange light presentation was pre-programmed and controlled from the console.

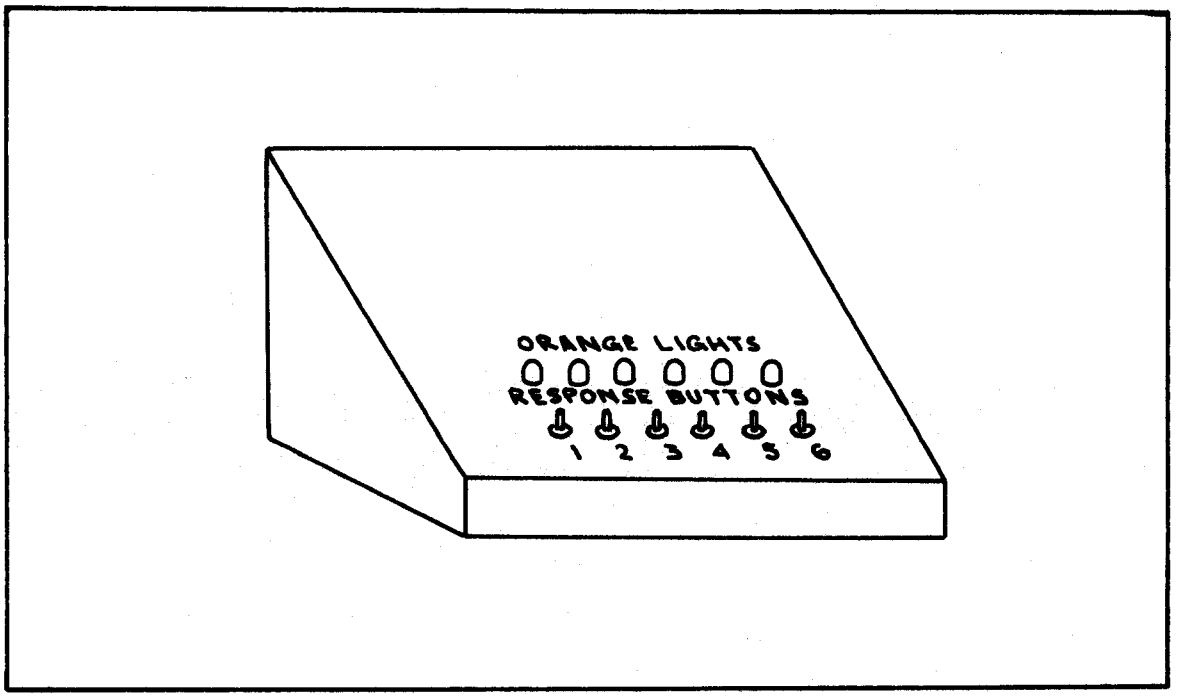


Figure 2. Panel B as it appeared to each subject in the no-learning task.

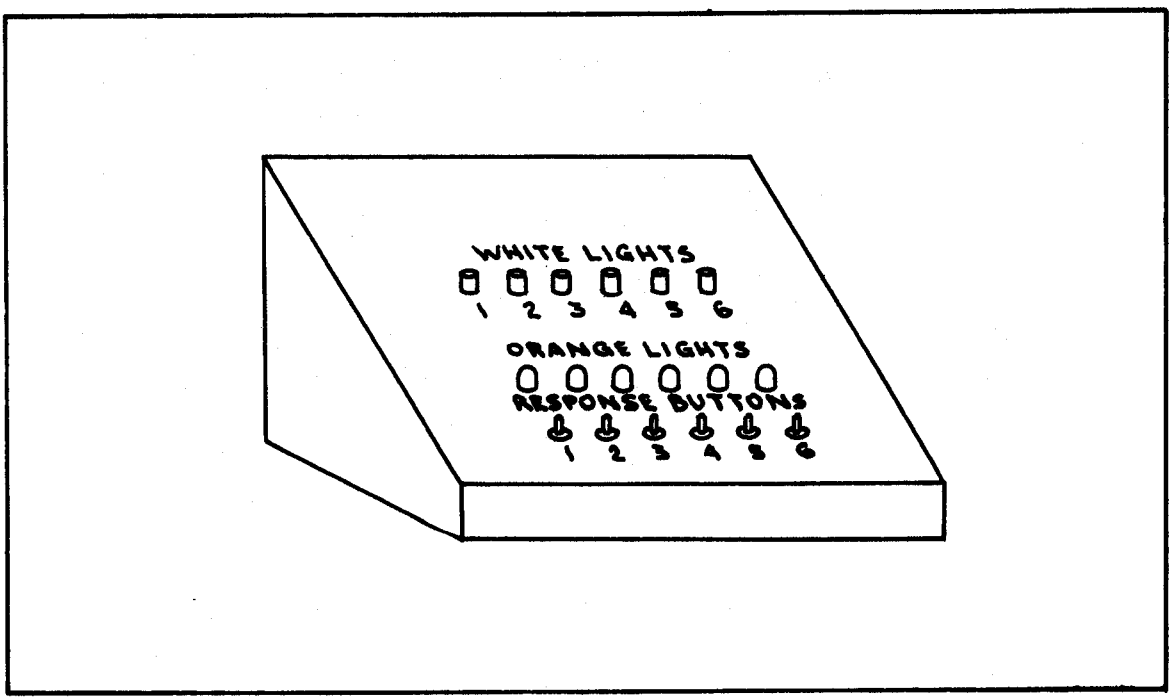


Figure 3. Panel B as it appeared to each subject in both the pair-learning and the problem-solving tasks.

The time between orange light presentations (inter-trial interval) was pre-programmed and controlled from the console.

A diagrammatic representation of panel B as it appeared to each subject in both the pair-learning and in the problem-solving tasks is presented in Figure 3. The six white lights numbered 1 through 6, the six orange lights and the six response buttons numbered 1 through 6 were used in both tasks. The onset, duration time and offset for the white and orange lights were pre-programmed and controlled from the console. The time between white light presentations (inter-trial interval) and the time between white light onset and orange light onset (interstimulus interval) were pre-programmed and controlled from the console.

The subject's panel was situated at a distance from the programming console of the GLA, in a small sound-treated room adjacent to the electrophysiological recording apparatus. Since the GLA normally operates on alternating current which, despite attempts at screening and grounding, resulted in a gross artifact in the recordings, it proved necessary to terminate the remote cable in a relay panel as an interface (Figure 4), and feed the buttons and lights on the panel with direct current from a 12 volt automotive battery.

The room had one small double-glass window, to permit observation of the subject. The interior was painted a neutral grey and was illuminated by a single incandescent bulb mounted in the centre of the ceiling in a large milk-glass diffusing globe.

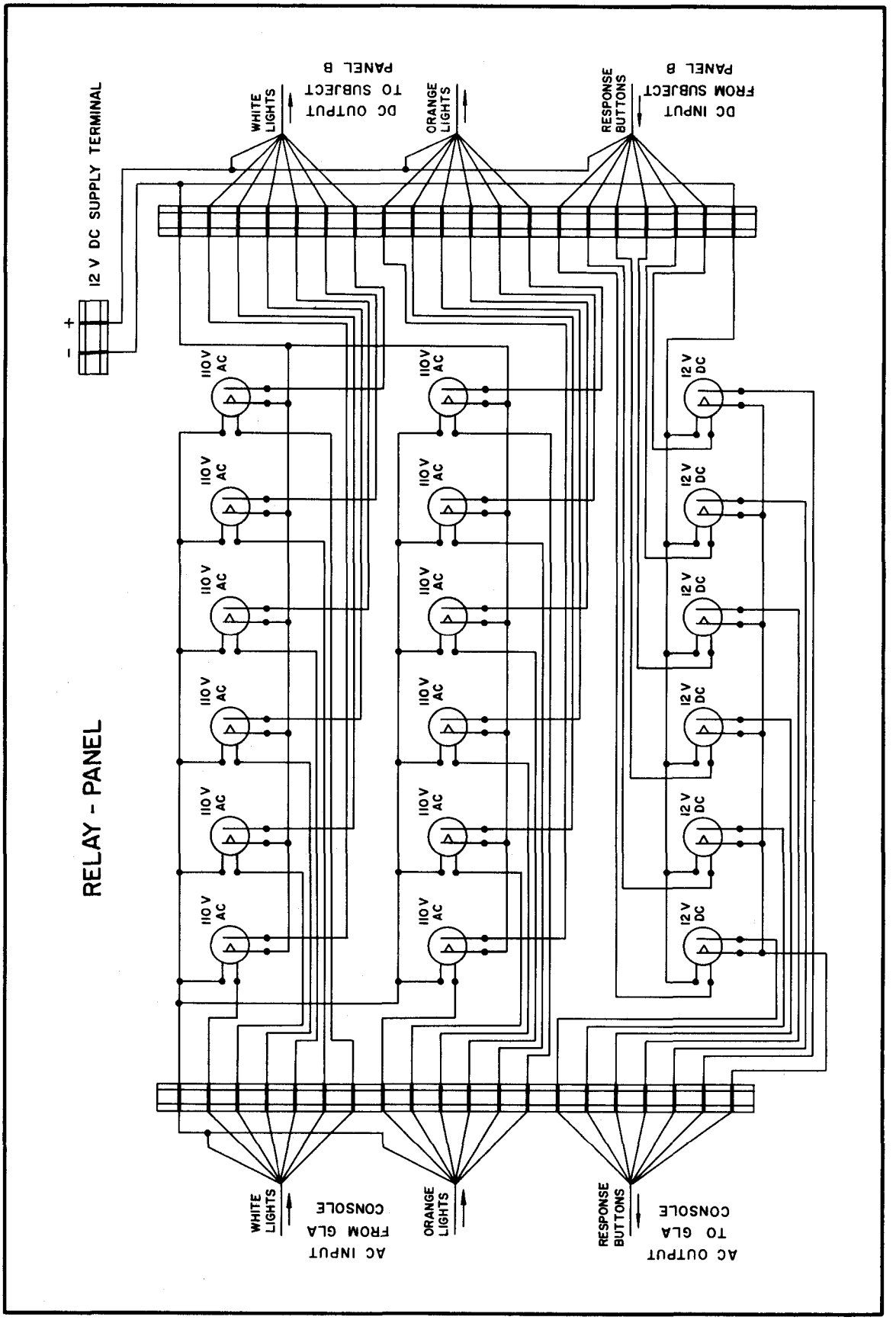


Figure 4 : Relay panel used to supply the buttons and lights of the subject panel with 12 volt direct current .

The subject sat in an arm-chair, facing the GLA panel, with the lead terminal box (Offner Model) mounted conveniently near, but out of the direct view. There were no other furnishings or apparatus in the room. This type of experimental room was used to eliminate electrophysiological responses caused by external novel stimulation. Such activation responses mediated by the reticular formation could have confounded the electrophysiological responses which were being attributed to the experimental tasks (Magoun, 1964).

Electrophysiological

A standard Offner eight-channel, ink recording TYPE R DYNOGRAPH was used to measure, amplify and record the electrophysiological activity of skeletal muscles in the form of electromyograms (EMGs). Channels one through six, of the eight channels were used. Each of the six channels was functionally made up of an input selector, input coupler, pre-amplifier, amplifier, zero setting control, and an ink-recording unit. Detailed information concerning the operation of this equipment is contained in the Offner Manual for TYPE R DYNOGRAPHS. This manual is available at Offner regional offices or directly from; Offner Division, Beckman Instruments, Inc., 3900 River Road, Schiller Park, Illinois.

Of the six channels, channel one was used to measure and record the direct EMG of the left forearm extensor muscle, channel three the direct EMG of the right forearm extensor muscle, and channel five the direct EMG of the speech muscles (depressor labii inferioris, geneoglossus, platysma, and the digastric muscles) via

the chin. Channel two was used to measure and record the integrated EMG of the left extensor muscle, channel four the integrated EMG of the right extensor muscle and channel six the integrated EMG of the speech muscles. The integrated EMGs were proportional to the average number, amplitude and duration of the impulses of the direct EMGs.

The direct EMG records which illustrated both the positive and negative moment-to-moment changes in the action potentials within the muscles were used to determine the source of change illustrated in the integrated EMG records. The integrated EMGs, summing the positive and negative changes without reference to sign, were recorded in one direction from a predetermined base and were used for purposes of analysis (see Appendix A for typical direct and integrated EMG recordings). The six EMGs for any one subject were recorded simultaneously on continuous 16 inch wide curvilinear record paper.

In addition to the eight ink-recording units for electrophysiological recording, the Dynograph was equipped with two event-marker pens. The onset and the offset of the orange light were continuously recorded on one of the marker pens in the no-learning task. The response, depressing the response button, was continuously recorded on the second marker pen. These experimental events were recorded simultaneously with the EMGs. The onset and the offset of both the white light and the orange light were continuously recorded on one of the marker pens for both the pair-learning and the problem-solving tasks. The response, depressing the correct response button, was continuously recorded on the second marker pen. Again, these

experimental task events were recorded simultaneously with the EMGs. This simultaneous recording of the experimental task events and the EMGs for each subject allowed for precise determination of the relationships between the experimental task events and the EMGs (to be referred to as physiological responses).

Offner type 350069 surface electrodes were used to pick up the elctrophysiological activity in the muscles. These electrodes are described in detail in Offner Manual 0-TB-002. This manual is available at the same addresses listed previously for the TYPE R DYNOGRAPH manual.

For each area of electrophysiological measurement, left and right forearm extensor muscles and speech muscles, two electrodes were used. The two electrodes were spaced two inches apart, center to center. This electrode placement procedure has been described as a bipolar lead, or, recording from two points, both of which are active (Davis, J., 1959). It was the electrophysiological activity, increases and decreases in action potentials, between the two electrodes which constituted the physiological responses. In addition, one ground electrode was attached to the inside surface of the left forearm of the subject. The Beckman, Offner electrode paste was the conduction medium used between the electrodes and the skin surface.

Procedure

Electrophysiological

The procedure used for subject preparation and for determining the specific areas where the electrodes were placed on the surface

of the skin was identical for each of the nine subjects. Initially, and before subject preparation, the general purpose of the experiment was explained to the subject. This was, that the experimenter was interested in measuring the activity of certain muscles while the subject performed a specific task. To do this the experimenter was required to attach six small recording units on the surface of the skin. The subject was then asked by the experimenter for permission to attach the recording units. Then with the subject's permission, the general skin areas for the elctrode positions over the forearm extensor muscles of both arms were prepared in the following manner.

The skin areas over the forearm extensor muscles of both arms were swabbed with alcohol. These areas were then shaved, to ensure maximum contact between skin and electrode, with warm distilled water and a safety razor. The arms were then rubbed briskly with a coarse turkish towel soaked in alcohol for approximately three to five minutes, or until the skin had begun to turn pink. This procedure, removing excess dead layers of skin and the oil from the pores minimized skin resistance which, in turn, resulted in clearer EMGs. The specific positions for the two electrodes over the left forearm extensor muscle and for the two electrodes over the right forearm extensor muscle were then determined in the following manner. A point, on a straight line, one-third of the distance from the lateral humeral epicondyle (elbow) to the styloid process of the ulna (wrist) was determined. The first electrode was centered over this point. A second point was determined two inches in the distal direction from

from the first point. The second electrode was centered over this point.

The general areas for the two electrode positions for the speech muscles *via* the chin were prepared in the same manner as outlined above. The specific positions for the two electrodes over the speech muscles were then determined as follows. On the midline of the chin a point three-quarters of an inch above the point of the chin was determined. The first electrode was centered over this point. On the midline of the chin a point three-quaters of an inch below the point of the chin was determined. The second electrode was centered over this point. All six electrodes were filled with Offner electrode conducting paste before being attached to the skin.

These electrode positions, for both the extensor and speech muscles, have been shown to be the optimal anatomical positions to measure the electrophysiological activity, in the form of surface EMGs. The detailed anatomical and electrophysiological considerations accounting for the determination of the electrode positions have been reported by J.C. Davis (1959).

In addition to the six electrodes used to measure the phyiological responses a ground electrode was attached to the lower, inside left forearm. This ground electrode was of the silver disc-type, one-half centimeter in diameter, manufactured by Grass Instruments Inc.

After the seven electrodes were positioned the subject was taken into the experimental room and seated comfortably in the arm chair. The electrode leads were then attached to the lead selector box. The subject was instructed to sit quietly and relax while the experimenter adjusted the recording apparatus. The skin resistance

for each pair of electrodes was then measured. If the resistance for each of the three pairs of electrodes was less than ten kilo-ohms the subject was used. The subject was disqualified if the skin resistance for any one pair of electrodes was in excess of ten kilo-ohms.

Following the determination of the skin resistances the subject rested for approximately ten minutes during which the dynograph was adjusted to measure and record the direct and integrated EMGs. After this adjustment period a two minute recording was made of the six channels while the subject remained in the resting position. The recording was made, as were all recordings, at ten millimeters per second. The purpose of this pre-experimental recording was to determine base levels of the physiological responses for comparisons with those obtained while the subject performed the experimental task.

On completion of the pre-experimental recording the subject was instructed in the experimental task procedure. This procedure varied for the three different experimental tasks.

Experimental Task

No-learning task procedure. The subject was instructed to depress and release the response button directly below each orange light as it came on. This procedure consisted of 72 orange light presentations; i.e., each of the six orange lights was presented in random order 12 times. The duration time for the orange light and inter-trial interval was 4.00 seconds each.

The instructions were read to the subject while he observed the panel. A copy of the instructions was then given to the

subject to read. The subject was then given the opportunity to ask questions which were answered by re-reading the pertinent sections of the instructions. The instructions for the no-learning task are contained in Appendix B. The physiological responses were recorded continuously throughout the experimental task.

Pair-learning task procedure. The subject was instructed to learn six randomized connections between six white lights and six response buttons; e.g., white light #6 to response button #2. This procedure consisted of 144 trials as follows. For any one trial the white light came on for eight seconds. During seconds five through eight of this eight second period the appropriate orange light came on. The orange light signalled the correct response button that the subject would have to depress for a correct response. The inter-trial interval, time between white light presentations, was 4.00 seconds. This white and orange light presentation procedure was operationally defined as a delayed procedure.

Each of the six white lights was randomly presented 24 times in the 144 trials and was followed always by the appropriate orange light. The order in which the six white lights were presented was randomly varied over 36 trials with each white light being presented once out of every block of six trials. This random order of the 36 white lights was constant (see Appendix C) and was repeated four times for a total of 144 trials. The randomization of the white light sequence was to eliminate memorization of the white light and/or response button sequence.

The white light response button connections were randomly determined and remained the same for each of the three subjects. These connections are given in Appendix C.

The above delayed procedure was used to allow the subject to respond before the orange light came on. Thus, the empirical criterion of 100 per cent learning, 12 consecutive correct responses before the orange light, where each white light had appeared twice, was established. It has been shown by Ladd (1965) that subjects respond consistently before the orange light in this 4.00 second delayed procedure. In addition, Ladd found that subjects learned to criterion within 72 trials on the average. The 144 trials were used since one of the objectives of this research was to determine the relationships between the physiological responses and performance when the subject continued actively in the experimental task after the empirical criterion had been established.

The instructions were read to the subject while he observed the panel. A copy of the instructions was then given to the subject to read. The subject was then given the opportunity to ask questions which were answered by re-reading the pertinent sections of the instructions. The instructions for the pair-learning task are contained in Appendix B. The physiological responses were recorded continuously throughout the experimental task.

Problem-solving task procedure. The subject was instructed to find out and learn the connection between 12 white light pairs and the six response buttons; e.g. white light pair #6, #1 to response button

number 5. The concept was numeric, that is the larger minus the smaller. This procedure consisted of 144 trials as follows. For any one trial the white light pair came on for eight seconds. During seconds five through eight of this eight second period the appropriate orange light came on. This white light pair and orange light presentation was, again, operationally defined as a delayed procedure. The orange light signalled the correct response button the subject would have to depress for a correct response. The inter-trial interval, time between white light pair presentations, was 4.00 seconds.

Each of the 12 white light pairs was randomly presented 12 times in the 144 trials and was always followed by the appropriate orange light. The order in which the 12 white light pairs were presented was randomly varied over 36 trials with each white light pair being presented once in every block of 12 trials. This random order of the 36 white light pairs was constant (see Appendix D) and was repeated four times to give the 144 trials required for the experimental session. The randomization of the white light pair sequence was to eliminate memorization of the white light pair and/or response button sequence.

The delayed procedure was used, again, to allow the subject to respond before the orange light came on. Thus the empirical criterion of 100 percent learning, 12 correct consecutive responses before the orange light, where each white light pair had appeared once was established. It had been determined previously by Schiech (1965) that subjects learned to this criterion in the problem-solving task within

seventy-two trials on the average. The 144 trials were used since one of the objectives of this research was to determine the relationship between the physiological responses and performance when the subject continued actively in the experimental task after the empirical criterion had been established.

The instructions were read to the subject while he observed the panel. A copy of the instructions was then given to the subject to read. The subject was then given the opportunity to ask questions which were answered by re-reading the pertinent sections of the instructions. The instructions for the problem-solving task are contained in Appendix B. The physiological responses were recorded continuously throughout the experiment.

In review, then, direct and integrated surface EMGs were measured and recorded identically for each of nine subjects; three subjects in a no-learning task, three subjects in a pair-learning task, and three subjects in a problem-solving task. The physiological responses were measured and recorded from the left forearm extensor muscles, the right forearm extensor muscles and the speech muscles *via* the chin. The nine subjects participated individually. The physiological responses and the empirical task events (white light onset, offset and/or orange light onset, offset, the response and the inter-trial interval) were ink-recorded simultaneously on the same chart paper. This, in turn, has allowed for a precise and critical evaluation, for each subject, of the relationship between the physiological responses and the experimental task.

CHAPTER III

RESULTS

The experimental results are presented in three sections. These sections include the level of learning, the physiological response measures, and the physiological response duration time.

Level of Learning

The level of learning was determined for the pair-learning subjects and for the problem-solving subjects. The level of learning was not determined for the no-learning subjects as there was no operationally defined learning task.

The level of learning was determined by the number of correct responses, before the onset of the orange light, in each of 24 blocks of six trials. One hundred percent learning was 12 correct consecutive responses before the onset of the orange light.

The three subjects in the pair-learning task each attained one hundred percent learning, as did each of the three subjects in the problem-solving task. These results are presented graphically by the performance curves in Figures 8 through 13. The raw scores for the performance curves are presented in Appendix E .

Physiological Response Measures

The three physiological responses, active arm (the arm used to depress and release the response button), passive arm and speech, were, in each case, the mean microvolt variations from zero for blocks of six trials. There were 12 such measurements for each of the three physiological responses for each of the three subjects

in the no-learning task. There were 24 such measurements for each of the three physiological responses for each of the three subjects in both the pair-learning and the problem-solving tasks.

The physiological responses of both the active arm, the passive arm and speech were determined from the integrated recordings for each of the nine subjects. The individual physiological response of the passive arm and of speech was determined by measuring the average height of pen deflection from the base-line, in millimeters, for each complete trial. That is, from the onset of one orange light to the onset of the next orange light for each of the three subjects in the no-learning task; and, from the onset of one white light to the onset of the next white light for each of the three subjects in both the pair-learning and problem-solving tasks. The physiological response of the active arm was determined by measuring the average height of pen deflection, in millimeters, from the base-line during the inter-trial interval. That is, from the off-set of one orange light to the onset of the next orange light in the no-learning task; and, from the off-set of the white light(s) to the onset of the next white light(s) in the two learning tasks. It was felt that by measuring the physiological response of the active arm during the inter-trial interval only, the effect of physical work (depressing and releasing the response button) on the physiological response would be minimized.

The measurement, average height of pen deflection from the base in millimeters, for each trial and for each of the three

physiological measures was a straight line-of-best-fit parallel to the base. The distance between the base and line-of-best-fit was then measured in millimeters. Two such independent measures were made for each trial, for each of the three physiological measures and for all subjects by two different scorers. The two independent measurements were then averaged to give the average pen deflection in millimeters from the base-line. This same procedure was used to determine the pre-experimental base-levels for each of the three physiological responses and for each of the nine subjects. These measurements were determined in the last 12 seconds of the two-minute pre-experimental recording. The subjects were not engaged in the experimental task during the pre-experimental recording. The raw data for these measurements are presented in Appendix E .

These data, in millimeters, were then converted to microvolts of pen deflection for each trial, for each of the three physiological measures, and for all subjects. This was done by multiplying the millimeters of pen deflection by micro-volts per millimeter. The microvolts per millimeter of deflection were determined individually for each of the three physiological responses of all subjects in terms of the sensitivity settings of the equipment required to obtain adequate recording for each physiological response.

The appropriate pre-experimental base-level in microvolts was then subtracted from each physiological response, in microvolts, for each trial, for each response and for all subjects. This procedure

reduced the three physiological responses to the same zero point of microvolts relative to the three experimental tasks. Thus, the microvolt variation in the physiological responses during the experimental tasks could be attributed only to the subjects' participation in the task. These converted data are presented in Appendix F.

The individual physiological responses in microvolts for each trial, for each physiological response and for each subject were then summed and averaged for each block of six trials. This average is now referred to as the "mean physiological response" for each of the three physiological measures; i.e., active arm, passive arm and speech. These mean physiological responses are presented in Appendix F.

The three mean physiological responses for each of the three subjects in the no-learning task are presented graphically in Figures 5, 6 and 7. The three mean physiological responses for each of the three subjects in both the pair-learning and the problem-solving tasks are presented graphically in Figures 8, 9, 10, 11, 12 and 13.

Inspection of the graphs (Figures 5, 6 and 7) for the three subjects in the no-learning task shows that there is relatively little variation between the three mean physiological responses for each subject during the course of the experimental task. Secondly, there appears to be little to no variation in the magnitude of each of the mean physiological responses during the course of the experimental task. Thirdly, there is little to no difference in the three mean physiological

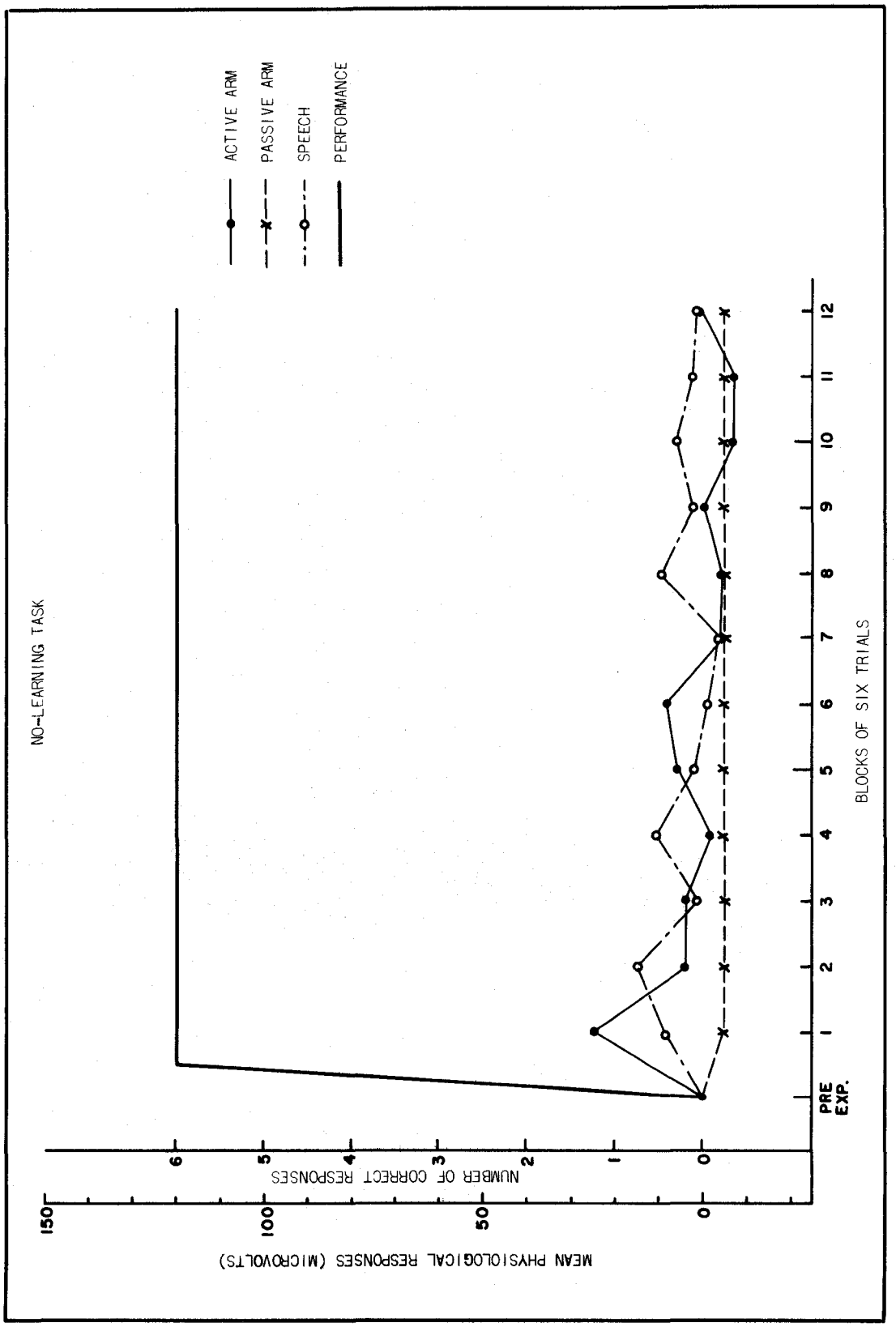


Figure 5. Subject Number 1. The mean physiological responses in microvolts of the active arm, passive arm and speech: $\left(\left(\text{mean physiological response} = \frac{\text{sum of 6 individual responses}}{6}\right) - \text{pre-experimental base-level}\right)$.

The performance curve indicates the number of correct responses in blocks of six trials.

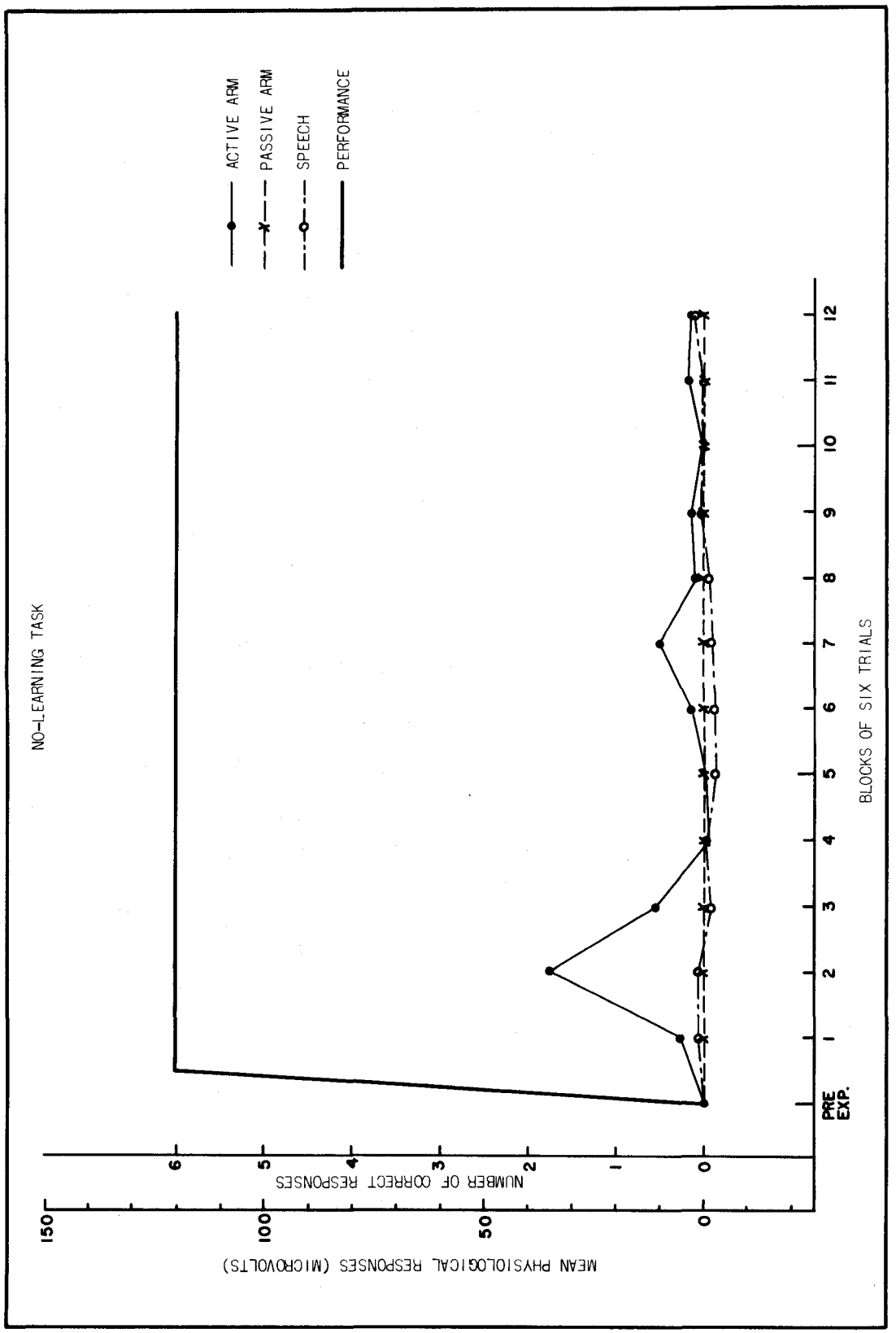


Figure 6. Subject Number 2. The mean physiological responses in microvolts of the active arm, passive arm and speech: ((mean physiological response = $\frac{(\text{sum of 6 individual responses})}{6}$ - pre-experimental base-level)).

The performance curve indicates the number of correct responses in blocks of six trials.

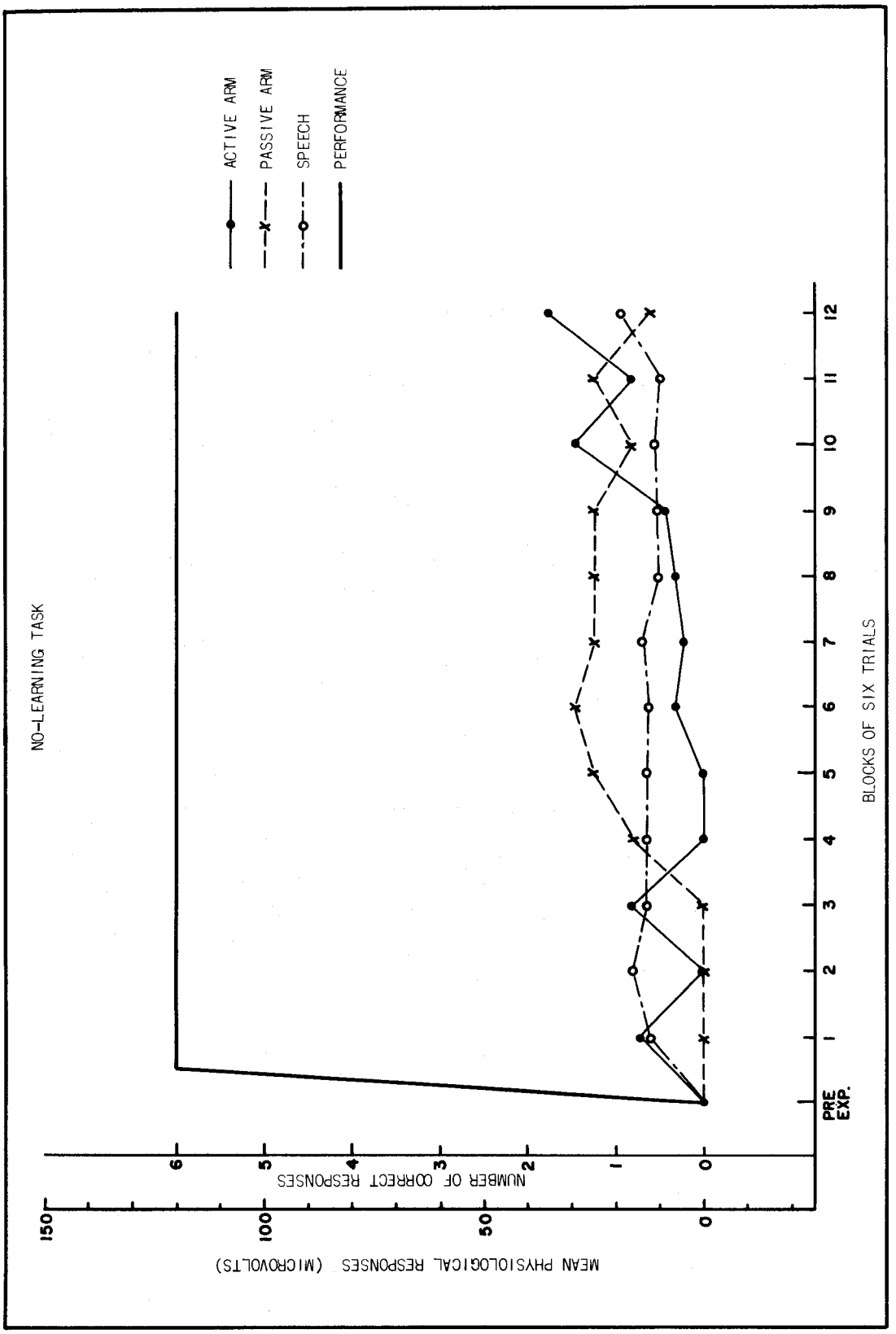


Figure 7. Subject Number 3. The mean physiological responses in microvolts of the active arm, passive arm and speech: ((mean physiological response = $\left(\frac{\text{sum of 6 individual responses}}{6}\right)$ - pre-experimental base-level)).
The performance curve indicates the number of correct responses in blocks of six trials.

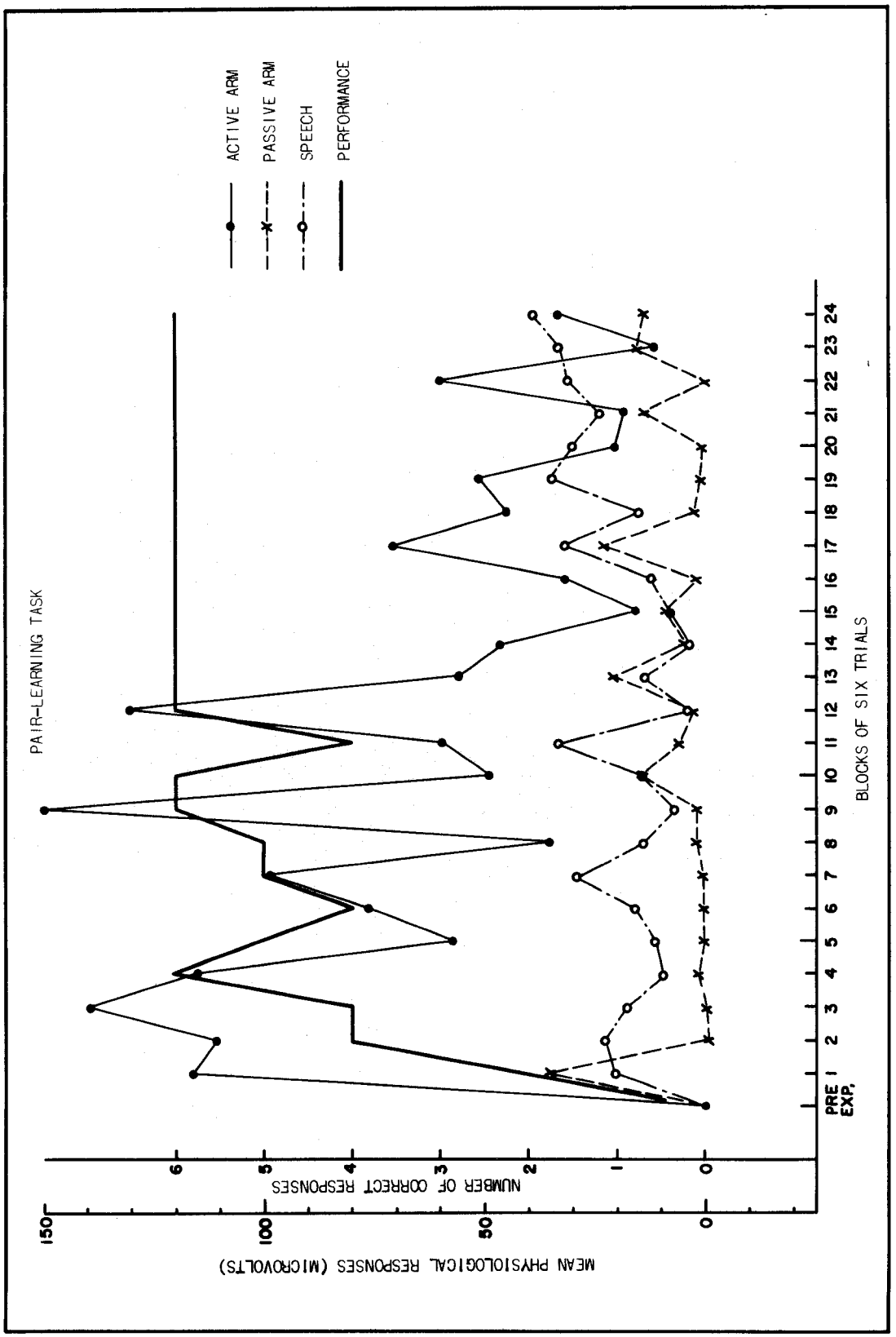


Figure 8. Subject Number 1. The mean physiological responses in microvolts of the active arm, passive arm and speech: ((mean physiological response = $\left(\frac{\text{sum of 6 individual responses}}{6}\right)$ - pre-experimental base-level)).

The performance curve indicates the number of correct responses in blocks of six trials.

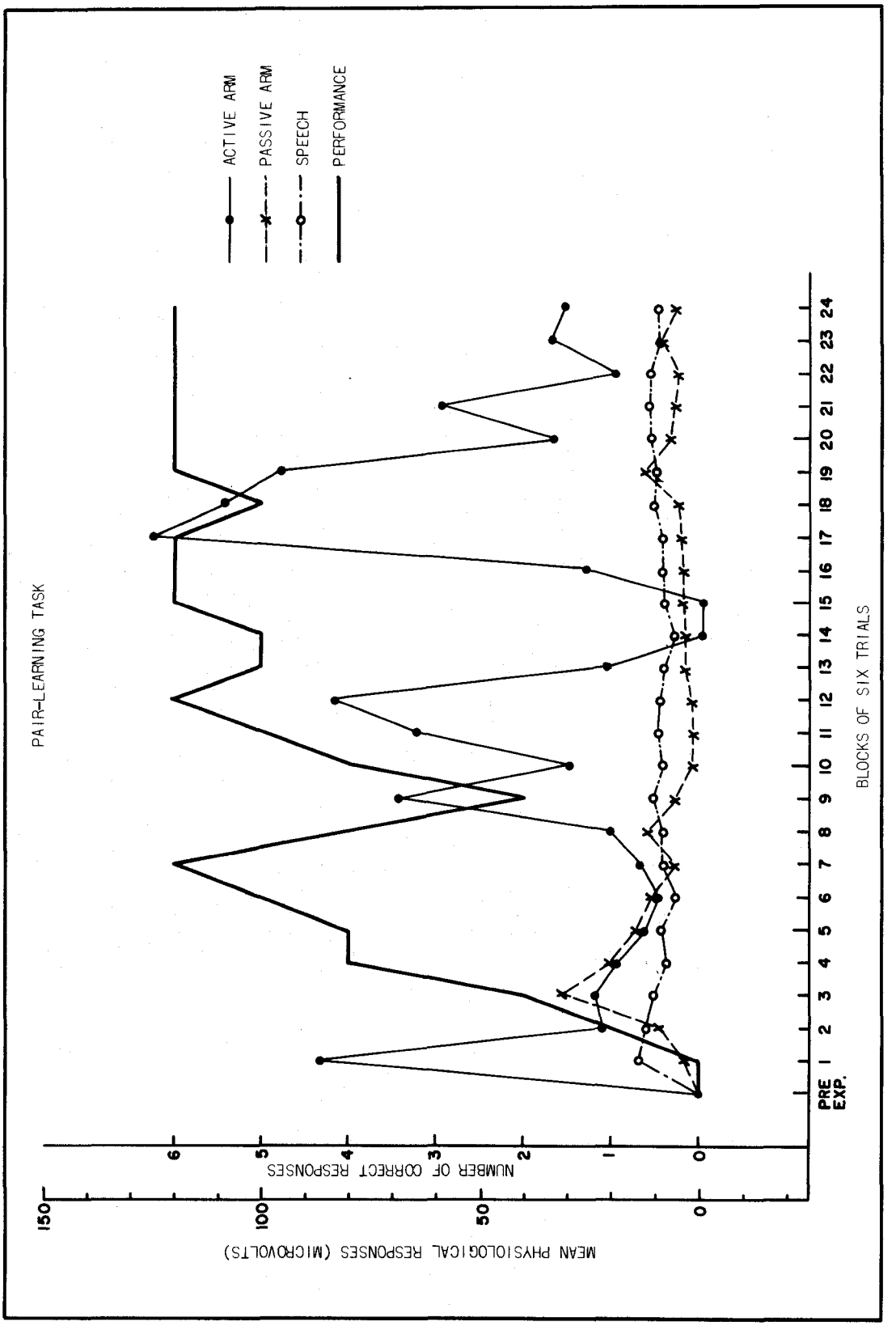


Figure 9. Subject Number 2. The mean physiological responses in microvolts of the active arm, passive arm and speech: ((mean physiological response = $\left(\frac{\text{sum of 6 individual responses}}{6}\right)$ - pre-experimental base-level)).

The performance curve indicates the number of correct responses in blocks of six trials.

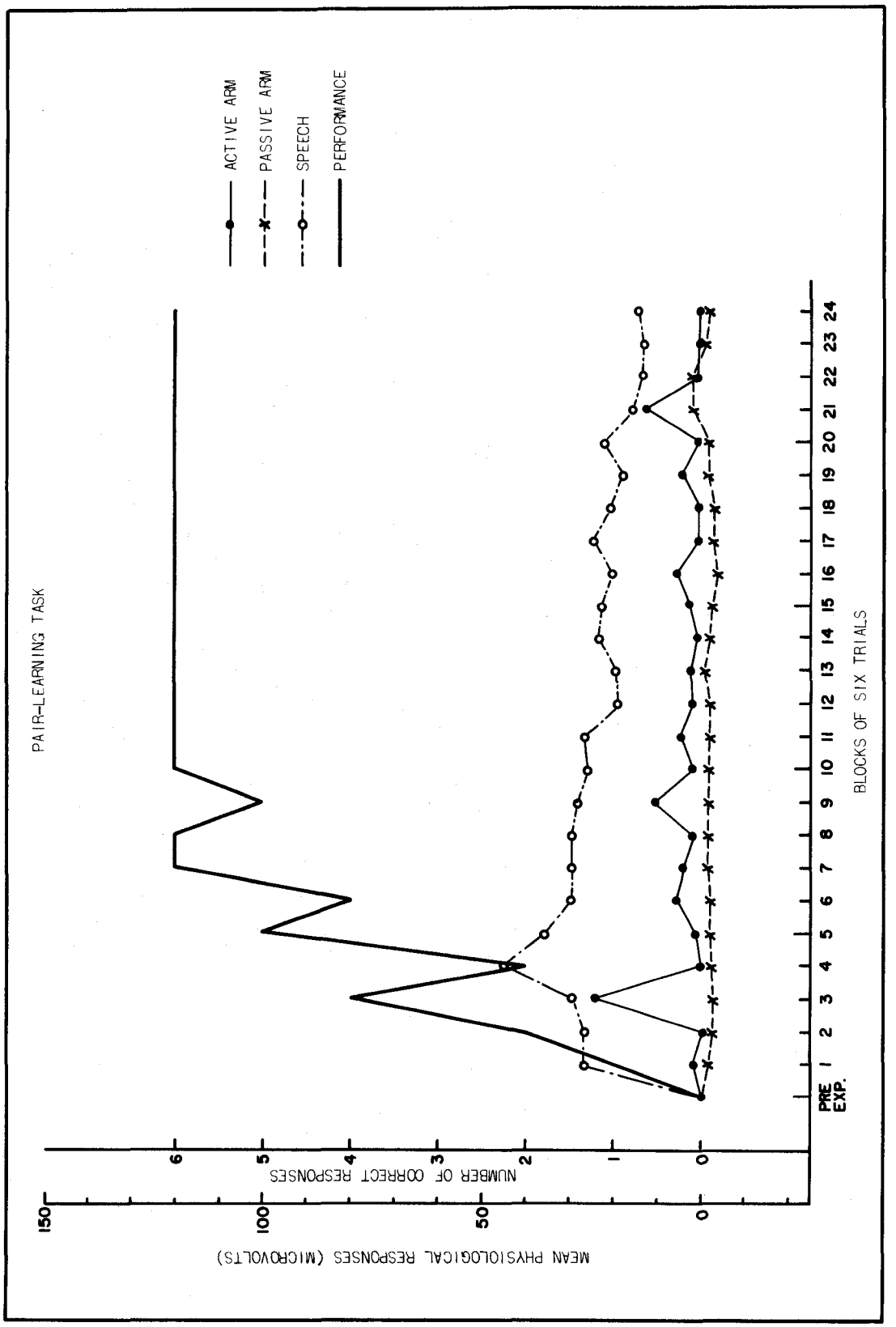


Figure 10. Subject Number 3. The mean physiological responses in microvolts of the active arm, passive arm and speech: ((mean physiological response = $\frac{(\text{sum of 6 individual responses})}{6}$ - pre-experimental base-level)).

The performance curve indicates the number of correct responses in blocks of six trials.

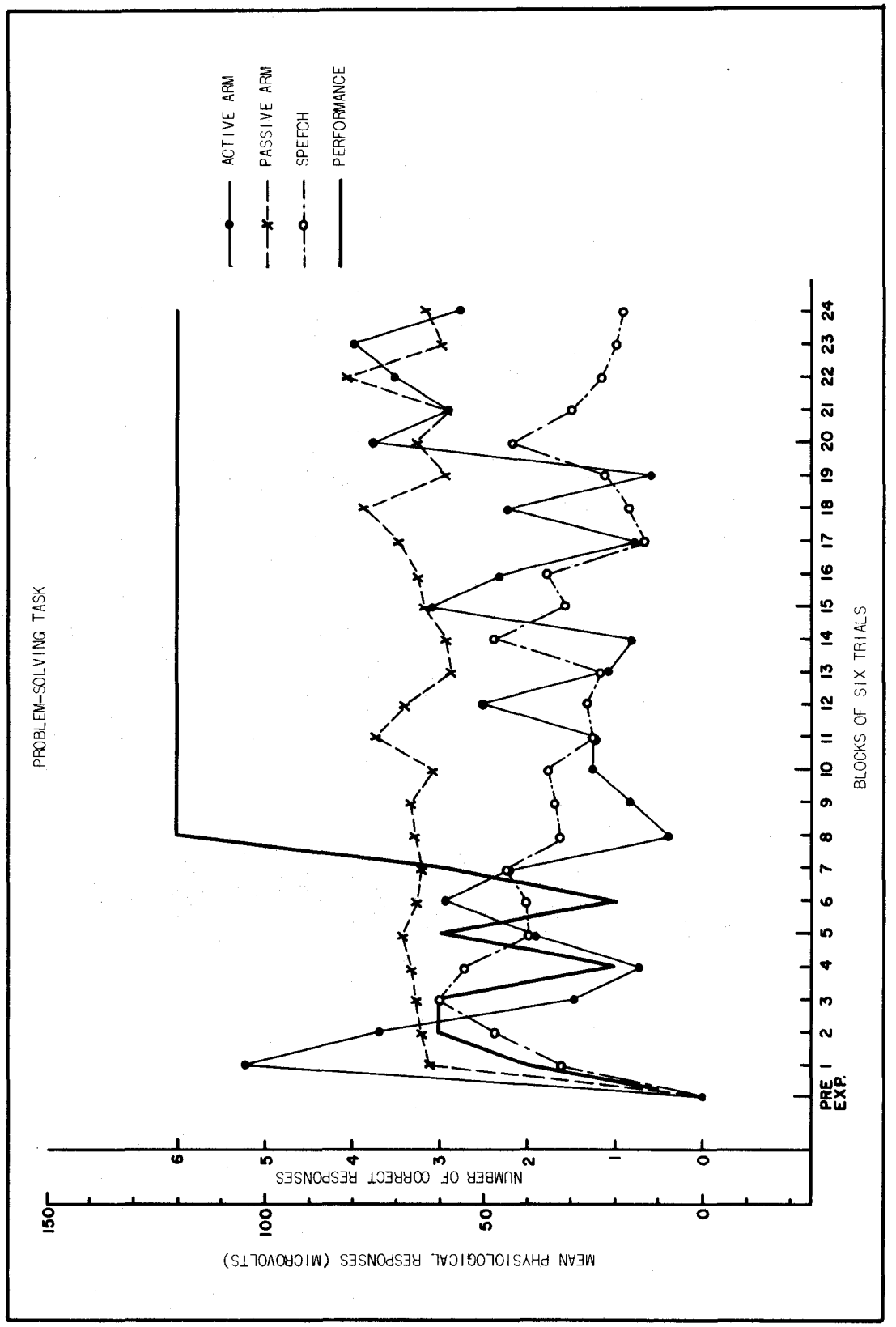


Figure 11. Subject Number 1. The mean physiological responses in microvolts of the active arm, passive arm and speech: ((mean physiological response = $\frac{(\text{sum of 6 individual responses})}{6}$ - pre-experimental base-level)).

The performance curve indicates the number of correct responses in blocks of six trials.

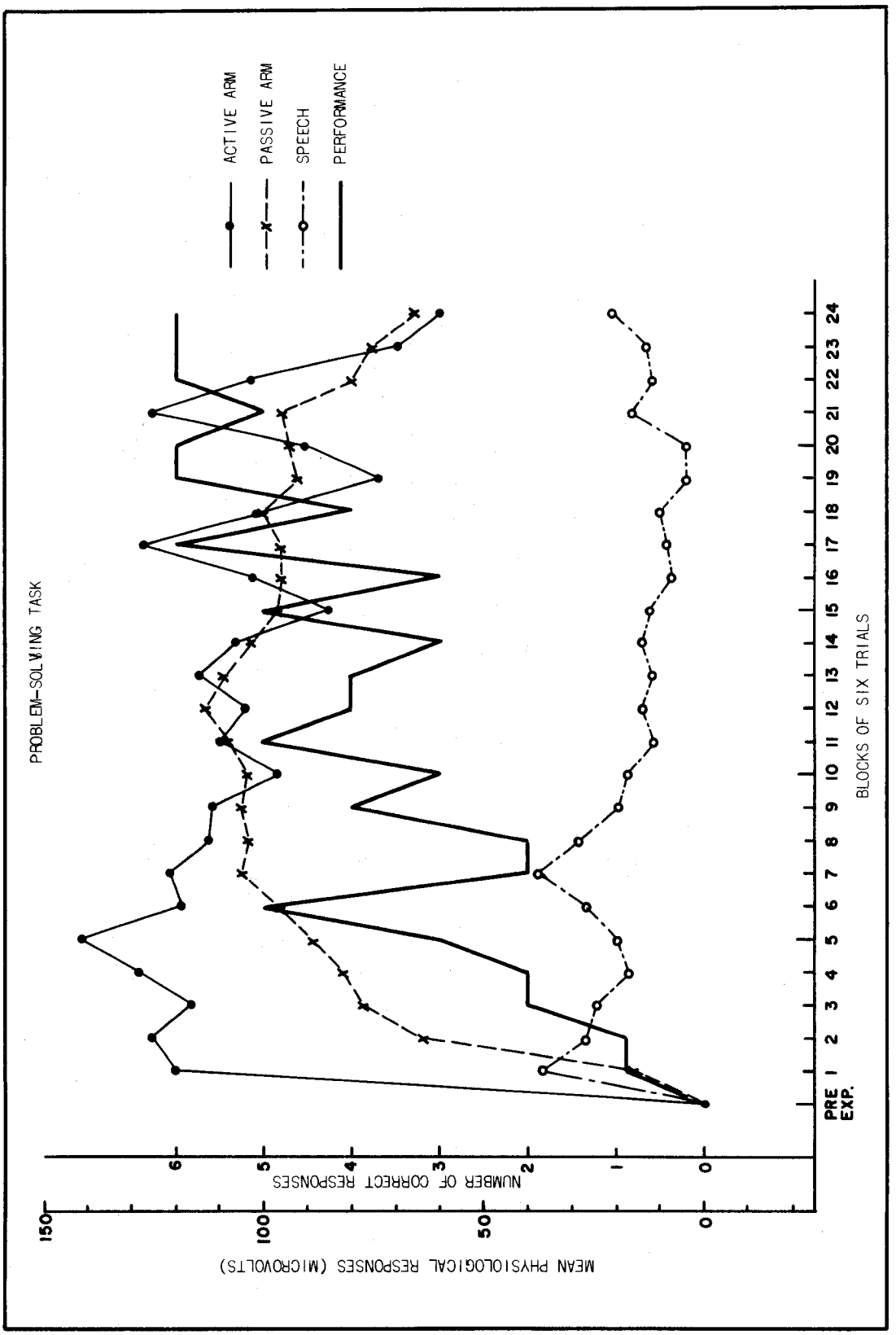


Figure 12. Subject Number 2. The mean physiological responses in microvolts of the active arm, passive arm and speech: ((mean physiological response = $\left(\frac{\text{sum of 6 individual responses}}{6}\right)$ - pre-experimental base-level)).

The performance curve indicates the number of correct responses in blocks of six trials.

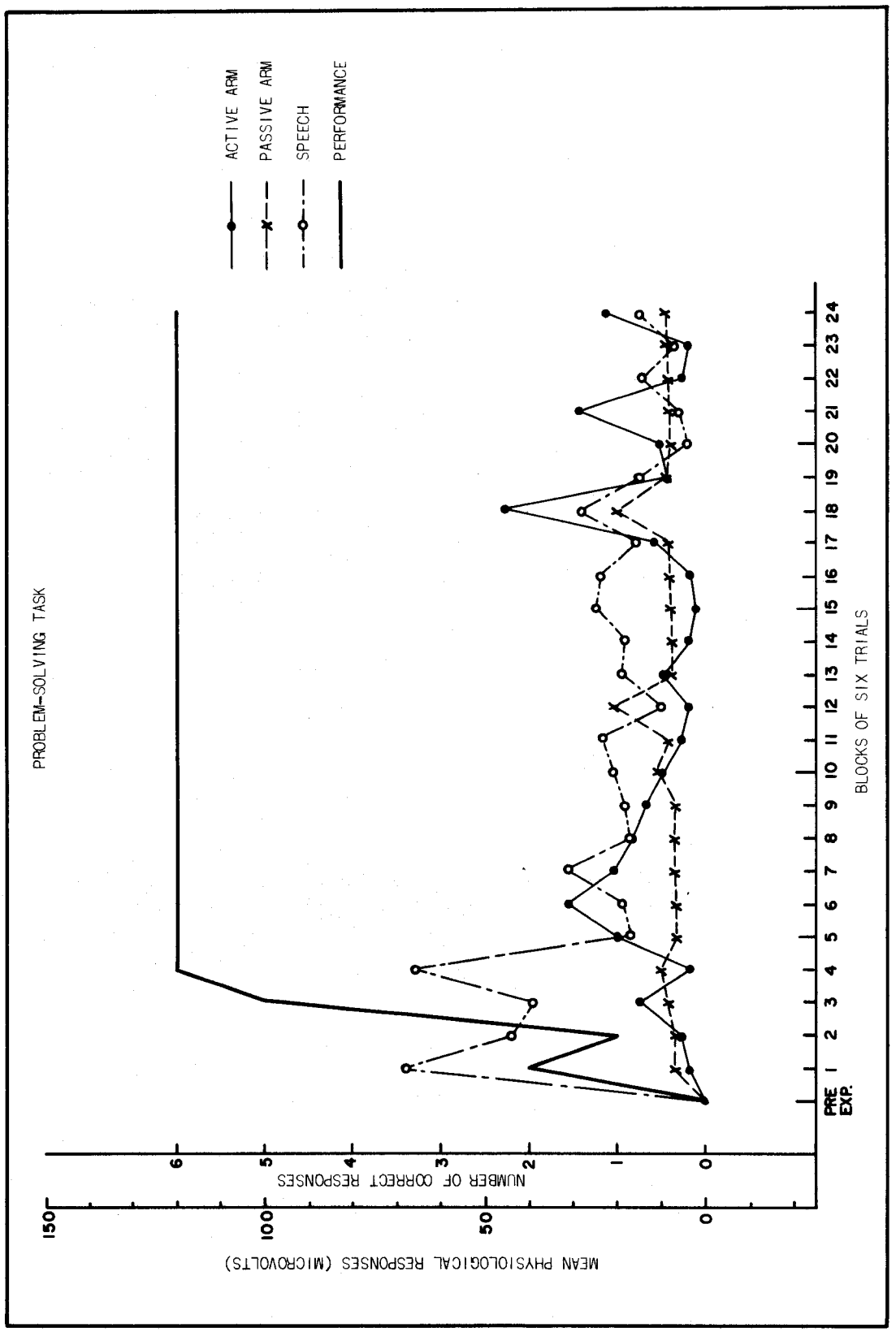


Figure 13. Subject Number 3. The mean physiological responses in microvolts of the active arm, passive arm and speech: ((mean physiological response = $\left(\frac{\text{sum of 6 individual responses}}{6}\right)$ - pre-experimental base-level)).

The performance curve indicates the number of correct responses in blocks of six trials.

response profiles between the three subjects.

A general inspection of the graphs for the three subjects in the pair-learning task demonstrates that, by comparison to the subjects in the no-learning task, there is a substantial increase in the magnitude of the mean physiological responses. It must be pointed out again, that these overall differences in the magnitude of the mean physiological responses between the subjects in the two tasks cannot be accounted for by physical work output, since the physical work is exactly the same for the two experimental tasks. Therefore, the overall increases in the magnitude of the mean physiological responses for the pair-learning subjects can be attributed only to the requirements, in terms of learning, of the pair-learning experimental task.

While there appears to be no variation between the mean physiological responses within each subject and between subjects in the no-learning task, there is considerable variation between both the three mean physiological responses within each subject and between subjects in the pair-learning task.

In subject number one, pair-learning (Figure 8), the magnitude of the mean physiological response in the active arm is far greater, proportionally, than that of the mean phsyiological response for either the passive arm or speech. While there is considerable variability in the active arm mean physiological response, the response parallels the performance curve closely. That is, considerable variability was demonstrated in the magnitude of the mean physio-

logical response and in the performance curve between trial blocks one and 12. Between trial blocks 12 and 24 asymptotic performance is established and the magnitude of the mean physiological response drops sharply towards the base. The mean physiological response of the passive arm for this subject appears to be considerably less in magnitude and fluctuates with no general pattern or trend with reference to performance. The mean physiological response for speech, while less in magnitude than the active arm parallels the performance curve closely, showing an initial increase and then decreasing between trial blocks one and 12. The speech response then shows a general increase between blocks 12 and 24 while the subject is performing continuously at asymptotic level.

The major physiological response for subject number two, pair-learning, was, again, in the active arm (Figure 9). In this case, however, the magnitude of the mean physiological response is both highly variable and shows little direct relationship to the highly variable performance curve between trial blocks one and 18. As with subject number one, there is a sharp drop in the magnitude of the mean physiological response when the subject is performing at asymptotic level between trial blocks 17 and 24. There is an initial increase in the magnitude of the mean physiological response of the passive arm between trial blocks one and three for subject number two. The response decreases between trial blocks three and ten and then continues in a straight line between trial blocks ten and 24. There is a slight increase in the magnitude of the mean physiological response for

speech in trial block one for subject number two. The response then remains constant through trial blocks four to 24. In relation to the mean physiological response for the active arm, the responses of the passive arm and speech are of far less magnitude and show little relationship to performance, while the response in the active arm does indicate a relationship to performance.

In contrast to subjects numbers one and two, pair-learning, the major physiological response for subject number three, pair-learning was speech (Figure 10). There is an initial and considerable increase in the magnitude of the mean physiological speech response between trial blocks one and four with a subsequent smooth decrease between trial blocks four and ten. Then, with the establishment of asymptotic performance between trial blocks ten and 24 there is a general leveling out in the magnitude of the response, indicating a relationship to performance. That is, during acquisition the response increases and then, as asymptotic behaviour is established the response decreases in magnitude over further trials. The mean physiological response for the active arm is minimal in magnitude in comparison to the speech response, and the general response pattern is a straight line throughout trial blocks one to 24, indicating little or no relationship to performance.

In relationship to performance a comparison, between the three subjects, of the mean physiological responses can be made. First, there appears to be only one dominant physiological response which shows a definite relationship to performance. There is high

variability in the dominant response where performance is erratic during acquisition (subjects numbers one and two), and low variability in the dominant response during acquisition where performance is low in variability (subject number three). Secondly, the dominant response drops off rapidly in magnitude with the establishment of asymptotic performance. The other two physiological responses, for each of the three subjects, show little relation to performance, and are of less magnitude than the dominant response.

In contrast to the physiological response relationships to performance for the subjects in both the no-learning task and in the pair-learning task, the physiological response relationships to performance for subjects in the problem-solving task are quite different. That is, all three mean physiological responses for the subjects in the problem-solving task show a relationship to performance.

For subject number one, problem-solving (Figure 11), there is a sharp increase in the magnitude of the mean physiological response of the active arm in trial blocks one and two. The response then decreases randomly between trial blocks two and 11. It is important to note here the relatively smooth decrease between trial blocks six and nine where the subject discovered the concept. This is followed by highly random activity in the response between trial blocks 11 and 24. This random activity was accounted for by the subject after the experiment. He stated that, after he had discovered the answer, he then tried to solve the problem using other methods. The mean physiological response for speech shows a similar and

parallel relationship to performance; a sharp increase in magnitude in trial blocks one to three with a subsequent relatively smooth decrease between trial blocks three and 11. The highly random response activity is demonstrated, again, between trial blocks 11 and 24 when the subject tried to solve the problem using other methods. The mean physiological response in the passive arm demonstrates an initial sharp increase in magnitude between trial blocks one and three, and then remains constant between trial blocks two and 11. The highly random variability is seen between trial blocks 11 and 24 where the subject tried to solve the problem using other methods. It is clearly demonstrated, then, that all three mean physiological responses show a relationship to performance for subject number one, problem-solving.

The mean physiological response of the active arm for subject number two, problem-solving (Figure 12), shows a very sharp and extreme increase in magnitude between trial blocks one and five. A slight gradual decrease is demonstrated between trial blocks five and 15, with increasing and random variability between blocks 15 and 21, and a sharp decrease between trial blocks 21 and 24. The mean physiological response of the passive arm shows an extreme increase, again, in the magnitude of the response between trial blocks one and 12. A slight gradual decrease is demonstrated between trial blocks 12 and 21, with a sharp decrease between trial blocks 21 and 24. In relationship to the performance curve, subject number two verbalized after the experiment, that he did not realize the answer until the end of the experiment. This would account for the high variability in the performance curve, as well as for the relatively high and

continuous mean physiological responses in trial blocks one through 21. The mean physiological response of speech shows a random increase between trial blocks one and seven and then a gradual decrease between trial blocks seven and 20. This was followed by an increase between trial blocks 20 and 24, again, where the subject realized the concept. A definite relationship of the three mean physiological responses and performance was demonstrated for subject number two, problem-solving as it was for subject number one, problem-solving.

The mean physiological response of the active arm for subject number three, problem-solving (Figure 13), shows a random increase in magnitude between trial blocks one and six with a subsequent decrease between trial blocks six and 17, followed by random variability of low magnitude between blocks 17 and 24. The mean physiological response of the passive arm shows a slight gradual increase between trial blocks one and four and then a slight decrease with little random variability between trial blocks four and 17. This activity is followed by random variability of low magnitude between trial blocks 17 and 24. The mean physiological response of speech demonstrates a variable, sharp increase in magnitude between trial blocks one and four and then a sharp decrease between trial blocks four and five. This activity is followed by a slight random decrease between trial blocks five and 17 followed, in turn, by random variability between trial blocks 17 and 24. Subject number three, problem-solving, said, after the experiment, that he had realized the answer in the beginning of the experiment, as is demonstrated in the per-

formance curve (Figure 13). In terms of the relationship between the performance curve and the physiological responses, this early realization of the concept would account for the initial increase in the magnitude of the three mean physiological responses between trial blocks one and six, and, for the subsequent decreases in the magnitude of the responses.

In summary, all three of the mean physiological responses for each of the three subjects in the problem-solving task show a definite relationship to the empirical performance curves. In contrast, only one of the mean physiological responses showed a definite relationship to the performance curves for each of the three subjects in the pair-learning task.

The total mean physiological response of each of the three electrophysiological measures for each of the three subjects in the no-learning task was then determined. This was accomplished by summing the 72 physiological responses for each electrophysiological measure and then taking the mean. These three means are referred to as the "net physiological responses". The net physiological responses were then determined by the same procedure for each electrophysiological measure for each of the three subjects in both the pair-learning and the problem-solving tasks. These results are presented in Table 1. The raw scores for the data in Table 1 are presented in Appendix F.

An analysis of variance was done on the data in Table 1 to determine if the differences among the net physiological responses over the three experimental procedures were significant. The results

Table 1

Net Physiological Responses in Microvolts

Subject	Active Arm	Passive Arm	Speech
No-Learning No. 1	1.59	- 5.00	4.19
No-Learning No. 2	6.07	0.00	- 0.57
No-Learning No. 3	11.47	16.66	12.89
Pair-Learning No. 1	67.24	7.05	20.08
Pair-Learning No. 2	41.81	7.55	9.21
Pair-Learning No. 3	3.36	- 2.02	24.03
Problem-Solving No. 1	43.48	65.45	33.05
Problem-Solving No. 2	106.90	90.57	17.26
Problem-Solving No. 3	12.50	9.03	23.19

of the analysis of variance indicate that the differences in the net physiological responses over the three experimental tasks were significant at the 0.05 level. This result indicates a significant increase in the net physiological responses from the no-learning task, to the pair-learning task, to the problem-solving task.

The lack of significance of the main effect between net physiological responses is accounted for by the close similarity of the three physiological responses for each subject in the no-learning task; by the close similarity of at least two of the physiological responses for each subject in the pair-learning task; and by the fact that at least two of the physiological response for each subject in the problem-solving task show a close similarity. The results of the analysis of variance are presented in Table 2.

A Newman-Keuls analysis was performed on the difference between the net physiological responses for the three experimental tasks, main effect A. These results indicate that differences in the net physiological responses between each of the three experimental tasks were significant. That is, the net physiological responses in the no-learning task were significantly less at the 0.05 level than in both the pair-learning and problem-solving tasks. The net physiological responses in the pair--learning task were significantly less at the 0.05 level than for the problem-solving task. These results are presented in Table 3.

The results of the Newman-Keuls test on the net physiological responses are very meaningful when it is considered that the

Table 2

Analysis of Variance on the Net Physiological Responses

Source of Variation	df	MS	F Ratio
Between Subjects	8		
A (Experimental Tasks)	2	3,563.59	3.58*
Subjects Within Groups	6	994.56	
Within Subjects	18		
B (Physiological Responses)	2	662.46	
AB	4	542.16	
B x Subjects Within Groups	12	409.80	

* $F_{.95}(6,2) = 3.46$

Table 3

Tests on Means of the Net Physiological Responses

Using Newman-Keuls Procedure

Tasks	No-Learning a_1	Pair-Learning a_2	Problem-Solving a_3
Ordered Means	15.77	59.29	133.81
	a_1	a_2	a_3
a_1	Differences Between Means	43.52	118.04
a_2			74.52

	$S_{\bar{A}} = 10.47$	$r = 2$	$r = 3$
	$q_{.95}(r,6) =$	3.46	4.34
	$S_{\bar{A}}q_{.95}(r,6) =$	36.23	45.44
	$q_{.99}(r,6) =$	5.24	6.33
	$S_{\bar{A}}q_{.99}(r,6) =$	54.86	66.27

	a_1	a_2	a_3
a_1		*	**
a_2			**

three net physiological responses for each subject, when combined, yield a relative percentage indication of the total electrophysiological activity in the skeletal musculature during task performance. Thus, participation in the no-learning task required significantly less electrophysiological activity than did participation in either the pair-learning or the problem-solving tasks. Further, participation in the pair-learning task required significantly less electrophysiological activity than did participation in the problem-solving task. These differences in the net physiological responses are presented graphically in Figure 14.

Physiological Response Duration

The physiological response duration was determined by measuring in millimeters the length of each response, on the direct EMG recording, for each one of the nine subjects. These results were then divided by 12, as the chart paper speed was 12 millimeters per second, to give the physiological duration in seconds. The physiological response durations were then summed and averaged over blocks of six trials. These means are referred to as the "mean physiological durations". The raw data in millimeters are contained in Appendix E and the converted data in seconds are contained in Appendix F.

The comparison of the mean physiological response durations over trial blocks for each of the three subjects in the no-learning task demonstrates that there was little variation in the response duration over trial blocks. In addition, the comparison demonstrates

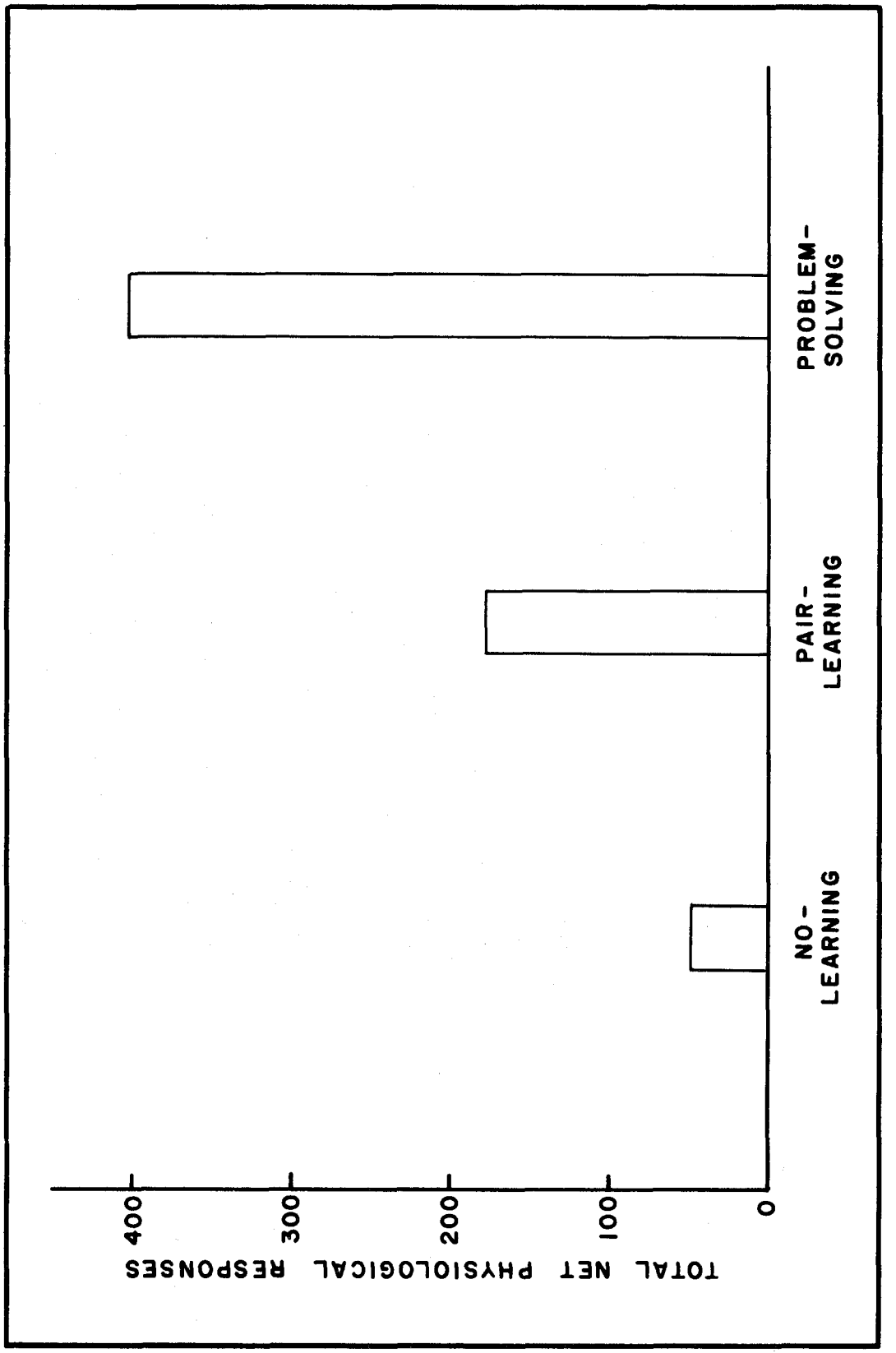


Figure 14. The total net physiological responses in microvolts (sum of active arm, passive arm and speech net responses) of all three subjects for each experimental task.

that the mean response durations between subjects were very similar. These results are presented in Figure 15.

In contrast, the mean physiological response durations for each of the three subjects in both the pair-learning and problem-solving tasks show a much longer mean response duration. Considerable variability was demonstrated within each subject in these two tasks, an high variability was demonstrated between the three subjects in the pair-learning task and the three subjects in the problem-solving task. These results are shown in Figures 16 and 17.

The mean physiological response durations over trial blocks were then summed and averaged for each subject. This mean is referred to as the "net physiological response duration". The net physiological response durations for the three subjects in the no-learning task were comparatively less than the net physiological response durations for the three subjects in either the pair-learning or the problem-solving tasks. The difference in the net physiological response durations between the three subjects in the pair-learning task and the three subjects in the problem-solving task was minimal by comparison. These comparisons are presented in Table 4.

A t test analysis was performed on the comparisons of the net physiological response durations to determine if the differences were significant. The analysis showed that the net physiological response durations of the three subjects in the no-learning task were significantly less at the 0.05 level than either the pair-learning or problem-solving task durations. The difference between

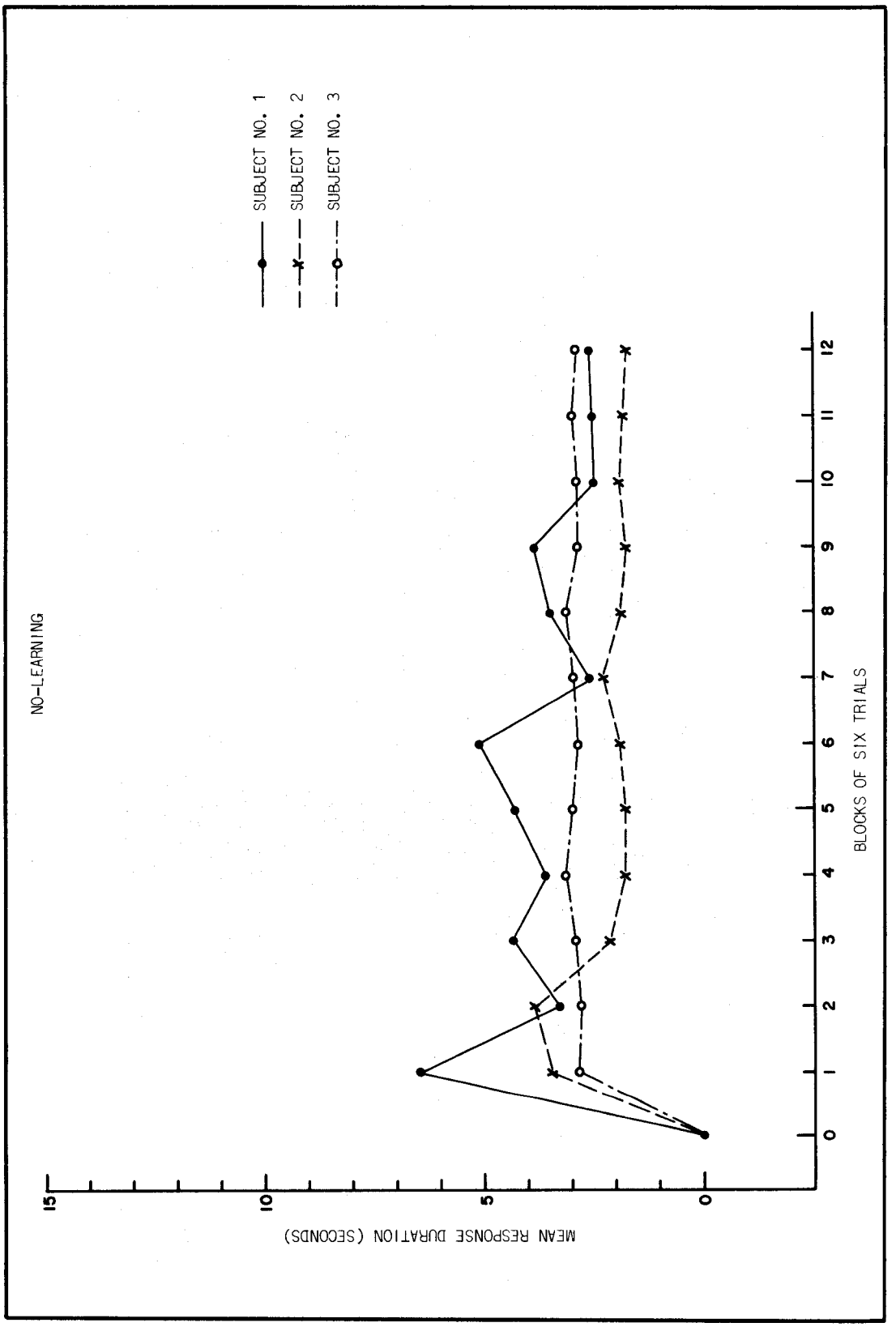


Figure 15. The mean physiological response durations in seconds: = ((sum of 6 individual response durations) / 6.0).

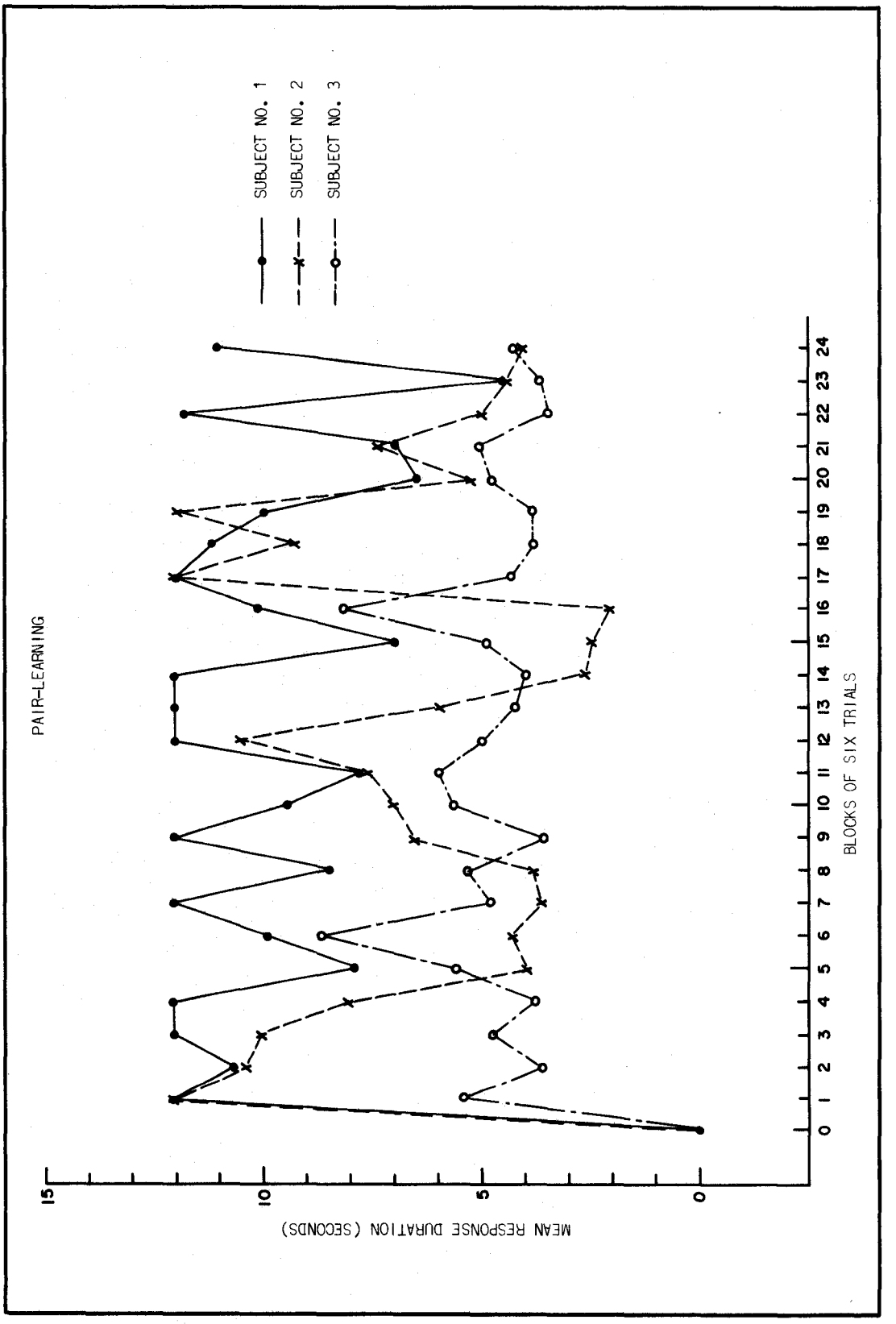


Figure 16. The mean physiological response durations in seconds: = ((sum of 6 individual response durations) / 6.0).

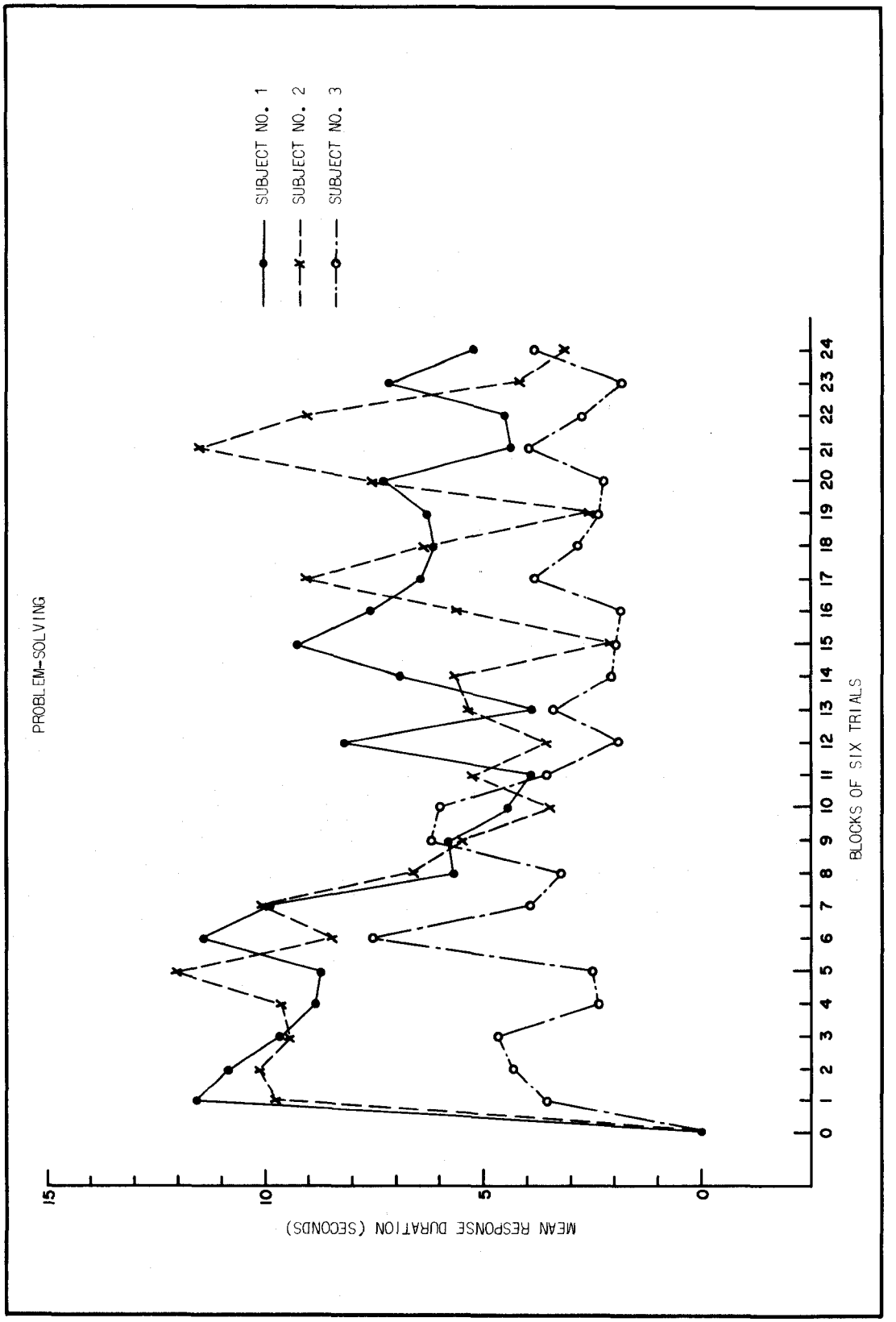


Figure 17. The mean physiological response durations in seconds: = ((sum of 6 individual response durations) / 6.0).

Table 4

Net Physiological Response Durations in Seconds

Subject	Net Physiological Response Duration
No-Learning No. 1	2.91 seconds
No-Learning No. 2	2.18 seconds
No-Learning No. 3	3.71 seconds
Pair-Learning No. 1	4.82 seconds
Pair-Learning No. 2	6.68 seconds
Pair-Learning No. 3	10.05 seconds
Problem-Solving No. 1	3.43 seconds
Problem-Solving No. 2	6.91 seconds
Problem-Solving No. 3	7.76 seconds

the three subjects in the pair-learning task and the problem-solving task were not significant. These results are presented in Table 5.

The significant difference between the no-learning task and the two learning tasks demonstrates clearly that the electrophysiological activity in the active arm was not a function only of physical work; i.e., depressing and releasing the response button. Instead, the activity must be attributed to the learning requirements of the two tasks. The physiological response duration discriminates between the performance of a perceptual-motor task (no-learning task) and of learning tasks.

Table 5

t Tests Between the Net Physiological Response Durations in Seconds

Comparisons	t
No-Learning versus Pair-Learning	2.66*
No-Learning versus Problem-Solving	2.22*
Pair-Learning versus Problem-Solving	0.00

* $t_{.05}(4) = 2.13$

CHAPTER IV

DISCUSSION

The discussion of the results is presented in three sections. These sections include the level of learning, the physiological responses and the physiological response durations.

The emphasis in the discussion is on the ordering and synthesis of the empirical results. This approach is in order as the research was, as clearly stated previously, of an highly exploratory nature with the emphasis on empirical fact finding, or, the empirical relationships between the physiological responses and individual learning.

Level of Learning

In the discussion of the level of learning it is necessary only to point out that, firstly, each of the three subjects in both of the two learning tasks achieved the operationally defined criterion of one hundred percent learning; i.e., 12 consecutive correct responses before the onset of the orange light. The physiological responses can be discussed, therefore, both in terms of acquisition and asymptotic performance. Secondly, in that each of the three subjects in both of the two learning tasks achieved criterion previous to the termination of the experiment, the physiological responses can be discussed in terms of over-learning (actively continuing in the experimental task beyond acquisition).

Physiological Response Measures

In reading the discussion of the physiological responses

it is extremely important to remember that the magnitude of each of the three mean physiological responses over trial blocks for each of the nine subjects was determined from the same relative zero point. This was accomplished by subtracting the appropriate pre-experimental base-level from the mean physiological responses. Therefore, the difference between the mean physiological responses in the three experimental tasks can be discussed in terms of the demands and complexity of the tasks.

The discussion of the results is prefaced by the writer's theoretical position on the meaning of the physiological responses in relationship to performance. The physiological responses as measured and quantified in this research are, at least, a relative percentage indication of the <u>total central physiological activity</u> required of the subjects to successfully perform the different experimental tasks. This theoretical position is set out in the assumptions listed below.

1) Task performance is controlled by the development of a specific and organized central process.
2) This central process not only controls the immediate stage of performance, but also "anticipates" later stages.
3) The particular level (magnitude) of central organization depends not only on the duration of previous activity, but also on the complexity of the task.
4) The central process has properties very similar to those postulated by Hebb (1955) for the "cell assembly" and phase sequence. In particular it a) usually has a specific

motor facilitation, and b) when well organized it will tend to diminish in, or cease activity altogether.

No-Learning Task

The relationships of the three mean physiological responses to performance for each of the three subjects were very similar. That is, each of the three responses throughout performance was of significantly lower magnitude than the responses of the subjects in the two learning tasks. Further, the responses showed minimal variation within each subject, and little to no variation between subjects. There was no systematic increase in the physiological responses throughout performance.

Similar results have been reported by Belanger (1857), Eason (1959) and MacNeilage (1966). The interpretation offered here is that the task was too simple and repetitious and/or too low in its demands on the individual subjects to produce any systematic increases in the physiological responses over trial blocks. Or, to perform the no-learning task as such produced an overall increase of low magnitude in the physiological responses which remained relatively constant throughout performance. In terms of central processes, this response pattern indicates that the subject is not required during performance to organize and develop a specific process to perform the task successfully. Instead, the successful performance of the task is anticipated or perceived immediately, and the magnitude of the responses indicate simply the level of central activity necessary to maintain performance.

Pair-Learning Task

The mean physiological responses over trial blocks for each subject, while idiosyncratic, demonstrated general relationships to performance. The results indicate that one of the three physiological responses demonstrated a relevant relationship to performance for each subject (Figures 8, 9 and 10). The source of this response was found to be different between the subjects.

The relationships of the relevant physiological responses to performance were shown to be consistent for each subject. That is: 1) where the response was highly variable during acquisition performance was highly variable, and where the response was low in variability during acquisition performance was low in variability; 2) a sharp decrease in the magnitude of the relevant physiological response was demonstrated by each subject when the subject was continuously performing at asymptotic level, and the decrease of the response preceded asymptotic performance; 3) there was continuous random activity in the relevant response after the decrease throughout the rest of the task performance, or over-learning.

The two additional physiological responses were considerably less in magnitude than the relevant response for each subject, and were very similar to each other for each subject and between subjects in magnitude. The relevant response was seen to approximate these two responses during over-learning. In these latter respects the physiological responses in the pair-learning task are quite similar

in magnitude and variability to the responses in the no-learning task.

Through analysis of variance the increase in the magnitude of the physiological response between the no-learning task and the pair-learning task was shown to be significant at the 0.05 level. This significant increase in magnitude is interpreted as meaning that performance of a complex learning task of a stimulus-response nature requires greater output in, and organization of the central processes than does performance of a perceptual-motor task. The organization would take place during performance and not before, as in the no-learning, or perceptual-motor task.

That performance is controlled by the development of a specific and organized central process is shown by the continuous increase in magnitude of the relevant response during acquisition. This would indicate that during acquisition both the level of central activity and the number of mechanisms involved was an increasing function. Then, with the establishment of asymptotic performance the response shows a rapid decrease and then levels out during over-learning. This rapid decrease and leveling out is attributed to the assumption that learning is complete or organized and the level of central activity and/or the number of mechanisms required to maintain learning diminishes.

The assumption that performance is controlled and anticipated centrally is supported by the immediate and sharp decrease in the relevant response prior to continued asymptotic performance. This

prior decrease is, further, a clear indication that learning centrally precedes the overt or performance activity, and is relatively independent of sensory stimulation. This idea was first postulated by Smith (1953).

The similarity between the physiological responses of the subjects in the pair-learning task, once continued asymptotic performance was established, and the subjects in the no-learning task would seem to indicate that: during over-learning the specific central process required to perform a task of stimulus-response nature is similar to that of a task of a perceptual-motor nature.

Problem-Solving Task

It was demonstrated in the problem-solving task that the three physiological responses for each subject showed a relationship to performance (Figures 11, 12 & 13). The relationships were: 1) a substantial increase in the magnitude of the responses during acquisition; 2) a general decrease in the magnitude of the responses following acquisition of the concept, where the decreases in the responses precede the criterion of one-hundred percent learning; 3) a relatively high and random activity in the responses after the initial decrease, or during over-learning.

Analysis of variance showed that the increase in magnitude of the physiological responses between the no-learning task and the problem-solving task was significant at the 0.01 level. The increase between the pair-learning task and the problem-solving task was significant, as well, at the 0.01 level.

These significant increases in magnitude are interpreted as indicating that the performance of a complex learning task of a cognitive

nature requires greater output in, and organization of, the central processes than does the performance of either a stimulus-response learning task or a perceptual-motor task. In terms of the assumptions listed previously, the significant differences give empirical support to the assumtion that: the particular level (magnitude) of central organization depends not only on the duration of previous activity, but also on the complexity of the task.

The increases in the physiological responses during acquisition are interpreted as signifying the development of a specific and organized central process necessary to comprehend and successfully perform the problem-solving task. That is, during acquisition both the level of central activity and number of mechanisms involved is an increasing function. The decreases in the magnitude of the responses with the acquisition of the concept are interpreted as meaning that once learning has been achieved the level of activity and/or number of mechanisms of the organized central process necessary to maintain learning is greatly reduced. The assumption that performance is controlled and anticipated centrally is supported, again, by the decreases in the responses prior to continued asymptotic performance.

The relatively high and consistent random activity of the physiological responses following acquisition is attributed to the nature of the task. That is, the subject must continuously mediate, use the concept to perform successfully in the problem-solving task. This results in an increased level of central activity during over-learning when compared to the responses in the pair-learning task

during over-learning. This activity during over-learning clearly differentiates the problem-solving task from the pair-learning task.

The lack of any significant differences between the three physiological responses (active arm, passive arm, and speech) within subjects is interpreted as supporting the theory that the physiological responses are a relative percentage indication of the total central physiological activity required to perform the experimental tasks. If this were not so one might expect to get significant differences between the physiological responses, at least between the response of the active arm and the other responses.

Physiological Response Durations

There was little variation in the mean response durations both within subjects and between subjects in the no-learning task. The response durations for the subjects in both the pair-learning task and the problem-solving task were highly variable both within and between subjects and were of greater duration than in the no-learning task. The increases in the duration of the response between the no-learning task and both the two learning tasks were shown by t tests to be significant at the 0.05 level. The differences between the duration of the responses between the subjects in the pair-learning task and the problem-solving task were not significant.

The significant differences in the physiological response durations can be attributed only to the demands, in terms of learning, of the experimental tasks and not to physical work, since this was identical for each of the three tasks. Instead, the results are

interpreted as indicating that the duration of the response in the active arm was, again, a function of the total central physiological activity required to successfully perform the experimental tasks. Otherwise, one would not expect any significant differences in the duration of the responses.

In relation to previous research the present results of the two-learning tasks are, for the most part, markedly different. The majority of previous research has shown that the physiological responses (physiological gradients) have been relatively smooth, monotonically increasing responses during acquisition (Malmo, 1965). In contrast, the present research shows that the physiological responses are generally highly variable during acquisition. This difference is attributed to the difference between the current and previous experimental tasks; i.e., complex learning tasks versus perceptual-motor tasks. In addition, the present research has attempted to establish the relationship between physiological responses and performance during over-learning, and the relationship of physiological response duration and performance. These two problems have not been explored in previous research.

In general it was felt that the present study supports the theory that the electrophysiological activity in the skeletal muscles during performance of complex learning tasks is a relative indication of the total central activity required to successfully perform the tasks. This relative activity is the muscles is probably accounted for, in part, by the sensitive gamma efferent system or,

muscle-spindle feed back circuits, and would presumably be mediated between the higher cortical areas and the periphery by the "ascending reticular activating system" and the "descending reticular facilitatory syste" (Magoun, 1964).

Suggestions for Further Research

It is recommended that the present study be replicated using an increased number of trials. In this way it could be determined if the physiological responses in problem-solving during over-learning would come to approximate the responses of the pair-learning task during over-learning and the responses of the no-learning task or, would the same relationships, established in this research, hold during over-learning with increased trials.

Tn that this exploratory research in conjunction with the available equipment has established a methodology by which the relationships between complex learning and peripheral physiological activity can be studied, it is further recommended that additional research using different experimental procedures be done. Such experiments together with the present study would result in a broader understanding of the relationships between peripheral physiological activity and complex learning.

CHAPTER V

SUMMARY

The problem in the present study was to investigate the relationships between individual complex learning and the electrophysiological activity in the forearm extensor muscles of both arms and the speech muscles *via* the chin. Three different experimental tasks were used, a no-learning task of a perceptual-motor nature, a pair-learning task of a stimulus-response nature, and a problem-solving task of a cognitive nature. The electrophysiological activity (physiological responses) was measured by the surface electromyographic technique.

Nine male undergraduate, monoligual students between 19 and 21 years of age participated in the experiments. The General Learning Apparatus and standard Offner eight-channel, ink recording TYPE R DYNOGRAPH of the department of Psychology, University of Windsor were used.

The three subjects in the no-learning task were instructed to respond to six orange lights by depressing the response buttons, one at a time, below the orange lights as the orange lights came on one at a time. The three subjects in the pair-learning task were instructed to learn six randomized connections between six white lights and six response buttons. The three subjects in the problem-solving task were instructed to learn the connection between pairs of white lights and the response button; i.e., the larger minus the smaller equalled the correct response. The level of learning was

measured over blocks of six trials. The physiological responses in the form of direct and integrated electromyograms were measured over blocks of six trials.

The results indicate that the relationship holding between the physiological responses and performance during the three experimental tasks is an increasing function. That is, as the complexity and/or demands of the task was increased from the no-learning task to the pair-learning task, to the problem-solving task the magnitude of the physiological responses was shown to increase significantly.

It was demonstrated, specifically, that in a no-learning task of a perceptual-motor nature there is little within subject and between subject variation in the physiological responses, and the responses did not show any systematic increase over performance. The physiological responses were, as well, of significantly less magnitude than the responses of the subjects in the two learning tasks.

In contrast to the above, it was demonstrated that in a complex learning task of a stimulus-response nature there was a significant increase in the magnitude of the physiological responses. One of the three physiological responses was found to be more relevant to performance. This relevant response was found to increase in magnitude during acquisition. The response then decreased rapidly and during over-learning continued at a relatively decreased and random magnitude. The rapid decrease at the point of acquisition was seen to precede asymptotic performance.

In comparison to the pair-learning task, it was established that in a complex learning task of a problem-solving or cognitive nature there was a significant increase in the magnitude of the physiological responses. During acquisition the physiological responses were found to increase in magnitude. At the point of acquisition the responses decreased rapidly and then during over-learning, continued at a relatively high but random magnitude. The decrease at the point of acquisition was seen to precede asymptotic performance.

The differences in the magnitude of the three different physiological responses within subjects was found to be not significant. The differences between the physiological response duration of the active arm of the subjects in both of the two learning tasks and the subjects in the no-learning task were significant. The differences in the physiological response durations of the subjects in the two learning tasks were not significant.

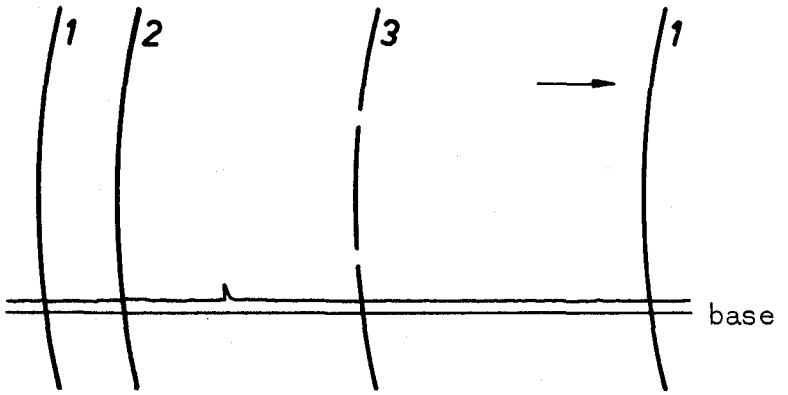
It was shown that the differences in both the magnitude of the physiological responses and the duration of the physiological responses could not be attributed to physical work. The physical work was identical in all three experimental tasks.

The results were discussed in terms of central processes. That is, the physiological responses were postulated as being relative indications of the total amount of central physiological activity and/or number of mechanisms involved in the performance of the experimental tasks. Thus, the significant increases in the magnitude of the physiological responses between the three tasks reflected increasing levels of central organization.

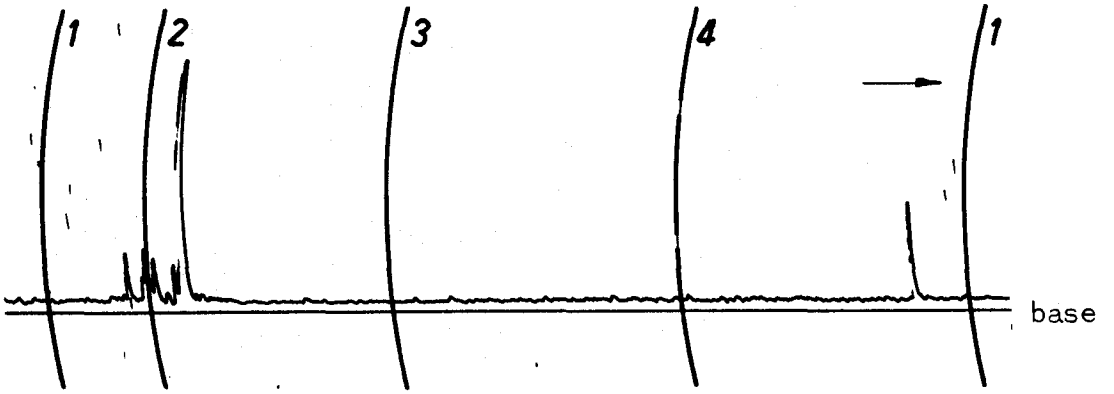
APPENDIX A

Integrated EMGs of the Passive Arm, Active Arm and Speech Responses for Trial Number 40

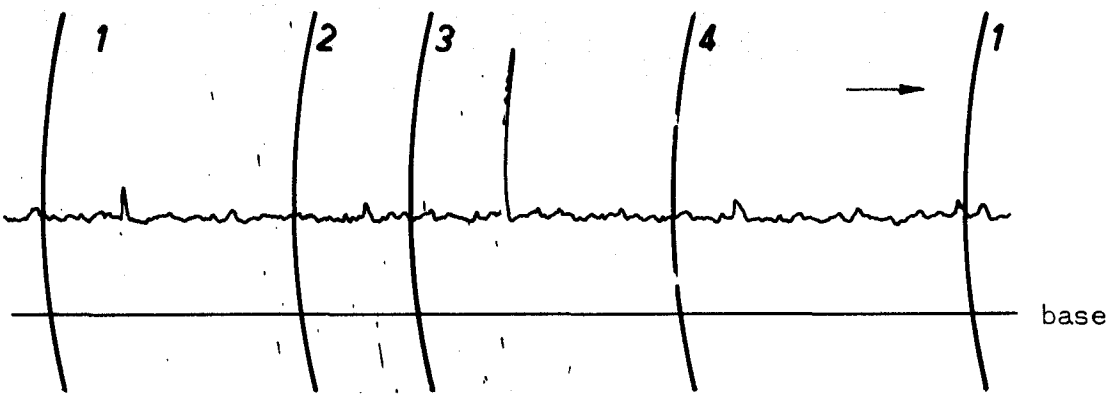
Appendix A Passive Arm



No-Learning. 1 = Orange Light Onset, 2 = Response, 3 = Orange Light Offset.

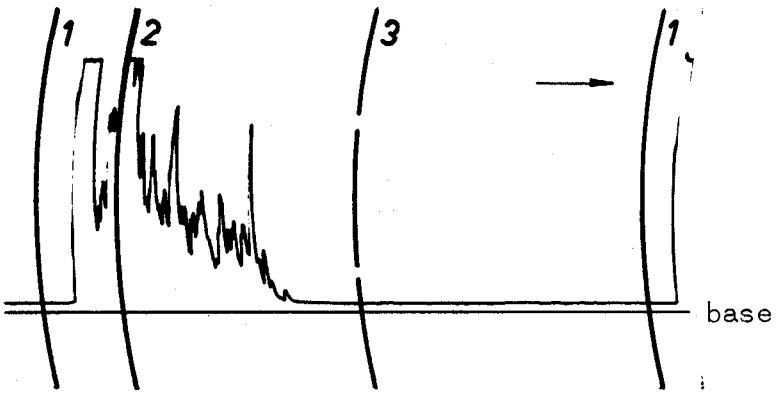


Pair-Learning. 1 = White Light Onset, 2 = Response, 3 = Orange Light Onset, 4 = White Light and Orange Light Offset.



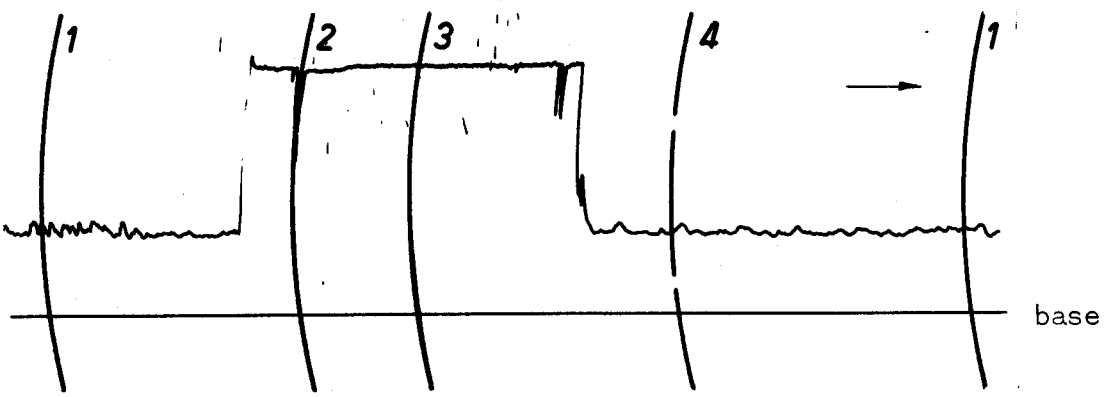
Problem-Solving. 1 = White Light Pair Onset, 2 = Response, 3 = Orange Light Onset, 4 = White Light and Orange Light Offset.

Appendix A continued. Active Arm

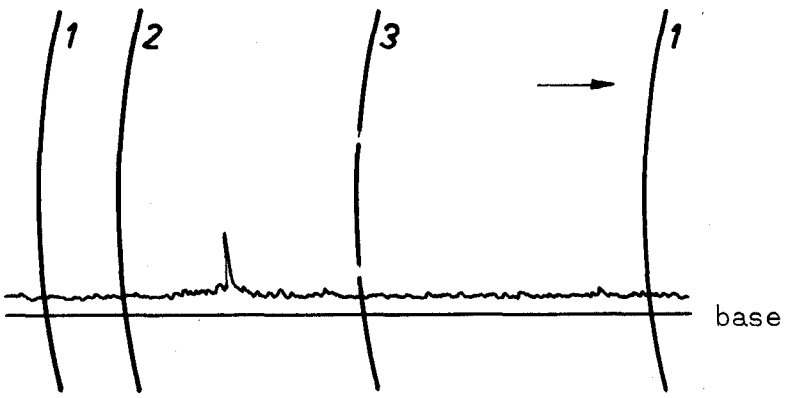


No-Learning. 1 = Orange Light Onset, 2 = Response, 3 = Orange Light Offset.

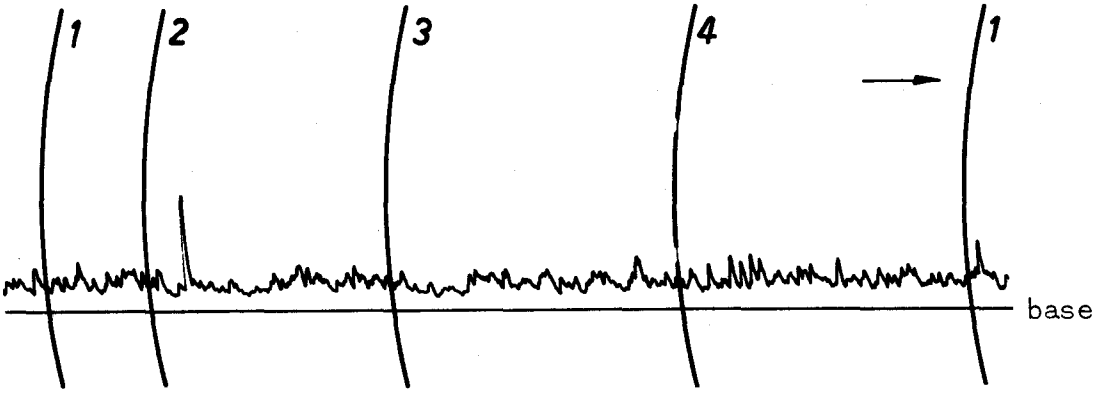
Pair-Learning. 1 = White Light Onset, 2 = Response, 3 = Orange Light Onset, 4 = White Light and Orange Light Offset.



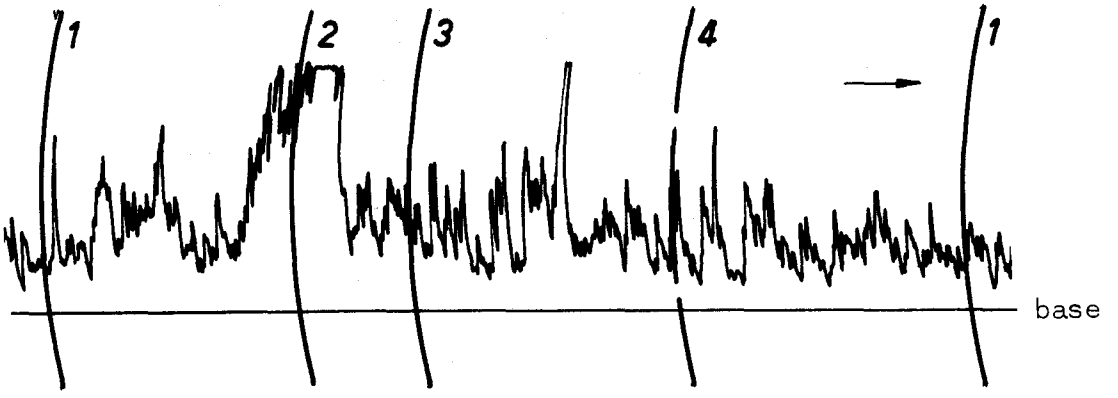
Problem-Solving. 1 = White Light Pair Onset, 2 = Response, 3 = Orange Light Onset, 4 = White Light and Orange Light Offset.



No-Learning. 1 = Orange Light Onset, 2 = Response, 3 = Orange Light Offset.



Pair-Learning. 1 = White Light Onset, 2 = Response, 3 = Orange Light Onset, 4 = White Light and Orange Light Offset.



Problem-Solving. 1 = White Light Pair Onset, 2 = Response, 3 = Orange Light Onset, 4 = White Light and Orange Light Offset.

APPENDIX B

Instructions: Experimental Tasks

No-Learning Task

THE EXPERIMENT, NOW, WILL WORK LIKE THIS:

1. When an orange light comes on you are to firmly depress and release the response button directly below it.

2. Your task is simply to respond to each orange light. There is nothing to learn.

3. Please respond with your right / left hand throughout the experiment.

4. Do you have any questions?

Pair-Learning Task

THE EXPERIMENT, NOW, WILL WORK LIKE THIS:

1. Each response button is electrically connected with a different white light.

2. Your task is to learn the correct response button white light connections.

3. You are to indicate your response to each white light by firmly depressing and releasing one (1) response button. Please respond to each white light.

4. When an orange light comes on after a white light it indicates

to you the correct response button connection for that particular white light. For example, if white light # 3 comes on and then the orange light above response button # 3 comes on, this indicates that white light # 3 is connected to response button # 3.

5. Your responses will be recorded automatically.

6. Please respond with your right / left hand throughout the experiment.

7. Do you have any questions?

Problem-Solving Task

THE EXPERIMENT, NOW, WILL WORK LIKE THIS:

1. Two white lights, a pair, will come on.

2. Each pair of white lights is electrically connected with a response button.

3. Your task is to find out and learn the connection between the pairs of white lights and the response buttons.

4. You are to indicate your response to each pair of white lights by firmly depressing and releasing one (1) response button. Please respond to each pair of white lights.

5. When an orange light comes on after a pair of white lights it indicates to you the correct response button connection for that

particular pair of white lights. For example, if a particular pair of white lights come on and then the orange light above response button # 3 comes on, this indicates that that particular pair of white lights is connected to response button # 3.

6. Your response will be recorded automatically.

7. Please respond with your right / left hand throughout the experiment.

8. Do you have any questions?

APPENDIX C

Random Order of Presentation of Thirty-six White Lights and the Response button Connections

1. - - 2 - - 5	19. - - 4 - - 6
2. - - 4 - - 6	20. - - 3 - - 4
3. - - 5 - - 2	21. - - 1 - - 3
4. - - 3 - - 4	22. - - 2 - - 5
5. - - 1 - - 3	23. - - 6 - - 1
6. - - 6 - - 1	24. - - 5 - - 2
7. - - 1 - - 3	25. - - 4 - - 6
8. - - 4 - - 6	26. - - 1 - - 3
9. - - 3 - - 4	27. - - 3 - - 4
10. - - 5 - - 2	28. - - 6 - - 1
11. - - 6 - - 1	29. - - 2 - - 5
12. - - 2 - - 5	30. - - 5 - - 2
13. - - 6 - - 1	31. - - 6 - - 1
14. - - 5 - - 2	32. - - 4 - - 6
15. - - 4 - - 6	33. - - 3 - - 4
16. - - 3 - - 4	34. - - 1 - - 3
17. - - 2 - - 5	35. - - 5 - - 2
18. - - 1 - - 3	36. - - 2 - - 5

APPENDIX D

Random Order of Presentation of the White Light Pairs

1. 5 - 6	19. 5 - 6
2. 3 - 6	20. 1 - 5
3. 4 - 5	21. 1 - 6
4. 1 - 6	22. 3 - 6
5. 1 - 5	23. 2 - 4
6. 4 - 6	24. 3 - 4

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7. 2 - 6	25. 4 - 6
8. 3 - 4	26. 3 - 5
9. 1 - 4	27. 4 - 5
10. 2 - 5	28. 1 - 5
11. 3 - 5	29. 1 - 6
12. 2 - 4	30. 2 - 5

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13. 1 - 4	31. 5 - 6
14. 2 - 5	32. 1 - 4
15. 4 - 6	33. 2 - 4
16. 3 - 5	34. 2 - 6
17. 2 - 6	35. 3 - 4
18. 4 - 5	36. 3 - 6

APPENDIX E

The Individual and the Mean Values
of the Physiological Responses in Millimeters
and, Performance in Terms of
Correct and Incorrect Individual Responses

Appendix E

SUBJECT NO. 1. NO LEARNING

(CONVERSION MM TO MICRO-VOLTS)

ACT. ARM	PASS. ARM	CHIN POT.
10.0	10.0	10.0

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
PRE-EXPERIMENTAL BASE LEVELS			1.00	.50	1.00
1	1	91.00	3.00	0.00	1.75
2	1	91.00	3.50	0.00	1.75
3	1	27.00	5.00	0.00	1.75
4	1	74.00	5.50	0.00	2.00
5	1	78.00	1.75	0.00	2.00
6	1	28.00	1.75	0.00	2.00
SUMMATIONS		389.00	20.50	0.00	11.25
MEAN VALUES		64.83	3.41	0.00	1.87
7	1	46.00	1.50	0.00	1.50
8	1	25.00	1.25	0.00	4.00
9	1	26.00	1.50	0.00	1.75
10	1	26.00	1.25	0.00	1.50
11	1	31.00	1.50	0.00	1.50
12	1	30.00	1.00	0.00	4.75
SUMMATIONS		184.00	8.00	0.00	15.00
MEAN VALUES		30.66	1.33	0.00	2.50
13	1	32.00	1.50	0.00	1.25
14	1	25.00	1.25	0.00	1.00
15	1	30.00	1.25	0.00	1.00
16	1	88.00	2.00	0.00	1.00
17	1	27.00	.50	0.00	1.00
18	1	59.00	1.50	0.00	1.50
SUMMATIONS		261.00	8.00	0.00	6.75
MEAN VALUES		43.50	1.33	0.00	1.12
19	1	65.00	1.50	0.00	1.50
20	1	37.00	1.00	0.00	2.00
21	1	32.00	.75	0.00	1.50
22	1	30.00	.50	0.00	1.00
23	1	27.00	.50	0.00	4.75
24	1	25.00	.50	0.00	1.50
SUMMATIONS		216.00	4.75	0.00	12.25
MEAN VALUES		36.00	.79	0.00	2.04

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
25	1	33.00	1.00	0.00	.50
26	1	31.00	.75	0.00	.50
27	1	87.00	4.50	0.00	.50
28	1	44.00	1.50	0.00	.50
29	1	37.00	1.00	0.00	.50
30	1	27.00	.50	0.00	4.75
SUMMATIONS		259.00	9.25	0.00	7.25
MEAN VALUES		43.16	1.54	0.00	1.20
31	1	88.00	4.50	0.00	.50
32	1	91.00	3.00	0.00	.50
33	1	37.00	1.00	0.00	.50
34	1	35.00	1.00	0.00	.50
35	1	28.00	.75	0.00	1.25
36	1	28.00	.50	0.00	2.00
SUMMATIONS		307.00	10.75	0.00	5.25
MEAN VALUES		51.16	1.79	0.00	.87
37	1	27.00	.75	0.00	.50
38	1	27.00	1.00	0.00	.50
39	1	30.00	.75	0.00	.50
40	1	22.00	.50	0.00	.50
41	1	25.00	.50	0.00	.50
42	1	26.00	.50	0.00	1.00
SUMMATIONS		157.00	4.00	0.00	3.50
MEAN VALUES		26.16	.66	0.00	.58
43	1	24.00	.25	0.00	1.00
44	1	56.00	2.75	0.00	1.00
45	1	57.00	0.00	0.00	1.00
46	1	22.00	0.00	0.00	.75
47	1	28.00	0.00	0.00	6.50
48	1	23.00	.50	0.00	1.25
SUMMATIONS		210.00	3.50	0.00	11.50
MEAN VALUES		35.00	.58	0.00	1.91
49	1	24.00	.50	0.00	1.25
50	1	22.00	.75	0.00	1.00
51	1	22.00	.25	0.00	1.00
52	1	55.00	3.00	0.00	1.25
53	1	60.00	1.00	0.00	1.25
54	1	50.00	0.00	0.00	1.25
SUMMATIONS		233.00	5.50	0.00	7.00
MEAN VALUES		38.83	.91	0.00	1.16

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
55	1	23.00	.25	0.00	1.00
56	1	29.00	.50	0.00	1.00
57	1	26.00	.50	0.00	1.25
58	1	24.00	.25	0.00	1.50
59	1	28.00	0.00	0.00	3.50
60	1	18.00	.25	0.00	1.00
SUMMATIONS		148.00	1.75	0.00	9.25
MEAN VALUES		24.66	.29	0.00	1.54
61	1	25.00	.25	0.00	1.25
62	1	25.00	0.00	0.00	1.25
63	1	29.00	.50	0.00	1.00
64	1	22.00	.50	0.00	1.00
65	1	25.00	.50	0.00	1.25
66	1	30.00	0.00	0.00	1.25
SUMMATIONS		156.00	1.75	0.00	7.00
MEAN VALUES		26.00	.29	0.00	1.16
67	1	33.00	1.75	0.00	1.25
68	1	30.00	.50	0.00	1.00
69	1	29.00	3.50	0.00	1.00
70	1	24.00	0.00	0.00	1.00
71	1	24.00	0.00	0.00	1.00
72	1	20.00	0.00	0.00	1.00
SUMMATIONS		160.00	5.75	0.00	6.25
MEAN VALUES		26.66	.95	0.00	1.04

SUBJECT NO. 2, NO LEARNING

(CONVERSION MM TO MICRO-VOLTS)

ACT. ARM	PASS. ARM	CHIN POT.
5.0	5.0	5.0

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
PRE-EXPERIMENTAL BASE LEVELS			2.00	2.00	2.50
1	1	56.00	4.25	2.00	2.00
2	1	45.00	4.25	2.00	1.50
3	1	40.00	4.50	2.00	1.50
4	1	40.00	2.00	2.00	2.00
5	1	15.00	1.50	2.00	6.75
6	1	13.00	1.50	2.00	1.75
SUMMATIONS		209.00	18.00	12.00	15.50
MEAN VALUES		34.83	3.00	2.00	2.58
7	1	15.00	7.75	2.00	2.25
8	1	50.00	3.25	2.00	3.50
9	1	35.00	26.00	2.00	4.50
10	1	68.00	7.00	2.00	2.50
11	1	34.00	6.25	2.00	1.25
12	1	28.00	3.50	2.00	1.75
SUMMATIONS		230.00	53.75	12.00	15.75
MEAN VALUES		38.33	8.95	2.00	2.62
13	1	22.00	5.50	2.00	2.00
14	1	35.00	2.50	2.00	2.00
15	1	27.00	4.00	2.00	2.00
16	1	16.00	7.50	2.00	2.00
17	1	14.00	3.00	2.00	2.00
18	1	16.00	2.50	2.00	3.00
SUMMATIONS		130.00	25.00	12.00	13.00
MEAN VALUES		21.66	4.16	2.00	2.16
19	1	20.00	1.50	2.00	2.75
20	1	22.00	1.50	2.00	2.50
21	1	15.00	1.50	2.00	2.00
22	1	18.00	2.00	2.00	2.00
23	1	14.00	2.50	2.00	2.00
24	1	18.00	1.50	2.00	3.00
SUMMATIONS		107.00	10.50	12.00	14.25
MEAN VALUES		17.83	1.75	2.00	2.37

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
25	1	19.00	1.50	2.00	1.75
26	1	14.00	1.50	2.00	2.00
27	1	17.00	3.00	2.00	2.00
28	1	18.00	2.50	2.00	2.00
29	1	22.00	1.50	2.00	2.00
30	1	16.00	1.50	2.00	2.00
SUMMATIONS		106.00	11.50	12.00	11.75
MEAN VALUES		17.66	1.91	2.00	1.95
31	1	23.00	6.25	2.00	2.00
32	1	20.00	2.25	2.00	2.00
33	1	13.00	1.50	2.00	2.00
34	1	13.00	2.25	2.00	2.00
35	1	23.00	1.50	2.00	2.00
36	1	20.00	1.50	2.00	2.00
SUMMATIONS		112.00	15.25	12.00	12.00
MEAN VALUES		18.66	2.54	2.00	2.00
37	1	40.00	8.25	2.00	2.00
38	1	20.00	6.00	2.00	2.00
39	1	22.00	1.50	2.00	2.00
40	1	20.00	1.75	2.00	2.00
41	1	21.00	2.50	2.00	2.50
42	1	13.00	4.00	2.00	2.00
SUMMATIONS		136.00	24.00	12.00	12.50
MEAN VALUES		22.66	4.00	2.00	2.08
43	1	15.00	2.50	2.00	2.00
44	1	29.00	2.50	2.00	2.00
45	1	16.00	2.50	2.00	2.50
46	1	16.00	1.75	2.00	2.50
47	1	15.00	2.00	2.00	2.50
48	1	19.00	3.00	2.00	2.00
SUMMATIONS		110.00	14.25	12.00	13.50
MEAN VALUES		18.33	2.37	2.00	2.25
49	1	19.00	2.75	2.00	2.50
50	1	13.00	1.50	2.00	2.00
51	1	13.00	2.50	2.00	2.50
52	1	23.00	3.00	2.00	3.00
53	1	17.00	1.50	2.00	3.00
54	1	19.00	4.00	2.00	3.00
SUMMATIONS		104.00	15.25	12.00	16.00
MEAN VALUES		17.33	2.54	2.00	2.66

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
55	1	20.00	1.50	2.00	2.50
56	1	17.00	2.50	2.00	2.50
57	1	25.00	3.00	2.00	2.50
58	1	18.00	2.50	2.00	2.50
59	1	19.00	1.50	2.00	2.50
60	1	17.00	1.50	2.00	2.50
SUMMATIONS		116.00	12.50	12.00	15.00
MEAN VALUES		19.33	2.08	2.00	2.50
61	1	31.00	4.25	2.00	2.50
62	1	16.00	2.25	2.00	2.50
63	1	17.00	2.50	2.00	2.50
64	1	19.00	2.50	2.00	2.50
65	1	13.00	2.25	2.00	2.50
66	1	13.00	2.50	2.00	2.50
SUMMATIONS		109.00	16.25	12.00	15.00
MEAN VALUES		18.16	2.70	2.00	2.50
67	1	17.00	2.00	2.00	2.50
68	1	17.00	2.25	2.00	2.75
69	1	15.00	4.50	2.00	2.50
70	1	17.00	2.50	2.00	3.00
71	1	22.00	2.50	2.00	4.75
72	1	18.00	1.50	2.00	2.00
SUMMATIONS		106.00	15.25	12.00	17.50
MEAN VALUES		17.66	2.54	2.00	2.91

SUBJECT NO. 3. NO LEARNING

(CONVERSION MM TO MICRO-VOLTS)

ACT. ARM	PASS. ARM	CHIN POT.
50.0	50.0	5.0

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
PRE-EXPERIMENTAL BASE LEVELS			1.00	1.00	.50
1	1	32.00	1.50	1.00	3.00
2	1	39.00	1.25	1.00	3.00
3	1	33.00	2.00	1.00	3.00
4	1	24.00	1.00	1.00	3.00
5	1	21.00	1.00	1.00	3.00
6	1	22.00	1.00	1.00	3.75
SUMMATIONS		171.00	7.75	6.00	18.75
MEAN VALUES		28.50	1.29	1.00	3.12
7	1	26.00	1.00	1.00	3.25
8	1	23.00	1.00	1.00	3.50
9	1	33.00	1.00	1.00	3.00
10	1	28.00	1.00	1.00	7.00
11	1	28.00	1.00	1.00	3.00
12	1	29.00	1.00	1.00	3.00
SUMMATIONS		167.00	6.00	6.00	22.75
MEAN VALUES		27.83	1.00	1.00	3.79
13	1	28.00	1.00	1.00	3.25
14	1	31.00	1.00	1.00	3.00
15	1	36.00	1.00	1.00	3.00
16	1	27.00	3.00	1.00	3.00
17	1	23.00	1.00	1.00	3.25
18	1	29.00	1.00	1.00	3.00
SUMMATIONS		174.00	8.00	6.00	18.50
MEAN VALUES		29.00	1.33	1.00	3.08
19	1	26.00	1.00	1.50	3.00
20	1	36.00	1.00	1.50	3.00
21	1	31.00	1.00	1.50	3.00
22	1	27.00	1.00	1.50	3.00
23	1	33.00	1.00	1.00	3.50
24	1	36.00	1.00	1.00	3.50
SUMMATIONS		189.00	6.00	8.00	19.00
MEAN VALUES		31.50	1.00	1.33	3.16

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
25	1	27.00	1.00	1.50	3.00
26	1	27.00	1.00	1.50	3.00
27	1	36.00	1.00	1.50	4.00
28	1	29.00	1.00	1.50	3.00
29	1	27.00	1.00	1.50	2.50
30	1	29.00	1.00	1.50	2.75
SUMMATIONS		175.00	6.00	9.00	18.25
MEAN VALUES		29.16	1.00	1.50	3.04
31	1	32.00	1.00	1.50	3.00
32	1	33.00	1.00	1.50	3.00
33	1	29.00	1.50	2.00	3.00
34	1	24.00	1.25	1.50	3.00
35	1	32.00	1.00	1.50	3.00
36	1	22.00	1.00	1.50	3.00
SUMMATIONS		172.00	6.75	9.50	18.00
MEAN VALUES		28.66	1.12	1.58	3.00
37	1	27.00	1.00	1.50	2.50
38	1	35.00	1.50	1.50	2.50
39	1	28.00	1.00	1.50	2.50
40	1	28.00	1.00	1.50	2.50
41	1	27.00	1.00	1.50	7.00
42	1	30.00	1.00	1.50	2.50
SUMMATIONS		175.00	6.50	9.00	19.50
MEAN VALUES		29.16	1.08	1.50	3.25
43	1	34.00	1.00	1.50	2.50
44	1	32.00	1.00	1.50	2.50
45	1	27.00	1.00	1.50	2.50
46	1	30.00	1.50	1.50	2.50
47	1	31.00	1.00	1.50	2.50
48	1	36.00	1.25	1.50	2.50
SUMMATIONS		190.00	6.75	9.00	15.00
MEAN VALUES		31.66	1.12	1.50	2.50
49	1	25.00	1.00	1.50	2.50
50	1	25.00	1.00	1.50	2.50
51	1	31.00	1.00	1.50	2.75
52	1	35.00	1.50	1.50	2.50
53	1	21.00	1.00	1.50	2.50
54	1	32.00	1.50	1.50	2.25
SUMMATIONS		169.00	7.00	9.00	15.00
MEAN VALUES		28.16	1.16	1.50	2.50

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
55	1	32.00	1.00	1.50	2.50
56	1	34.00	1.00	1.50	2.50
57	1	25.00	1.50	1.50	3.00
58	1	27.00	3.50	1.50	2.50
59	1	24.00	1.50	1.00	2.50
60	1	26.00	1.00	1.00	3.25
SUMMATIONS		168.00	9.50	8.00	16.25
MEAN VALUES		28.00	1.58	1.33	2.70
61	1	25.00	1.00	1.50	2.00
62	1	31.00	1.00	1.50	2.50
63	1	26.00	1.00	1.50	2.50
64	1	26.00	1.00	1.50	2.50
65	1	27.00	1.50	1.50	3.00
66	1	43.00	2.50	1.50	2.50
SUMMATIONS		178.00	8.00	9.00	15.00
MEAN VALUES		29.66	1.33	1.50	2.50
67	1	27.00	3.00	1.50	8.00
68	1	33.00	1.50	1.00	6.75
69	1	34.00	1.50	1.00	2.50
70	1	22.00	1.75	1.50	3.50
71	1	30.00	1.00	1.50	2.50
72	1	25.00	1.50	1.00	2.50
SUMMATIONS		171.00	10.25	7.50	25.75
MEAN VALUES		28.50	1.70	1.25	4.29

SUBJECT NO. 1. PAIR LEARNING

(CONVERSION MM TO MICRO-VOLTS)

ACT. ARM	PASS. ARM	CHIN POT.
5.0	5.0	5.0

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
PRE-EXPERIMENTAL BASE LEVELS			1.00	1.00	1.00
1	1	119.00	24.00	18.00	4.00
2	1	121.00	18.00	2.50	4.50
3	0	121.00	23.00	11.00	2.50
4	0	121.00	17.00	2.00	4.25
5	0	121.00	32.75	12.75	9.25
6	0	121.00	31.00	1.50	6.25
SUMMATIONS		724.00	145.75	47.75	30.75
MEAN VALUES		120.66	24.29	7.95	5.12
7	1	121.00	32.50	1.00	4.00
8	1	80.00	21.25	1.00	7.00
9	1	121.00	30.50	1.00	5.75
10	1	76.00	20.00	1.00	5.50
11	0	121.00	30.50	.50	5.75
12	0	121.00	5.50	.50	5.00
SUMMATIONS		640.00	140.25	5.00	33.00
MEAN VALUES		106.66	23.37	.83	5.50
13	0	121.00	28.75	.50	4.50
14	1	121.00	13.50	1.00	3.50
15	1	121.00	33.50	1.00	4.00
16	0	121.00	33.00	1.00	7.25
17	1	121.00	33.50	1.00	4.75
18	1	121.00	31.00	1.00	3.50
SUMMATIONS		726.00	173.25	5.50	27.50
MEAN VALUES		121.00	28.87	.91	4.58
19	1	118.00	5.00	1.00	3.50
20	1	119.00	33.50	1.50	2.50
21	1	121.00	33.00	1.75	1.50
22	1	121.00	31.50	1.00	1.50
23	1	121.00	32.00	1.00	2.50
24	1	121.00	9.50	1.50	6.00
SUMMATIONS		721.00	144.50	7.75	17.50
MEAN VALUES		120.16	24.08	1.29	2.91

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
25	1	29.00	3.00	1.00	2.00
26	1	44.00	2.75	1.00	2.00
27	1	37.00	3.50	1.00	9.00
28	1	121.00	19.00	1.00	3.00
29	1	121.00	29.00	1.00	1.50
30	0	121.00	17.50	1.00	2.00
SUMMATIONS		473.00	74.75	6.00	19.50
MEAN VALUES		78.83	12.45	1.00	3.25
31	1	53.00	4.75	1.00	1.50
32	1	121.00	5.50	1.50	1.50
33	0	121.00	3.00	1.00	7.00
34	1	121.00	32.00	1.00	5.00
35	1	121.00	23.25	1.00	1.25
36	0	56.00	29.00	1.00	9.00
SUMMATIONS		593.00	97.50	6.50	25.25
MEAN VALUES		98.83	16.25	1.08	4.20
37	1	121.00	32.25	1.00	6.00
38	1	121.00	33.00	1.00	7.75
39	1	121.00	5.50	1.00	1.75
40	1	121.00	26.25	1.00	3.00
41	1	121.00	5.50	1.00	8.75
42	0	121.00	22.00	1.50	14.00
SUMMATIONS		726.00	124.50	6.50	41.25
MEAN VALUES		121.00	20.75	1.08	6.87
43	1	121.00	21.00	1.00	5.00
44	0	64.00	9.75	2.50	9.50
45	1	81.00	1.50	1.38	3.25
46	1	64.00	2.00	1.00	2.25
47	1	121.00	12.75	1.13	1.50
48	1	54.00	1.50	1.50	1.50
SUMMATIONS		505.00	48.50	8.51	23.00
MEAN VALUES		84.16	8.08	1.41	3.83
49	1	116.00	33.50	1.25	1.50
50	1	121.00	21.75	1.00	1.50
51	1	121.00	33.50	1.38	1.50
52	1	121.00	31.75	1.00	1.75
53	1	121.00	33.50	1.50	3.38
54	1	121.00	33.00	1.50	5.00
SUMMATIONS		721.00	187.00	7.63	14.63
MEAN VALUES		120.16	31.16	1.27	2.43

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
55	1	121.00	6.50	1.50	5.25
56	1	49.00	22.00	1.00	2.50
57	1	121.00	18.75	1.00	1.50
58	1	121.00	5.75	1.50	1.50
59	1	121.00	10.50	9.25	8.00
60	1	32.00	1.50	8.75	4.25
SUMMATIONS		565.00	65.00	23.00	23.00
MEAN VALUES		94.16	10.83	3.83	3.83
61	1	21.00	2.38	1.50	11.25
62	0	53.00	2.50	3.00	8.75
63	1	34.00	2.00	1.50	6.50
64	0	115.00	31.25	3.50	11.13
65	1	121.00	31.50	2.25	6.25
66	1	121.00	20.25	1.00	2.50
SUMMATIONS		465.00	89.88	12.75	46.38
MEAN VALUES		77.50	14.98	2.12	7.73
67	1	121.00	5.75	1.00	2.13
68	1	121.00	33.50	1.00	1.50
69	1	121.00	33.50	1.00	1.50
70	1	121.00	33.00	1.00	2.00
71	1	121.00	32.50	1.00	1.38
72	1	121.00	24.00	4.00	2.50
SUMMATIONS		726.00	162.25	9.00	11.01
MEAN VALUES		121.00	27.04	1.50	1.83
73	1	121.00	22.00	1.25	2.50
74	1	121.00	8.00	1.75	3.00
75	1	121.00	12.50	18.50	3.50
76	1	121.00	10.00	3.25	8.00
77	1	121.00	13.25	4.00	3.50
78	1	121.00	7.75	3.00	2.75
SUMMATIONS		726.00	73.50	31.75	23.25
MEAN VALUES		121.00	12.25	5.29	3.87
79	1	121.00	6.00	2.25	2.25
80	1	121.00	6.00	2.25	1.50
81	1	121.00	15.00	2.00	2.00
82	1	121.00	13.25	1.50	1.50
83	1	121.00	12.00	1.50	1.38
84	1	121.00	9.75	1.50	2.00
SUMMATIONS		726.00	62.00	11.00	10.63
MEAN VALUES		121.00	10.33	1.83	1.77

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
85	1	121.00	7.50	9.00	4.50
86	1	121.00	4.00	2.00	3.75
87	1	90.00	7.25	2.00	2.50
88	1	32.00	3.00	1.25	1.50
89	1	25.00	1.38	1.25	2.00
90	1	29.00	1.50	1.00	1.50
SUMMATIONS		418.00	24.63	16.50	15.75
MEAN VALUES		69.66	4.10	2.75	2.62
91	1	115.00	8.50	2.50	6.00
92	1	80.00	3.00	1.00	5.00
93	1	121.00	4.50	1.00	2.75
94	1	121.00	11.00	1.75	2.75
95	1	121.00	14.00	1.00	2.75
96	1	52.00	4.25	1.00	1.75
SUMMATIONS		610.00	45.25	8.25	21.00
MEAN VALUES		101.66	7.54	1.37	3.50
97	1	117.00	12.75	1.00	6.50
98	1	121.00	6.50	1.50	2.50
99	1	121.00	22.75	7.00	18.00
100	1	121.00	22.00	1.00	12.50
101	1	121.00	17.00	22.00	2.75
102	1	121.00	10.00	1.00	2.50
SUMMATIONS		722.00	91.00	33.50	44.75
MEAN VALUES		120.33	15.16	5.58	7.45
103	1	121.00	6.00	1.00	3.00
104	1	121.00	8.00	3.75	2.50
105	1	121.00	7.00	1.00	3.00
106	1	111.00	17.50	1.00	4.50
107	1	121.00	13.25	1.00	6.50
108	1	75.00	8.75	1.00	5.00
SUMMATIONS		670.00	60.50	8.75	24.50
MEAN VALUES		111.66	10.08	1.45	4.08
109	1	121.00	13.25	1.00	12.00
110	1	121.00	33.00	1.00	12.75
111	1	121.00	10.00	1.38	10.50
112	1	121.00	6.75	1.00	2.50
113	1	63.00	3.00	1.00	7.50
114	1	45.00	1.50	2.00	3.00
SUMMATIONS		592.00	67.50	7.38	48.25
MEAN VALUES		98.66	11.25	1.23	8.04

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
115	1	104.00	10.00	1.25	4.50
116	1	39.00	6.25	1.50	2.63
117	1	117.00	5.75	1.00	2.25
118	1	36.00	2.00	1.00	10.00
119	1	37.00	4.25	1.00	5.50
120	1	57.00	2.25	1.00	17.75
SUMMATIONS		390.00	30.50	6.75	42.63
MEAN VALUES		65.00	5.08	1.12	7.10
121	1	48.00	2.25	2.00	4.75
122	1	25.00	1.13	1.50	3.00
123	1	56.00	2.50	1.38	3.25
124	1	117.00	8.75	2.50	2.50
125	1	121.00	5.00	1.25	3.00
126	1	50.00	8.75	14.00	19.00
SUMMATIONS		417.00	28.38	22.63	35.50
MEAN VALUES		69.50	4.73	3.77	5.91
127	1	121.00	7.00	1.00	20.00
128	1	114.00	5.00	1.00	10.00
129	1	116.00	4.50	1.00	4.00
130	1	115.00	16.75	1.00	3.75
131	1	121.00	23.00	1.00	3.00
132	1	121.00	22.00	1.00	3.00
SUMMATIONS		708.00	78.25	6.00	43.75
MEAN VALUES		118.00	13.04	1.00	7.29
133	1	111.00	4.50	1.00	2.75
134	1	40.00	3.25	5.75	8.00
135	1	33.00	1.38	2.00	17.50
136	1	28.00	2.00	1.50	10.50
137	1	18.00	1.25	1.00	2.50
138	1	32.00	8.00	15.00	5.00
SUMMATIONS		262.00	20.38	26.25	46.25
MEAN VALUES		43.66	3.39	4.37	7.70
139	1	121.00	5.75	9.00	6.50
140	1	121.00	15.00	2.50	14.00
141	1	75.00	2.50	1.50	17.25
142	1	118.00	12.50	5.00	6.75
143	1	116.00	2.50	1.00	3.00
144	1	110.00	7.63	3.75	6.00
SUMMATIONS		661.00	45.88	22.75	53.50
MEAN VALUES		110.16	7.64	3.79	8.91

SUBJECT NO. 2. PAIR LEARNING

(CONVERSION MM TO MICRO-VOLTS)

ACT. ARM	PASS. ARM	CHIN POT.
5.0	5.0	5.0

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
PRE-EXPERIMENTAL BASE LEVELS			.50	1.00	2.00
1	0	121.00	30.50	1.25	4.00
2	0	121.00	17.25	1.50	4.50
3	0	121.00	26.00	2.00	5.25
4	0	121.00	10.75	1.75	5.75
5	0	121.00	12.75	2.38	4.50
6	0	121.00	9.25	1.25	4.25
SUMMATIONS		726.00	106.50	10.13	28.25
MEAN VALUES		121.00	17.75	1.68	4.70
7	0	121.00	7.75	3.25	4.00
8	0	121.00	2.25	2.50	5.00
9	0	121.00	5.00	2.00	4.00
10	0	59.00	11.50	2.75	5.00
11	1	85.00	.50	4.00	4.50
12	0	114.00	2.50	3.00	4.00
SUMMATIONS		621.00	29.50	17.50	26.50
MEAN VALUES		103.50	4.91	2.91	4.41
13	0	121.00	2.00	8.00	4.00
14	0	121.00	9.00	14.00	5.25
15	0	64.00	13.00	3.00	3.25
16	1	60.00	1.25	2.75	3.75
17	0	117.00	2.50	8.00	4.00
18	1	121.00	4.00	7.50	4.00
SUMMATIONS		604.00	31.75	43.25	24.25
MEAN VALUES		100.66	5.29	7.20	4.04
19	0	121.00	8.25	7.00	3.50
20	1	121.00	3.00	7.00	3.00
21	1	58.00	.50	4.00	3.00
22	1	33.00	.75	4.00	3.50
23	0	114.00	11.50	4.00	4.00
24	1	38.00	.75	4.00	4.00
SUMMATIONS		485.00	24.75	30.00	21.00
MEAN VALUES		80.83	4.12	5.00	3.50

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
25	1	29.00	1.38	4.00	3.50
26	1	25.00	1.00	3.50	3.25
27	1	23.00	11.50	3.25	3.50
28	0	112.00	2.00	4.00	4.50
29	0	19.00	1.50	5.50	4.25
30	1	26.00	1.38	3.00	3.00
SUMMATIONS		234.00	18.76	23.25	22.00
MEAN VALUES		39.00	3.12	3.87	3.66
31	1	28.00	.88	3.00	3.00
32	1	35.00	1.00	2.50	4.00
33	1	35.00	2.00	2.50	3.50
34	0	66.00	6.50	4.50	3.75
35	1	43.00	2.75	1.50	1.50
36	1	51.00	1.25	4.50	2.50
SUMMATIONS		258.00	14.38	18.50	18.25
MEAN VALUES		43.00	2.39	3.08	3.04
37	1	22.00	2.00	4.00	3.00
38	1	50.00	2.50	1.50	3.00
39	1	30.00	6.75	1.75	3.50
40	1	20.00	5.00	1.63	4.00
41	1	26.00	2.13	2.00	4.00
42	1	70.00	.50	2.50	4.00
SUMMATIONS		218.00	18.88	13.38	21.50
MEAN VALUES		36.33	3.14	2.23	3.58
43	0	40.00	.50	1.50	4.00
44	0	45.00	22.25	2.50	3.50
45	1	60.00	.63	4.00	3.25
46	1	26.00	.50	4.00	3.50
47	1	26.00	2.38	4.00	3.50
48	0	30.00	1.00	4.00	3.75
SUMMATIONS		227.00	27.26	20.00	21.50
MEAN VALUES		37.83	4.54	3.33	3.58
49	1	21.00	1.00	6.00	3.25
50	0	41.00	12.00	2.00	3.50
51	0	121.00	16.00	1.25	3.75
52	1	28.00	2.50	1.50	4.25
53	0	121.00	30.00	1.25	3.75
54	0	59.00	23.50	1.00	6.00
SUMMATIONS		391.00	85.00	13.00	24.50
MEAN VALUES		65.16	14.16	2.16	4.08

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
55	0	50.00	13.50	1.00	3.00
56	1	32.00	2.50	1.25	3.00
57	1	52.00	9.75	1.00	3.75
58	1	121.00	8.75	1.50	4.00
59	1	121.00	3.25	1.25	4.00
60	0	47.00	1.00	1.50	4.00
SUMMATIONS		423.00	38.75	7.50	21.75
MEAN VALUES		70.50	6.45	1.25	3.62
61	1	19.00	1.13	1.50	3.50
62	1	30.00	18.00	1.50	3.50
63	1	45.00	12.00	1.00	4.00
64	1	121.00	11.25	1.00	4.00
65	0	121.00	28.50	1.00	4.50
66	1	121.00	9.75	1.50	4.00
SUMMATIONS		457.00	80.63	7.50	23.50
MEAN VALUES		76.16	13.43	1.25	3.91
67	1	121.00	13.25	1.00	4.00
68	1	121.00	7.25	1.50	4.00
69	1	121.00	25.50	1.50	4.00
70	1	121.00	12.00	1.25	3.50
71	1	121.00	25.00	1.25	3.50
72	1	28.00	20.00	1.25	3.50
SUMMATIONS		633.00	103.00	7.75	22.50
MEAN VALUES		105.50	17.16	1.29	3.75
73	0	110.00	.50	1.50	6.00
74	1	115.00	24.00	2.00	3.00
75	1	62.00	3.00	2.00	2.50
76	1	21.00	.38	1.25	3.50
77	1	21.00	.25	1.25	3.00
78	1	28.00	.25	1.50	3.25
SUMMATIONS		357.00	28.38	9.50	21.25
MEAN VALUES		59.50	4.73	1.58	3.54
79	1	19.00	1.00	1.50	3.00
80	1	35.00	.25	1.50	3.75
81	1	19.00	.50	1.50	2.75
82	1	24.00	.25	1.50	2.50
83	1	20.00	.25	1.75	4.00
84	0	38.00	.25	1.50	3.00
SUMMATIONS		155.00	2.50	9.25	19.00
MEAN VALUES		25.83	.41	1.54	3.16

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
85	1	30.00	.50	1.50	3.50
86	1	25.00	.50	2.00	3.50
87	1	29.00	.50	1.50	3.50
88	1	22.00	.25	1.50	3.75
89	1	22.00	.25	2.00	4.00
90	1	20.00	.25	2.00	3.25
SUMMATIONS		148.00	2.25	10.50	21.50
MEAN VALUES		24.66	.37	1.75	3.58
91	1	18.00	.25	1.50	3.00
92	1	24.00	.25	2.00	3.50
93	1	23.00	.25	1.75	4.00
94	1	22.00	.25	2.00	4.50
95	1	21.00	7.75	1.50	3.00
96	1	14.00	26.00	1.50	3.50
SUMMATIONS		122.00	34.75	10.25	21.50
MEAN VALUES		20.33	5.79	1.70	3.58
97	1	121.00	9.50	1.50	3.50
98	1	121.00	32.00	2.00	3.50
99	1	121.00	28.50	2.50	3.50
100	1	121.00	31.00	1.50	3.50
101	1	121.00	31.00	1.50	3.50
102	1	121.00	21.00	2.00	4.00
SUMMATIONS		726.00	153.00	11.00	21.50
MEAN VALUES		121.00	25.50	1.83	3.58
103	1	121.00	19.50	1.88	3.50
104	1	121.00	19.25	1.50	4.00
105	1	30.00	7.00	1.75	6.25
106	1	56.00	32.00	1.50	4.00
107	0	106.00	29.50	2.75	4.25
108	1	121.00	25.50	2.50	3.00
SUMMATIONS		555.00	132.75	11.88	25.00
MEAN VALUES		92.50	22.12	1.98	4.16
109	1	121.00	20.50	5.00	3.50
110	1	121.00	12.00	4.00	4.50
111	1	121.00	21.00	3.00	4.00
112	1	121.00	24.50	3.50	4.00
113	1	121.00	25.00	3.50	4.00
114	1	121.00	15.00	2.00	4.00
SUMMATIONS		726.00	118.00	21.00	24.00
MEAN VALUES		121.00	19.66	3.50	4.00

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
115	1	30.00	21.50	3.50	4.25
116	1	121.00	1.75	2.00	4.00
117	1	21.00	3.00	2.50	4.75
118	1	28.00	10.00	1.50	4.25
119	1	85.00	2.75	2.00	3.75
120	1	29.00	3.50	2.00	4.75
SUMMATIONS		314.00	42.50	13.50	25.75
MEAN VALUES		52.33	7.08	2.25	4.29
121	1	18.00	10.00	1.50	4.00
122	1	121.00	3.00	2.50	4.00
123	1	29.00	14.00	1.25	4.75
124	1	121.00	22.75	2.50	5.00
125	1	121.00	4.00	2.50	4.50
126	1	31.00	20.00	2.00	4.00
SUMMATIONS		441.00	73.75	12.25	26.25
MEAN VALUES		73.50	12.29	2.04	4.37
127	1	57.00	1.00	2.50	4.75
128	1	49.00	2.75	2.00	4.50
129	1	28.00	5.75	1.25	4.50
130	1	78.00	2.00	1.50	4.50
131	1	33.00	13.25	3.00	4.00
132	1	55.00	1.25	1.25	4.00
SUMMATIONS		300.00	26.00	11.50	26.25
MEAN VALUES		50.00	4.33	1.91	4.37
133	1	28.00	3.00	1.50	3.25
134	1	24.00	16.50	1.50	3.50
135	1	21.00	5.00	2.00	4.25
136	1	100.00	5.25	6.00	4.25
137	1	33.00	6.00	2.50	3.50
138	1	60.00	7.75	2.50	4.00
SUMMATIONS		266.00	43.50	16.00	22.75
MEAN VALUES		44.33	7.25	2.66	3.79
139	1	20.00	9.00	1.50	3.75
140	1	32.00	2.00	1.50	4.00
141	1	21.00	17.25	1.50	4.00
142	1	121.00	4.00	2.50	3.50
143	1	26.00	4.00	1.25	4.00
144	1	22.00	3.50	5.00	4.00
SUMMATIONS		242.00	39.75	13.25	23.25
MEAN VALUES		40.33	6.62	2.20	3.87

SUBJECT NO. 3, PAIR LEARNING

(CONVERSION MM TO MICRO-VOLTS)

ACT. ARM	PASS. ARM	CHIN POT.
5.0	5.0	5.0

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
PRE-EXPERIMENTAL BASE LEVELS			1.00	1.00	1.50
1	0	29.00	1.00	.75	8.50
2	0	49.00	1.38	.75	7.25
3	1	121.00	2.00	.50	6.50
4	0	42.00	1.00	.50	7.00
5	0	57.00	1.00	.50	6.00
6	0	27.00	1.00	.50	5.75
SUMMATIONS		325.00	7.38	3.50	41.00
MEAN VALUES		54.16	1.23	.58	6.83
7	0	35.00	1.63	.50	6.50
8	0	43.00	1.00	.50	6.50
9	1	27.00	.88	.50	7.00
10	1	26.00	.75	.50	5.75
11	0	34.00	.50	.50	7.50
12	0	37.00	.50	.25	7.00
SUMMATIONS		202.00	5.26	2.75	40.25
MEAN VALUES		33.66	.87	.45	6.70
13	0	33.00	.50	.25	8.75
14	1	39.00	.75	.25	7.00
15	1	41.00	30.00	.50	6.00
16	0	83.00	1.63	.50	7.50
17	1	52.00	.88	.50	6.25
18	1	38.00	.63	.50	8.75
SUMMATIONS		286.00	34.39	2.50	44.25
MEAN VALUES		47.66	5.73	.41	7.37
19	0	41.00	.75	.50	13.00
20	0	37.00	.88	.50	12.75
21	0	42.00	.88	.50	11.75
22	0	41.00	1.00	.50	11.25
23	1	24.00	1.00	.50	7.25
24	1	26.00	1.00	.50	7.00
SUMMATIONS		211.00	5.51	3.00	63.00
MEAN VALUES		35.16	.91	.50	10.50

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
25	0	65.00	1.00	.50	7.75
26	1	43.00	1.00	.50	7.50
27	1	29.00	1.00	.50	6.25
28	1	27.00	1.00	.75	18.00
29	1	112.00	2.00	.50	6.00
30	1	60.00	1.25	.50	6.00
SUMMATIONS		336.00	7.25	3.25	51.50
MEAN VALUES		56.00	1.20	.54	8.58
31	1	112.00	4.50	.50	6.00
32	0	72.00	.88	.50	7.50
33	1	31.00	1.00	.50	6.75
34	1	108.00	2.50	.50	9.50
35	0	75.00	1.50	.50	9.00
36	1	121.00	2.00	.50	6.00
SUMMATIONS		519.00	12.38	3.00	44.75
MEAN VALUES		86.50	2.06	.50	7.45
37	1	37.00	3.00	1.00	11.00
38	1	121.00	2.50	.50	7.50
39	1	39.00	.88	.50	5.75
40	1	30.00	.75	.50	5.50
41	1	32.00	1.00	.75	8.50
42	1	29.00	2.50	.50	5.75
SUMMATIONS		288.00	10.63	3.75	44.00
MEAN VALUES		48.00	1.77	.62	7.33
43	1	40.00	1.00	.50	6.00
44	1	41.00	.75	.50	6.50
45	1	116.00	2.50	.75	6.00
46	1	39.00	1.25	.50	12.75
47	1	37.00	.88	.50	6.75
48	1	46.00	1.50	.50	6.75
SUMMATIONS		319.00	7.88	3.25	44.75
MEAN VALUES		53.16	1.31	.54	7.45
49	1	28.00	1.25	.50	5.50
50	1	28.00	1.00	.50	6.25
51	0	60.00	1.00	.50	7.75
52	1	27.00	1.00	.50	6.25
53	1	48.00	13.00	.75	10.00
54	1	25.00	.75	.50	6.50
SUMMATIONS		216.00	18.00	3.25	42.25
MEAN VALUES		36.00	3.00	.54	7.04

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
55	1	32.00	.75	.50	6.00
56	1	48.00	.88	.50	6.00
57	1	63.00	1.00	.75	10.00
58	1	46.00	1.75	.50	6.25
59	1	113.00	2.50	.50	5.00
60	1	39.00	1.25	.50	6.75
SUMMATIONS		341.00	8.13	3.25	40.00
MEAN VALUES		56.83	1.35	.54	6.66
61	1	32.00	1.00	.50	5.50
62	1	114.00	4.00	.50	6.50
63	1	37.00	.88	.50	6.00
64	1	32.00	.75	.50	6.25
65	1	33.00	1.13	.50	9.50
66	1	108.00	4.00	.50	7.50
SUMMATIONS		356.00	11.76	3.00	41.25
MEAN VALUES		59.33	1.96	.50	6.87
67	1	121.00	4.00	.50	6.00
68	1	50.00	.75	.50	5.75
69	1	31.00	.75	.50	6.00
70	1	30.00	.75	.50	5.00
71	1	34.00	.75	.50	4.50
72	1	33.00	.75	.50	4.50
SUMMATIONS		299.00	7.75	3.00	31.75
MEAN VALUES		49.83	1.29	.50	5.29
73	1	42.00	2.50	2.50	4.00
74	1	30.00	1.00	.50	5.50
75	1	35.00	1.00	.50	4.75
76	1	35.00	2.00	.50	7.25
77	1	60.00	1.25	.50	5.00
78	1	50.00	1.00	.50	5.50
SUMMATIONS		252.00	8.75	5.00	32.00
MEAN VALUES		42.00	1.45	.83	5.33
79	1	42.00	1.00	.50	5.75
80	1	34.00	1.13	.50	5.50
81	1	43.00	.75	.50	6.25
82	1	41.00	1.00	.50	7.50
83	1	39.00	1.25	.50	5.75
84	1	39.00	1.50	.50	5.75
SUMMATIONS		238.00	6.63	3.00	36.50
MEAN VALUES		39.66	1.10	.50	6.08

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
85	1	32.00	1.00	.50	5.25
86	1	33.00	1.00	.50	5.25
87	1	35.00	1.00	.50	7.25
88	1	115.00	2.50	.25	6.75
89	1	41.00	1.00	.25	6.00
90	1	34.00	1.00	.50	5.50
SUMMATIONS		290.00	7.50	2.50	36.00
MEAN VALUES		48.33	1.25	.41	6.00
91	1	114.00	2.50	.25	6.25
92	1	49.00	2.00	.25	5.50
93	1	121.00	3.00	.25	5.50
94	1	121.00	3.00	.25	5.00
95	1	40.00	1.00	.25	6.25
96	1	45.00	.75	.25	5.25
SUMMATIONS		490.00	12.25	1.50	33.75
MEAN VALUES		81.66	2.04	.25	5.62
97	1	51.00	1.00	.50	10.00
98	1	34.00	1.00	.50	6.00
99	1	41.00	1.00	.50	6.25
100	1	34.00	1.00	.50	5.00
101	1	55.00	1.00	.25	6.25
102	1	45.00	1.25	.50	5.00
SUMMATIONS		260.00	6.25	2.75	38.50
MEAN VALUES		43.33	1.04	.45	6.41
103	1	37.00	1.00	.25	6.00
104	1	42.00	1.00	.25	4.50
105	1	31.00	1.00	.25	5.25
106	1	46.00	1.00	.50	6.75
107	1	39.00	1.00	.50	6.00
108	1	35.00	1.25	.50	5.50
SUMMATIONS		230.00	6.25	2.25	34.00
MEAN VALUES		38.33	1.04	.37	5.66
109	1	37.00	1.00	1.00	5.50
110	1	39.00	1.00	.50	5.25
111	1	40.00	1.25	.50	5.25
112	1	37.00	1.38	.50	4.00
113	1	40.00	5.25	.50	5.50
114	1	39.00	1.00	.50	5.00
SUMMATIONS		232.00	10.88	3.50	30.50
MEAN VALUES		38.66	1.81	.58	5.08

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
115	1	68.00	1.13	.50	5.75
116	1	41.00	.75	.50	6.50
117	1	51.00	1.50	.25	4.50
118	1	39.00	1.25	.25	5.00
119	1	34.00	.75	.50	4.50
120	1	49.00	.88	1.50	8.50
SUMMATIONS		282.00	6.26	3.50	34.75
MEAN VALUES		47.00	1.04	.58	5.79
121	1	39.00	.50	1.50	5.00
122	1	46.00	.75	1.50	5.50
123	1	38.00	.75	1.50	4.75
124	1	34.00	10.00	1.50	5.50
125	1	66.00	8.00	1.25	3.50
126	1	79.00	.75	1.00	3.50
SUMMATIONS		302.00	20.75	8.25	27.75
MEAN VALUES		50.33	3.45	1.37	4.62
127	1	39.00	1.00	1.00	3.50
128	1	39.00	.75	1.00	4.25
129	1	37.00	1.00	1.00	3.50
130	1	29.00	2.50	2.00	5.25
131	1	30.00	.75	2.00	4.25
132	1	32.00	.88	1.25	4.00
SUMMATIONS		206.00	6.88	8.25	24.75
MEAN VALUES		34.33	1.14	1.37	4.12
133	1	34.00	1.00	.75	4.75
134	1	35.00	1.00	.50	3.50
135	1	40.00	1.00	.50	3.50
136	1	32.00	1.00	.50	5.00
137	1	36.00	1.00	.50	4.00
138	1	42.00	1.25	2.00	3.50
SUMMATIONS		219.00	6.25	4.75	24.25
MEAN VALUES		36.50	1.04	.79	4.04
139	1	39.00	1.00	.50	3.50
140	1	58.00	1.00	.50	3.00
141	1	39.00	.75	.50	3.00
142	1	48.00	.75	.50	7.25
143	1	37.00	1.50	.50	6.00
144	1	33.00	1.00	.50	4.00
SUMMATIONS		254.00	6.00	3.00	26.75
MEAN VALUES		42.33	1.00	.50	4.45

SUBJECT NO. 1. PROBLEM SOLVING

(CONVERSION MM TO MICRO-VOLTS)

ACT. ARM	PASS. ARM	CHIN POT.
5.0	5.0	5.0

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
PRE-EXPERIMENTAL BASE LEVELS			10.00	1.00	1.50
1	0	112.00	33.00	11.50	5.00
2	0	121.00	33.00	13.50	11.25
3	1	121.00	31.00	14.00	9.75
4	0	121.00	30.00	13.50	4.75
5	0	110.00	25.50	14.00	7.00
6	1	109.00	33.00	14.00	9.75
SUMMATIONS		694.00	185.50	80.50	47.50
MEAN VALUES		115.66	30.91	13.41	7.91
7	1	121.00	26.00	13.50	9.75
8	1	121.00	31.00	14.00	9.25
9	0	121.00	30.00	14.00	10.25
10	1	105.00	22.25	14.00	10.50
11	0	106.00	27.50	14.50	11.00
12	0	75.00	11.50	13.75	14.25
SUMMATIONS		649.00	148.25	83.75	65.00
MEAN VALUES		108.16	24.70	13.95	10.83
13	0	63.00	11.50	13.50	18.00
14	1	67.00	12.25	15.00	14.50
15	1	121.00	21.75	14.00	12.25
16	0	102.00	17.50	15.00	11.00
17	1	106.00	18.50	13.50	10.50
18	0	121.00	14.00	13.50	15.50
SUMMATIONS		580.00	95.50	84.50	81.75
MEAN VALUES		96.66	15.91	14.08	13.62
19	0	67.00	11.50	14.00	16.75
20	0	100.00	15.00	14.00	12.00
21	0	67.00	11.50	14.00	13.75
22	1	97.00	13.00	14.00	7.00
23	0	121.00	14.50	15.00	11.75
24	0	78.00	12.00	15.00	13.00
SUMMATIONS		530.00	77.50	86.00	74.25
MEAN VALUES		88.33	12.91	14.33	12.37

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
25	1	60.00	12.50	16.00	9.75
26	0	106.00	24.50	14.50	9.00
27	0	76.00	12.00	14.50	12.50
28	1	111.00	13.00	15.00	10.50
29	0	121.00	32.00	14.50	7.00
30	1	50.00	11.50	14.00	6.25
SUMMATIONS		524.00	105.50	88.50	55.00
MEAN VALUES		87.33	17.58	14.75	9.16
31	0	107.00	29.00	14.00	6.75
32	0	121.00	25.00	14.00	10.00
33	0	117.00	16.50	14.50	12.50
34	1	97.00	29.50	14.00	7.25
35	0	121.00	12.25	14.00	12.00
36	0	121.00	17.50	14.00	8.50
SUMMATIONS		684.00	129.75	84.50	57.00
MEAN VALUES		114.00	21.62	14.08	9.50
37	1	89.00	33.00	14.00	9.50
38	1	121.00	13.00	13.50	11.00
39	0	121.00	13.00	14.00	12.00
40	0	71.00	11.00	13.50	13.75
41	0	108.00	30.00	13.50	9.50
42	1	80.00	12.00	14.00	7.00
SUMMATIONS		590.00	112.00	82.50	62.75
MEAN VALUES		98.33	18.66	13.75	10.45
43	1	46.00	11.50	14.50	6.50
44	1	85.00	13.00	14.00	7.75
45	1	58.00	11.50	14.50	8.50
46	1	56.00	11.00	14.00	6.75
47	1	38.00	11.00	14.00	9.50
48	1	59.00	11.00	13.50	9.00
SUMMATIONS		342.00	69.00	84.50	48.00
MEAN VALUES		57.00	11.50	14.08	8.00
49	1	60.00	11.00	13.50	10.00
50	1	52.00	11.00	14.00	7.50
51	1	113.00	24.50	16.75	6.50
52	1	57.00	11.50	14.00	9.00
53	1	34.00	11.00	14.00	7.50
54	1	32.00	11.00	13.50	8.25
SUMMATIONS		348.00	80.00	85.75	48.75
MEAN VALUES		58.00	13.33	14.29	8.12

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
55	1	45.00	11.00	13.50	11.00
56	1	26.00	10.50	13.25	20.50
57	1	29.00	10.50	13.00	7.75
58	1	26.00	11.00	13.50	3.00
59	1	20.00	23.00	13.00	4.00
60	1	121.00	24.00	14.00	5.00
SUMMATIONS		267.00	90.00	80.25	51.25
MEAN VALUES		44.50	15.00	13.37	8.54
61	1	31.00	11.50	14.00	4.00
62	1	35.00	11.50	15.00	9.00
63	1	25.00	33.00	13.50	12.50
64	1	49.00	11.25	17.00	5.00
65	1	50.00	11.50	18.50	4.75
66	1	45.00	11.50	17.25	4.25
SUMMATIONS		235.00	90.25	95.25	39.50
MEAN VALUES		39.16	15.04	15.87	6.58
67	1	113.00	33.00	13.50	7.25
68	1	70.00	10.50	13.00	7.00
69	1	113.00	23.00	21.00	3.25
70	1	52.00	10.50	12.50	2.50
71	1	33.00	10.25	12.38	18.00
72	1	110.00	33.00	15.00	2.75
SUMMATIONS		491.00	120.25	87.38	40.75
MEAN VALUES		81.83	20.04	14.56	6.79
73	1	45.00	10.50	13.00	4.50
74	1	38.00	13.25	12.50	2.50
75	1	43.00	12.75	12.50	2.75
76	1	33.00	10.00	12.00	3.25
77	1	21.00	29.50	12.25	14.00
78	1	56.00	10.00	12.50	9.50
SUMMATIONS		236.00	86.00	74.75	36.50
MEAN VALUES		39.33	14.33	12.45	6.08
79	1	20.00	18.00	12.00	16.00
80	1	121.00	14.00	13.00	13.00
81	1	38.00	10.00	12.50	6.00
82	1	73.00	10.00	13.00	18.00
83	1	55.00	10.50	13.00	4.25
84	1	107.00	17.00	12.50	8.25
SUMMATIONS		414.00	79.50	76.00	65.50
MEAN VALUES		69.00	13.25	12.66	10.91

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
85	1	121.00	30.75	13.00	18.00
86	1	22.00	10.00	12.50	6.50
87	1	109.00	32.25	13.00	6.50
88	1	80.00	10.25	12.50	8.00
89	1	105.00	26.50	14.50	4.75
90	1	114.00	26.50	19.25	3.50
SUMMATIONS		551.00	136.25	84.75	47.25
MEAN VALUES		91.83	22.70	14.12	7.87
91	1	101.00	19.75	20.75	4.00
92	1	28.00	10.00	12.50	3.50
93	1	109.00	32.50	12.50	12.25
94	1	45.00	10.00	12.50	10.00
95	1	111.00	33.00	13.50	13.00
96	1	60.00	10.00	12.50	8.50
SUMMATIONS		454.00	115.25	84.25	51.25
MEAN VALUES		75.66	19.20	14.04	8.54
97	1	23.00	10.00	13.00	4.75
98	1	26.00	10.00	13.00	7.75
99	1	113.00	18.00	13.00	3.50
100	1	40.00	11.00	12.50	4.25
101	1	121.00	19.00	12.50	2.13
102	1	65.00	11.00	25.00	2.00
SUMMATIONS		388.00	79.00	89.00	24.38
MEAN VALUES		64.66	13.16	14.83	4.06
103	1	63.00	33.00	14.75	1.50
104	1	102.00	18.75	17.00	2.50
105	1	43.00	17.00	13.00	3.00
106	1	112.00	22.50	21.25	8.00
107	1	22.00	10.50	13.00	9.50
108	1	28.00	11.25	19.50	4.75
SUMMATIONS		370.00	113.00	98.50	29.25
MEAN VALUES		61.66	18.83	16.41	4.87
109	1	35.00	11.00	14.00	6.75
110	1	99.00	11.25	12.50	6.50
111	1	32.00	10.00	12.50	5.00
112	1	108.00	12.00	12.50	5.50
113	1	49.00	20.00	12.75	6.00
114	1	52.00	10.00	12.50	6.00
SUMMATIONS		375.00	74.25	76.75	35.75
MEAN VALUES		62.50	12.37	12.79	5.95

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
115	1	38.00	11.00	14.00	10.00
116	1	103.00	31.00	13.50	9.00
117	1	121.00	32.00	15.00	9.00
118	1	121.00	33.00	18.00	9.00
119	1	121.00	33.00	12.75	9.00
120	1	80.00	10.00	12.00	15.00
SUMMATIONS		584.00	150.00	85.25	61.00
MEAN VALUES		97.33	25.00	14.20	10.16
121	1	47.00	9.50	16.00	23.00
122	1	26.00	16.00	11.50	5.00
123	1	45.00	9.50	12.25	5.00
124	1	52.00	33.00	11.00	4.00
125	1	121.00	32.00	11.00	3.25
126	1	121.00	30.50	12.00	4.75
SUMMATIONS		412.00	130.50	73.75	45.00
MEAN VALUES		68.66	21.75	12.29	7.50
127	1	121.00	32.50	30.00	3.50
128	1	121.00	31.00	29.00	3.75
129	1	62.00	30.00	12.00	4.25
130	1	52.00	9.00	11.25	6.50
131	1	39.00	9.00	11.00	9.75
132	1	26.00	32.75	11.00	8.50
SUMMATIONS		421.00	144.25	104.25	36.25
MEAN VALUES		70.16	24.04	17.37	6.04
133	1	47.00	25.00	11.25	9.50
134	1	121.00	33.00	12.00	3.75
135	1	121.00	33.00	12.00	3.75
136	1	121.00	33.00	12.00	2.00
137	1	121.00	21.50	17.00	4.25
138	1	47.00	9.50	12.50	9.50
SUMMATIONS		578.00	155.00	76.75	32.75
MEAN VALUES		96.33	25.83	12.79	5.45
139	1	107.00	33.00	12.00	2.25
140	1	121.00	33.00	12.25	2.50
141	1	121.00	23.00	25.00	3.50
142	1	53.00	9.00	11.00	3.50
143	1	29.00	19.50	11.00	12.75
144	1	32.00	8.50	10.50	6.00
SUMMATIONS		463.00	126.00	81.75	30.50
MEAN VALUES		77.16	21.00	13.62	5.08

SUBJECT NO. 2, PROBLEM SOLVING

(CONVERSION MM TO MICRO-VOLTS)

ACT. ARM	PASS. ARM	CHIN POT.
5.0	5.0	5.0

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
PRE-EXPERIMENTAL BASE LEVELS			2.50	1.50	2.00
1	0	121.00	32.50	2.25	9.00
2	0	121.00	32.50	1.25	10.25
3	1	121.00	32.00	2.25	9.50
4	0	76.00	20.00	5.00	9.50
5	0	43.00	10.00	8.00	7.75
6	0	104.00	32.00	10.00	9.50
SUMMATIONS		586.00	159.00	28.75	55.50
MEAN VALUES		97.66	26.50	4.79	9.25
7	0	121.00	29.50	11.00	7.00
8	0	69.00	23.00	13.50	5.50
9	0	68.00	23.00	15.00	8.00
10	1	108.00	32.00	16.00	11.25
11	0	121.00	31.00	15.00	7.00
12	0	121.00	26.75	15.00	5.50
SUMMATIONS		608.00	165.25	85.50	44.25
MEAN VALUES		101.33	27.54	14.25	7.37
13	0	121.00	27.25	17.50	7.50
14	1	69.00	20.00	17.50	8.75
15	0	103.00	32.00	17.50	6.75
16	0	50.00	17.00	16.50	5.00
17	0	107.00	30.00	17.00	6.50
18	1	121.00	28.50	16.50	6.25
SUMMATIONS		571.00	154.75	102.50	40.75
MEAN VALUES		95.16	25.79	17.08	6.79
19	1	121.00	32.00	17.00	5.25
20	1	121.00	32.00	17.00	5.25
21	0	121.00	29.00	17.50	6.25
22	0	65.00	25.00	17.00	4.25
23	0	93.00	29.00	19.00	6.50
24	0	58.00	21.50	20.00	5.25
SUMMATIONS		579.00	168.50	107.50	32.75
MEAN VALUES		96.50	28.08	17.91	5.45

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
25	1	121.00	29.50	18.00	5.25
26	0	121.00	32.00	18.00	5.50
27	0	121.00	32.00	19.00	6.50
28	1	121.00	29.75	20.00	5.00
29	0	121.00	32.00	20.50	6.50
30	1	121.00	30.00	20.00	6.75
SUMMATIONS		726.00	185.25	115.50	35.50
MEAN VALUES		121.00	30.87	19.25	5.91
31	1	64.00	32.25	20.50	5.75
32	1	55.00	25.50	21.00	8.50
33	1	45.00	19.25	20.50	6.75
34	1	99.00	20.00	20.50	6.75
35	1	121.00	30.25	21.00	8.75
36	0	121.00	29.75	22.00	7.75
SUMMATIONS		505.00	157.00	125.50	44.25
MEAN VALUES		84.16	26.16	20.91	7.37
37	0	121.00	29.50	22.00	17.25
38	0	42.00	24.50	21.50	9.25
39	0	103.00	20.00	22.00	10.50
40	0	97.00	25.00	23.00	6.50
41	1	121.00	31.00	23.50	7.00
42	1	121.00	30.25	23.00	6.75
SUMMATIONS		605.00	160.25	135.00	57.25
MEAN VALUES		100.83	26.70	22.50	9.54
43	0	121.00	29.00	22.00	8.50
44	1	77.00	29.50	22.00	6.25
45	1	51.00	20.00	22.50	9.25
46	0	70.00	23.00	22.00	10.25
47	0	30.00	24.00	22.50	5.50
48	0	46.00	24.25	22.00	6.25
SUMMATIONS		395.00	149.75	133.00	46.00
MEAN VALUES		65.83	24.95	22.16	7.66
49	0	40.00	21.00	22.00	6.00
50	1	96.00	28.50	22.50	6.00
51	1	65.00	31.50	23.00	6.00
52	0	30.00	21.75	23.00	6.75
53	1	28.00	20.50	22.50	6.25
54	1	70.00	26.00	23.00	4.75
SUMMATIONS		329.00	149.25	136.00	35.75
MEAN VALUES		54.83	24.87	22.66	5.95

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
55	1	27.00	24.25	23.00	5.25
56	1	28.00	19.50	22.50	4.75
57	1	30.00	19.00	22.00	7.00
58	0	36.00	22.00	22.00	6.25
59	0	30.00	26.50	22.50	5.25
60	0	55.00	20.00	21.00	4.50
SUMMATIONS		206.00	131.25	133.00	33.00
MEAN VALUES		34.33	21.87	22.16	5.50
61	1	23.00	26.00	25.00	4.50
62	0	121.00	29.50	22.50	4.00
63	1	59.00	20.00	22.50	4.00
64	1	37.00	30.50	23.00	3.38
65	1	32.00	20.50	23.50	5.00
66	1	43.00	20.25	23.25	4.75
SUMMATIONS		315.00	146.75	139.75	25.63
MEAN VALUES		52.50	24.45	23.29	4.27
67	1	70.00	23.00	23.50	4.50
68	1	31.00	28.25	24.50	4.50
69	1	45.00	22.00	25.00	5.00
70	1	26.00	21.50	24.50	5.50
71	0	20.00	21.00	24.00	5.00
72	0	22.00	24.50	23.50	4.75
SUMMATIONS		214.00	140.25	145.00	29.25
MEAN VALUES		35.66	23.37	24.16	4.87
73	1	51.00	31.50	24.00	3.25
74	0	42.00	21.75	24.00	5.00
75	1	70.00	26.00	23.50	4.25
76	1	70.00	25.00	23.00	4.50
77	1	33.00	20.75	23.00	3.50
78	0	55.00	27.75	22.50	5.75
SUMMATIONS		321.00	152.75	140.00	26.25
MEAN VALUES		53.50	25.45	23.33	4.37
79	1	55.00	25.00	22.00	5.00
80	0	40.00	23.75	25.00	5.25
81	1	23.00	19.75	21.25	4.50
82	0	103.00	27.50	21.00	4.50
83	0	105.00	27.00	22.00	5.00
84	1	15.00	19.25	21.00	4.75
SUMMATIONS		341.00	142.25	132.25	29.00
MEAN VALUES		56.83	23.70	22.04	4.83

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
85	1	20.00	18.75	21.00	4.50
86	1	20.00	18.50	20.50	3.50
87	0	21.00	19.00	20.50	4.50
88	1	17.00	23.25	21.00	5.00
89	1	27.00	19.00	21.25	6.00
90	1	21.00	19.00	21.50	3.50
SUMMATIONS		126.00	117.50	125.75	27.00
MEAN VALUES		21.00	19.58	20.95	4.50
91	0	21.00	25.00	21.00	4.00
92	1	110.00	30.00	21.25	4.00
93	1	121.00	28.50	21.00	2.00
94	0	52.00	18.50	20.50	3.00
95	1	16.00	18.00	20.50	4.50
96	0	18.00	18.00	20.00	3.00
SUMMATIONS		338.00	138.00	124.25	20.50
MEAN VALUES		56.33	23.00	20.70	3.41
97	1	45.00	20.00	20.00	3.75
98	1	29.00	18.50	20.50	4.00
99	1	108.00	32.50	21.00	3.00
100	1	121.00	32.50	21.00	3.00
101	1	121.00	32.00	21.00	4.25
102	1	121.00	32.00	21.25	4.00
SUMMATIONS		545.00	167.50	124.75	22.00
MEAN VALUES		90.83	27.91	20.79	3.66
103	0	93.00	28.00	22.25	4.25
104	1	62.00	19.25	21.00	4.00
105	1	30.00	18.50	21.00	3.50
106	1	107.00	31.00	22.00	4.75
107	0	65.00	19.25	21.00	3.50
108	1	21.00	20.75	22.00	4.00
SUMMATIONS		378.00	136.75	129.25	24.00
MEAN VALUES		63.00	22.79	21.54	4.00
109	1	30.00	19.00	21.00	3.00
110	1	30.00	16.75	20.00	3.25
111	1	23.00	16.00	19.00	4.00
112	1	24.00	18.00	19.50	2.00
113	1	20.00	17.00	20.50	3.00
114	1	23.00	17.00	19.50	2.00
SUMMATIONS		150.00	103.75	119.50	17.25
MEAN VALUES		25.00	17.29	19.91	2.87

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
115	1	108.00	21.00	20.00	3.00
116	1	121.00	24.00	19.50	2.50
117	1	42.00	15.50	24.00	2.00
118	1	26.00	15.50	18.00	3.75
119	1	63.00	16.75	18.00	2.00
120	1	94.00	31.50	23.00	3.75
SUMMATIONS		454.00	124.25	122.50	17.00
MEAN VALUES		75.66	20.70	20.41	2.83
121	1	121.00	28.25	19.00	5.00
122	1	121.00	27.75	24.50	4.50
123	0	121.00	29.75	19.00	5.25
124	1	121.00	30.25	22.00	5.25
125	1	95.00	19.50	20.00	6.00
126	1	106.00	29.75	20.00	5.50
SUMMATIONS		685.00	165.25	124.50	31.50
MEAN VALUES		114.16	27.54	20.75	5.25
127	1	82.00	19.25	18.50	5.00
128	1	108.00	29.75	18.00	4.50
129	1	69.00	17.50	17.00	4.00
130	1	100.00	32.00	18.00	4.50
131	1	121.00	25.50	17.50	4.00
132	1	62.00	14.25	17.00	4.00
SUMMATIONS		542.00	138.25	106.00	26.00
MEAN VALUES		90.33	23.04	17.66	4.33
133	1	52.00	25.00	15.50	4.00
134	1	73.00	18.50	15.00	4.00
135	1	27.00	14.50	18.00	4.00
136	1	28.00	13.00	21.00	4.50
137	1	23.00	14.00	15.50	6.00
138	1	46.00	13.50	15.50	5.00
SUMMATIONS		249.00	98.50	100.50	27.50
MEAN VALUES		41.50	16.41	16.75	4.58
139	1	78.00	17.50	15.50	15.00
140	1	25.00	13.00	15.00	3.50
141	1	30.00	13.50	14.00	7.50
142	1	21.00	13.50	14.50	4.25
143	1	16.00	17.00	15.00	3.50
144	1	18.00	12.50	14.50	3.50
SUMMATIONS		188.00	87.00	88.50	37.25
MEAN VALUES		31.33	14.50	14.75	6.20

SUBJECT NO. 3. PROBLEM SOLVING

(CONVERSION MM TO MICRO-VOLTS)

ACT. ARM	PASS. ARM	CHIN POT.
5.0	5.0	5.0

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
PRE-EXPERIMENTAL BASE LEVELS			1.75	1.75	2.50
1	0	33.00	2.25	3.25	21.50
2	1	44.00	2.38	3.00	17.00
3	0	30.00	2.50	3.00	11.00
4	0	35.00	2.25	3.00	13.75
5	0	30.00	2.25	3.13	18.00
6	1	42.00	2.50	3.50	15.00
SUMMATIONS		214.00	14.13	18.88	96.25
MEAN VALUES		35.66	2.35	3.14	16.04
7	1	35.00	5.00	3.50	13.25
8	0	47.00	2.25	3.00	12.00
9	0	29.00	2.50	3.00	13.50
10	0	35.00	2.50	3.25	11.15
11	0	49.00	2.25	3.00	11.00
12	0	62.00	2.25	3.13	6.25
SUMMATIONS		257.00	16.75	18.88	67.15
MEAN VALUES		42.83	2.79	3.14	11.19
13	1	35.00	2.25	3.00	7.25
14	0	42.00	2.50	3.50	7.00
15	1	27.00	3.00	3.50	6.50
16	1	27.00	2.25	3.50	7.50
17	1	106.00	15.00	3.75	17.00
18	1	42.00	2.50	3.75	16.00
SUMMATIONS		279.00	27.50	21.00	61.25
MEAN VALUES		46.50	4.58	3.50	10.20
19	1	22.00	2.50	4.00	13.00
20	1	23.00	2.50	3.88	17.00
21	1	19.00	2.38	3.50	10.00
22	1	27.00	2.38	3.75	26.00
23	1	27.00	2.25	3.88	17.50
24	1	22.00	2.25	3.50	10.00
SUMMATIONS		140.00	14.26	22.51	93.50
MEAN VALUES		23.33	2.37	3.75	15.58

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
25	1	22.00	11.00	3.50	7.50
26	1	26.00	2.50	3.00	7.50
27	1	34.00	2.50	3.00	9.00
28	1	20.00	2.50	3.00	3.50
29	1	28.00	2.50	3.00	4.00
30	1	20.00	12.75	3.00	3.75
SUMMATIONS		150.00	33.75	18.50	35.25
MEAN VALUES		25.00	5.62	3.08	5.87
31	1	121.00	15.00	3.25	4.25
32	1	42.00	3.00	3.13	4.00
33	1	68.00	3.00	3.25	8.50
34	1	75.00	3.75	3.25	7.25
35	1	121.00	21.00	3.13	6.25
36	1	29.00	2.50	3.00	6.50
SUMMATIONS		456.00	48.25	19.01	36.75
MEAN VALUES		76.00	8.04	3.16	6.12
37	1	24.00	4.25	3.50	6.00
38	1	121.00	14.00	3.25	6.75
39	1	26.00	9.50	3.50	7.75
40	1	30.00	2.38	3.00	17.00
41	1	21.00	2.38	3.00	10.50
42	1	17.00	2.50	3.00	4.25
SUMMATIONS		239.00	35.01	19.25	52.25
MEAN VALUES		39.83	5.83	3.20	8.70
43	1	36.00	12.00	3.25	5.25
44	1	35.00	3.00	3.00	6.00
45	1	30.00	2.50	3.00	6.50
46	1	28.00	8.00	3.25	5.50
47	1	35.00	2.75	3.50	6.00
48	1	29.00	2.50	3.25	6.00
SUMMATIONS		193.00	30.75	19.25	35.25
MEAN VALUES		32.16	5.12	3.20	5.87
49	1	24.00	2.50	3.25	6.00
50	1	27.00	2.25	3.25	5.00
51	1	58.00	3.75	3.25	6.75
52	1	22.00	6.50	3.25	6.00
53	1	121.00	6.00	3.00	6.75
54	1	121.00	6.00	3.00	6.75
SUMMATIONS		373.00	27.00	19.00	37.25
MEAN VALUES		62.16	4.50	3.16	6.20

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
55	1	121.00	5.00	3.25	7.75
56	1	28.00	2.50	3.25	7.50
57	1	35.00	3.00	3.25	6.50
58	1	22.00	2.50	7.00	4.50
59	1	32.00	4.50	3.50	6.00
60	1	121.00	4.00	3.50	7.00
SUMMATIONS		359.00	21.50	23.75	39.25
MEAN VALUES		59.83	3.58	3.95	6.54
61	1	88.00	4.25	3.50	7.25
62	1	20.00	2.50	3.25	6.00
63	1	21.00	2.50	3.25	7.00
64	1	34.00	2.50	3.25	15.00
65	1	30.00	3.00	3.25	4.25
66	1	20.00	2.50	3.25	3.00
SUMMATIONS		213.00	17.25	19.75	42.50
MEAN VALUES		35.50	2.87	3.29	7.08
67	1	19.00	2.50	3.50	3.00
68	1	15.00	2.50	3.50	3.00
69	1	21.00	2.50	19.00	4.50
70	1	18.00	2.50	3.25	4.75
71	1	23.00	2.50	3.50	5.50
72	1	18.00	2.50	3.25	6.00
SUMMATIONS		114.00	15.00	36.00	26.75
MEAN VALUES		19.00	2.50	6.00	4.45
73	1	18.00	2.50	3.50	6.00
74	1	16.00	2.50	3.25	6.50
75	1	16.00	2.50	3.25	7.00
76	1	52.00	2.50	3.25	6.25
77	1	17.00	2.50	3.25	6.00
78	1	83.00	9.00	3.25	6.00
SUMMATIONS		202.00	21.50	19.75	37.75
MEAN VALUES		33.66	3.58	3.29	6.29
79	1	16.00	2.50	3.25	5.75
80	1	30.00	2.50	3.25	10.00
81	1	20.00	2.50	3.25	5.25
82	1	21.00	2.25	3.25	4.50
83	1	18.00	2.25	3.25	5.00
84	1	17.00	2.25	3.25	6.25
SUMMATIONS		122.00	14.25	19.50	36.75
MEAN VALUES		20.33	2.37	3.25	6.12

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
85	1	19.00	2.25	3.25	6.75
86	1	22.00	2.25	3.25	7.25
87	1	17.00	2.25	3.25	7.50
88	1	17.00	2.25	3.25	8.00
89	1	23.00	2.25	3.25	8.00
90	1	21.00	2.25	3.50	7.00
SUMMATIONS		119.00	13.50	19.75	44.50
MEAN VALUES		19.83	2.25	3.29	7.41
91	1	18.00	2.50	3.25	5.00
92	1	17.00	2.25	3.50	5.75
93	1	22.00	2.25	3.25	7.75
94	1	17.00	2.50	3.25	8.00
95	1	16.00	2.25	3.25	8.50
96	1	18.00	2.25	3.50	7.75
SUMMATIONS		108.00	14.00	20.00	42.75
MEAN VALUES		18.00	2.33	3.33	7.12
97	1	20.00	2.25	3.25	5.50
98	1	35.00	2.50	3.25	4.50
99	1	26.00	3.75	3.50	4.00
100	1	45.00	3.25	3.50	5.50
101	1	80.00	3.50	3.50	7.00
102	1	21.00	9.00	3.50	7.00
SUMMATIONS		227.00	24.25	20.50	33.50
MEAN VALUES		37.83	4.04	3.41	5.58
103	1	30.00	25.50	8.00	7.50
104	1	40.00	10.25	8.00	9.00
105	1	25.00	7.50	8.00	8.75
106	1	27.00	16.00	3.50	9.25
107	1	27.00	2.75	3.50	7.75
108	1	24.00	3.25	3.50	5.25
SUMMATIONS		173.00	65.25	34.50	47.50
MEAN VALUES		28.83	10.87	5.75	7.91
109	1	24.00	3.38	3.50	5.50
110	1	27.00	3.63	3.50	6.25
111	1	21.00	5.00	3.50	7.00
112	1	30.00	3.50	3.50	8.50
113	1	20.00	2.50	3.50	2.50
114	1	20.00	2.38	3.25	2.50
SUMMATIONS		142.00	20.39	20.75	32.25
MEAN VALUES		23.66	3.39	3.45	5.37

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (MM)	ACTIVE ARM (MM)	PASSIVE ARM (MM)	CHIN POTENTIAL (MM)
115	1	26.00	2.25	3.25	3.50
116	1	23.00	2.50	3.50	4.25
117	1	18.00	2.50	3.50	2.50
118	1	15.00	10.00	3.25	2.50
119	1	19.00	2.50	3.25	2.50
120	1	32.00	3.50	3.25	4.50
SUMMATIONS		133.00	23.25	20.00	19.75
MEAN VALUES		22.16	3.87	3.33	3.29
121	1	12.00	2.25	3.25	2.50
122	1	30.00	6.50	3.25	3.13
123	1	21.00	7.00	3.25	3.50
124	1	121.00	11.50	3.25	4.00
125	1	21.00	13.25	3.50	4.00
126	1	34.00	4.50	3.50	4.25
SUMMATIONS		239.00	45.00	20.00	21.38
MEAN VALUES		39.83	7.50	3.33	3.56
127	1	22.00	2.50	3.50	3.00
128	1	27.00	2.50	3.50	4.00
129	1	40.00	4.25	3.50	8.25
130	1	26.00	3.00	3.25	3.00
131	1	25.00	2.38	3.25	12.00
132	1	24.00	2.75	3.50	2.50
SUMMATIONS		164.00	17.38	20.50	32.75
MEAN VALUES		27.33	2.89	3.41	5.45
133	1	16.00	2.50	3.50	3.00
134	1	14.00	2.38	3.25	3.25
135	1	19.00	4.00	3.50	4.00
136	1	24.00	2.25	3.25	4.50
137	1	18.00	2.00	3.50	4.75
138	1	17.00	2.00	3.25	4.25
SUMMATIONS		108.00	15.13	20.25	23.75
MEAN VALUES		18.00	2.52	3.37	3.95
139	1	18.00	3.50	3.25	4.00
140	1	28.00	2.50	3.25	5.00
141	1	23.00	4.50	3.50	5.00
142	1	121.00	6.25	3.50	5.50
143	1	21.00	9.00	4.00	7.00
144	1	17.00	12.00	3.50	5.50
SUMMATIONS		228.00	37.75	21.00	32.00
MEAN VALUES		38.00	6.29	3.50	5.33

APPENDIX F

The Individual and the Mean Values
of the Physiological Responses in Microvolts
and, Performance in Terms of
Correct and Incorrect Individual Responses

Appendix F

SUBJECT NO. 1. NO LEARNING

RESPONSE DURATION IN SECONDS
ELECTROPHYSIOLOGICAL MEASUREMENTS IN MICRO-VOLTS

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
PRE-EXPERIMENTAL BASE LEVELS			10.00	5.00	10.00
1	1	9.10	20.00	-5.00	7.50
2	1	9.10	25.00	-5.00	7.50
3	1	2.70	40.00	-5.00	7.50
4	1	7.40	45.00	-5.00	10.00
5	1	7.80	7.50	-5.00	10.00
6	1	2.80	7.50	-5.00	10.00
SUMMATIONS		38.90	145.00	-30.00	52.50
MEAN VALUES		6.48	24.16	-5.00	8.75
7	1	4.60	5.00	-5.00	5.00
8	1	2.50	2.50	-5.00	30.00
9	1	2.60	5.00	-5.00	7.50
10	1	2.60	2.50	-5.00	5.00
11	1	3.10	5.00	-5.00	5.00
12	1	3.00	0.00	-5.00	37.50
SUMMATIONS		18.40	20.00	-30.00	90.00
MEAN VALUES		3.06	3.33	-5.00	15.00
13	1	3.20	5.00	-5.00	2.50
14	1	2.50	2.50	-5.00	0.00
15	1	3.00	2.50	-5.00	0.00
16	1	8.80	10.00	-5.00	0.00
17	1	2.70	-5.00	-5.00	0.00
18	1	5.90	5.00	-5.00	5.00
SUMMATIONS		26.10	20.00	-30.00	7.50
MEAN VALUES		4.35	3.33	-5.00	1.25
19	1	6.50	5.00	-5.00	5.00
20	1	3.70	0.00	-5.00	10.00
21	1	3.20	-2.50	-5.00	5.00
22	1	3.00	-5.00	-5.00	0.00
23	1	2.70	-5.00	-5.00	37.50
24	1	2.50	-5.00	-5.00	5.00
SUMMATIONS		21.60	-12.50	-30.00	62.50
MEAN VALUES		3.60	-2.08	-5.00	10.41

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
25	1	3.30	0.00	-5.00	-5.00
26	1	3.10	-2.50	-5.00	-5.00
27	1	8.70	35.00	-5.00	-5.00
28	1	4.40	5.00	-5.00	-5.00
29	1	3.70	0.00	-5.00	-5.00
30	1	2.70	-5.00	-5.00	37.50
SUMMATIONS		25.90	32.50	-30.00	12.50
MEAN VALUES		4.31	5.41	-5.00	2.08
31	1	8.80	35.00	-5.00	-5.00
32	1	9.10	20.00	-5.00	-5.00
33	1	3.70	0.00	-5.00	-5.00
34	1	3.50	0.00	-5.00	-5.00
35	1	2.80	-2.50	-5.00	2.50
36	1	2.80	-5.00	-5.00	10.00
SUMMATIONS		30.70	47.50	-30.00	-7.50
MEAN VALUES		5.11	7.91	-5.00	-1.25
37	1	2.70	-2.50	-5.00	-5.00
38	1	2.70	0.00	-5.00	-5.00
39	1	3.00	-2.50	-5.00	-5.00
40	1	2.20	-5.00	-5.00	-5.00
41	1	2.50	-5.00	-5.00	-5.00
42	1	2.60	-5.00	-5.00	0.00
SUMMATIONS		15.70	-20.00	-30.00	-25.00
MEAN VALUES		2.61	-3.33	-5.00	-4.16
43	1	2.40	-7.50	-5.00	0.00
44	1	5.60	17.50	-5.00	0.00
45	1	5.70	-10.00	-5.00	0.00
46	1	2.20	-10.00	-5.00	-2.50
47	1	2.80	-10.00	-5.00	55.00
48	1	2.30	-5.00	-5.00	2.50
SUMMATIONS		21.00	-25.00	-30.00	55.00
MEAN VALUES		3.50	-4.16	-5.00	9.16
49	1	2.40	-5.00	-5.00	2.50
50	1	2.20	-2.50	-5.00	0.00
51	1	2.20	-7.50	-5.00	0.00
52	1	5.50	20.00	-5.00	2.50
53	1	6.00	0.00	-5.00	2.50
54	1	5.00	-10.00	-5.00	2.50
SUMMATIONS		23.30	-5.00	-30.00	10.00
MEAN VALUES		3.88	-.83	-5.00	1.66

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
55	1	2.30	-7.50	-5.00	0.00
56	1	2.90	-5.00	-5.00	0.00
57	1	2.60	-5.00	-5.00	2.50
58	1	2.40	-7.50	-5.00	5.00
59	1	2.80	-10.00	-5.00	25.00
60	1	1.80	-7.50	-5.00	0.00
SUMMATIONS		14.80	-42.50	-30.00	32.50
MEAN VALUES		2.46	-7.08	-5.00	5.41
61	1	2.50	-7.50	-5.00	2.50
62	1	2.50	-10.00	-5.00	2.50
63	1	2.90	-5.00	-5.00	0.00
64	1	2.20	-5.00	-5.00	0.00
65	1	2.50	-5.00	-5.00	2.50
66	1	3.00	-10.00	-5.00	2.50
SUMMATIONS		15.60	-42.50	-30.00	10.00
MEAN VALUES		2.60	-7.08	-5.00	1.66
67	1	3.30	7.50	-5.00	2.50
68	1	3.00	-5.00	-5.00	0.00
69	1	2.90	25.00	-5.00	0.00
70	1	2.40	-10.00	-5.00	0.00
71	1	2.40	-10.00	-5.00	0.00
72	1	2.00	-10.00	-5.00	0.00
SUMMATIONS		16.00	-2.50	-30.00	2.50
MEAN VALUES		2.66	-.41	-5.00	.41

SUBJECT NO. 2. NO LEARNING

RESPONSE DURATION IN SECONDS
ELECTROPHYSIOLOGICAL MEASUREMENTS IN MICRO-VOLTS

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
PRE-EXPERIMENTAL BASE LEVELS			10.00	10.00	12.50
1	1	5.60	11.25	0.00	-2.50
2	1	4.50	11.25	0.00	-5.00
3	1	4.00	12.50	0.00	-5.00
4	1	4.00	0.00	0.00	-2.50
5	1	1.50	-2.50	0.00	21.25
6	1	1.30	-2.50	0.00	-3.75
SUMMATIONS		20.90	30.00	0.00	2.50
MEAN VALUES		3.48	5.00	0.00	.41
7	1	1.50	28.75	0.00	-1.25
8	1	5.00	6.25	0.00	5.00
9	1	3.50	120.00	0.00	10.00
10	1	6.80	25.00	0.00	0.00
11	1	3.40	21.25	0.00	-6.25
12	1	2.80	7.50	0.00	-3.75
SUMMATIONS		23.00	208.75	0.00	3.75
MEAN VALUES		3.83	34.79	0.00	.62
13	1	2.20	17.50	0.00	-2.50
14	1	3.50	2.50	0.00	-2.50
15	1	2.70	10.00	0.00	-2.50
16	1	1.60	27.50	0.00	-2.50
17	1	1.40	5.00	0.00	-2.50
18	1	1.60	2.50	0.00	2.50
SUMMATIONS		13.00	65.00	0.00	-10.00
MEAN VALUES		2.16	10.83	0.00	-1.66
19	1	2.00	-2.50	0.00	1.25
20	1	2.20	-2.50	0.00	0.00
21	1	1.50	-2.50	0.00	-2.50
22	1	1.80	0.00	0.00	-2.50
23	1	1.40	2.50	0.00	-2.50
24	1	1.80	-2.50	0.00	2.50
SUMMATIONS		10.70	-7.50	0.00	-3.75
MEAN VALUES		1.78	-1.25	0.00	-.62

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
25	1	1.90	-2.50	0.00	-3.75
26	1	1.40	-2.50	0.00	-2.50
27	1	1.70	5.00	0.00	-2.50
28	1	1.80	2.50	0.00	-2.50
29	1	2.20	-2.50	0.00	-2.50
30	1	1.60	-2.50	0.00	-2.50
SUMMATIONS		10.60	-2.50	0.00	-16.25
MEAN VALUES		1.76	-.41	0.00	-2.70
31	1	2.30	21.25	0.00	-2.50
32	1	2.00	1.25	0.00	-2.50
33	1	1.30	-2.50	0.00	-2.50
34	1	1.30	1.25	0.00	-2.50
35	1	2.30	-2.50	0.00	-2.50
36	1	2.00	-2.50	0.00	-2.50
SUMMATIONS		11.20	16.25	0.00	-15.00
MEAN VALUES		1.86	2.70	0.00	-2.50
37	1	4.00	31.25	0.00	-2.50
38	1	2.00	20.00	0.00	-2.50
39	1	2.20	-2.50	0.00	-2.50
40	1	2.00	-1.25	0.00	-2.50
41	1	2.10	2.50	0.00	0.00
42	1	1.30	10.00	0.00	-2.50
SUMMATIONS		13.60	60.00	0.00	-12.50
MEAN VALUES		2.26	10.00	0.00	-2.08
43	1	1.50	2.50	0.00	-2.50
44	1	2.90	2.50	0.00	-2.50
45	1	1.60	2.50	0.00	0.00
46	1	1.60	-1.25	0.00	0.00
47	1	1.50	0.00	0.00	0.00
48	1	1.90	5.00	0.00	-2.50
SUMMATIONS		11.00	11.25	0.00	-7.50
MEAN VALUES		1.83	1.87	0.00	-1.25
49	1	1.90	3.75	0.00	0.00
50	1	1.30	-2.50	0.00	-2.50
51	1	1.30	2.50	0.00	0.00
52	1	2.30	5.00	0.00	2.50
53	1	1.70	-2.50	0.00	2.50
54	1	1.90	10.00	0.00	2.50
SUMMATIONS		10.40	16.25	0.00	5.00
MEAN VALUES		1.73	2.70	0.00	.83

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
55	1	2.00	-2.50	0.00	0.00
56	1	1.70	2.50	0.00	0.00
57	1	2.50	5.00	0.00	0.00
58	1	1.80	2.50	0.00	0.00
59	1	1.90	-2.50	0.00	0.00
60	1	1.70	-2.50	0.00	0.00
SUMMATIONS		11.60	2.50	0.00	0.00
MEAN VALUES		1.93	.41	0.00	0.00
61	1	3.10	11.25	0.00	0.00
62	1	1.60	1.25	0.00	0.00
63	1	1.70	2.50	0.00	0.00
64	1	1.90	2.50	0.00	0.00
65	1	1.30	1.25	0.00	0.00
66	1	1.30	2.50	0.00	0.00
SUMMATIONS		10.90	21.25	0.00	0.00
MEAN VALUES		1.81	3.54	0.00	0.00
67	1	1.70	0.00	0.00	0.00
68	1	1.70	1.25	0.00	1.25
69	1	1.50	12.50	0.00	0.00
70	1	1.70	2.50	0.00	2.50
71	1	2.20	2.50	0.00	11.25
72	1	1.80	-2.50	0.00	-2.50
SUMMATIONS		10.60	16.25	0.00	12.50
MEAN VALUES		1.76	2.70	0.00	2.08

SUBJECT NO. 3. NO LEARNING

RESPONSE DURATION IN SECONDS
ELECTROPHYSIOLOGICAL MEASUREMENTS IN MICRO-VOLTS

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
PRE-EXPERIMENTAL BASE LEVELS			50.00	50.00	2.50
1	1	3.20	25.00	0.00	12.50
2	1	3.90	12.50	0.00	12.50
3	1	3.30	50.00	0.00	12.50
4	1	2.40	0.00	0.00	12.50
5	1	2.10	0.00	0.00	12.50
6	1	2.20	0.00	0.00	16.25
SUMMATIONS		17.10	87.50	0.00	78.75
MEAN VALUES		2.85	14.58	0.00	13.12
7	1	2.60	0.00	0.00	13.75
8	1	2.30	0.00	0.00	15.00
9	1	3.30	0.00	0.00	12.50
10	1	2.80	0.00	0.00	32.50
11	1	2.80	0.00	0.00	12.50
12	1	2.90	0.00	0.00	12.50
SUMMATIONS		16.70	0.00	0.00	98.75
MEAN VALUES		2.78	0.00	0.00	16.45
13	1	2.80	0.00	0.00	13.75
14	1	3.10	0.00	0.00	12.50
15	1	3.60	0.00	0.00	12.50
16	1	2.70	100.00	0.00	12.50
17	1	2.30	0.00	0.00	13.75
18	1	2.90	0.00	0.00	12.50
SUMMATIONS		17.40	100.00	0.00	77.50
MEAN VALUES		2.90	16.66	0.00	12.91
19	1	2.60	0.00	25.00	12.50
20	1	3.60	0.00	25.00	12.50
21	1	3.10	0.00	25.00	12.50
22	1	2.70	0.00	25.00	12.50
23	1	3.30	0.00	0.00	15.00
24	1	3.60	0.00	0.00	15.00
SUMMATIONS		18.90	0.00	100.00	80.00
MEAN VALUES		3.15	0.00	16.66	13.33

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
25	1	2.70	0.00	25.00	12.50
26	1	2.70	0.00	25.00	12.50
27	1	3.60	0.00	25.00	17.50
28	1	2.90	0.00	25.00	12.50
29	1	2.70	0.00	25.00	10.00
30	1	2.90	0.00	25.00	11.25
SUMMATIONS		17.50	0.00	150.00	76.25
MEAN VALUES		2.91	0.00	25.00	12.70
31	1	3.20	0.00	25.00	12.50
32	1	3.30	0.00	25.00	12.50
33	1	2.90	25.00	50.00	12.50
34	1	2.40	12.50	25.00	12.50
35	1	3.20	0.00	25.00	12.50
36	1	2.20	0.00	25.00	12.50
SUMMATIONS		17.20	37.50	175.00	75.00
MEAN VALUES		2.86	6.25	29.16	12.50
37	1	2.70	0.00	25.00	10.00
38	1	3.50	25.00	25.00	10.00
39	1	2.80	0.00	25.00	10.00
40	1	2.80	0.00	25.00	10.00
41	1	2.70	0.00	25.00	32.50
42	1	3.00	0.00	25.00	10.00
SUMMATIONS		17.50	25.00	150.00	82.50
MEAN VALUES		2.91	4.16	25.00	13.75
43	1	3.40	0.00	25.00	10.00
44	1	3.20	0.00	25.00	10.00
45	1	2.70	0.00	25.00	10.00
46	1	3.00	25.00	25.00	10.00
47	1	3.10	0.00	25.00	10.00
48	1	3.60	12.50	25.00	10.00
SUMMATIONS		19.00	37.50	150.00	60.00
MEAN VALUES		3.16	6.25	25.00	10.00
49	1	2.50	0.00	25.00	10.00
50	1	2.50	0.00	25.00	10.00
51	1	3.10	0.00	25.00	11.25
52	1	3.50	25.00	25.00	10.00
53	1	2.10	0.00	25.00	10.00
54	1	3.20	25.00	25.00	8.75
SUMMATIONS		16.90	50.00	150.00	60.00
MEAN VALUES		2.81	8.33	25.00	10.00

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
55	1	3.20	0.00	25.00	10.00
56	1	3.40	0.00	25.00	10.00
57	1	2.50	25.00	25.00	12.50
58	1	2.70	125.00	25.00	10.00
59	1	2.40	25.00	0.00	10.00
60	1	2.60	0.00	0.00	13.75
SUMMATIONS		16.80	175.00	100.00	66.25
MEAN VALUES		2.80	29.16	16.66	11.04
61	1	2.50	0.00	25.00	7.50
62	1	3.10	0.00	25.00	10.00
63	1	2.60	0.00	25.00	10.00
64	1	2.60	0.00	25.00	10.00
65	1	2.70	25.00	25.00	12.50
66	1	4.30	75.00	25.00	10.00
SUMMATIONS		17.80	100.00	150.00	60.00
MEAN VALUES		2.96	16.66	25.00	10.00
67	1	2.70	100.00	25.00	37.50
68	1	3.30	25.00	0.00	31.25
69	1	3.40	25.00	0.00	10.00
70	1	2.20	37.50	25.00	15.00
71	1	3.00	0.00	25.00	10.00
72	1	2.50	25.00	0.00	10.00
SUMMATIONS		17.10	212.50	75.00	113.75
MEAN VALUES		2.85	35.41	12.50	18.95

SUBJECT NO. 1. PAIR LEARNING

RESPONSE DURATION IN SECONDS
ELECTROPHYSIOLOGICAL MEASUREMENTS IN MICRO-VOLTS

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
PRE-EXPERIMENTAL BASE LEVELS			5.00	5.00	5.00
1	1	11.90	115.00	85.00	15.00
2	1	12.10	85.00	7.50	17.50
3	0	12.10	110.00	50.00	7.50
4	0	12.10	80.00	5.00	16.25
5	0	12.10	158.75	58.75	41.25
6	0	12.10	150.00	2.50	26.25
SUMMATIONS		72.40	698.75	208.75	123.75
MEAN VALUES		12.06	116.45	34.79	20.62
7	1	12.10	157.50	0.00	15.00
8	1	8.00	101.25	0.00	30.00
9	1	12.10	147.50	0.00	23.75
10	1	7.60	95.00	0.00	22.50
11	0	12.10	147.50	-2.50	23.75
12	0	12.10	22.50	-2.50	20.00
SUMMATIONS		64.00	671.25	-5.00	135.00
MEAN VALUES		10.66	111.87	-.83	22.50
13	0	12.10	138.75	-2.50	17.50
14	1	12.10	62.50	0.00	12.50
15	1	12.10	162.50	0.00	15.00
16	0	12.10	160.00	0.00	31.25
17	1	12.10	162.50	0.00	18.75
18	1	12.10	150.00	0.00	12.50
SUMMATIONS		72.60	836.25	-2.50	107.50
MEAN VALUES		12.10	139.37	-.41	17.91
19	1	11.80	20.00	0.00	12.50
20	1	11.90	162.50	2.50	7.50
21	1	12.10	160.00	3.75	2.50
22	1	12.10	152.50	0.00	2.50
23	1	12.10	155.00	0.00	7.50
24	1	12.10	42.50	2.50	25.00
SUMMATIONS		72.10	692.50	8.75	57.50
MEAN VALUES		12.01	115.41	1.45	9.58

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
25	1	2.90	10.00	0.00	5.00
26	1	4.40	8.75	0.00	5.00
27	1	3.70	12.50	0.00	40.00
28	1	12.10	90.00	0.00	10.00
29	1	12.10	140.00	0.00	2.50
30	0	12.10	82.50	0.00	5.00
SUMMATIONS		47.30	343.75	0.00	67.50
MEAN VALUES		7.88	57.29	0.00	11.25
31	1	5.30	18.75	0.00	2.50
32	1	12.10	22.50	2.50	2.50
33	0	12.10	10.00	0.00	30.00
34	1	12.10	155.00	0.00	20.00
35	1	12.10	111.25	0.00	1.25
36	0	5.60	140.00	0.00	40.00
SUMMATIONS		59.30	457.50	2.50	96.25
MEAN VALUES		9.88	76.25	.41	16.04
37	1	12.10	156.25	0.00	25.00
38	1	12.10	160.00	0.00	33.75
39	1	12.10	22.50	0.00	3.75
40	1	12.10	126.25	0.00	10.00
41	1	12.10	22.50	0.00	38.75
42	0	12.10	105.00	2.50	65.00
SUMMATIONS		72.60	592.50	2.50	176.25
MEAN VALUES		12.10	98.75	.41	29.37
43	1	12.10	100.00	0.00	20.00
44	0	6.40	43.75	7.50	42.50
45	1	8.10	2.50	1.90	11.25
46	1	6.40	5.00	0.00	6.25
47	1	12.10	58.75	.65	2.50
48	1	5.40	2.50	2.50	2.50
SUMMATIONS		50.50	212.50	12.55	85.00
MEAN VALUES		8.41	35.41	2.09	14.16
49	1	11.60	162.50	1.25	2.50
50	1	12.10	103.75	0.00	2.50
51	1	12.10	162.50	1.90	2.50
52	1	12.10	153.75	0.00	3.75
53	1	12.10	162.50	2.50	11.90
54	1	12.10	160.00	2.50	20.00
SUMMATIONS		72.10	905.00	8.15	43.15
MEAN VALUES		12.01	150.83	1.35	7.19

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
55	1	12.10	27.50	2.50	21.25
56	1	4.90	105.00	0.00	7.50
57	1	12.10	88.75	0.00	2.50
58	1	12.10	23.75	2.50	2.50
59	1	12.10	47.50	41.25	35.00
60	1	3.20	2.50	38.75	16.25
SUMMATIONS		56.50	295.00	85.00	85.00
MEAN VALUES		9.41	49.16	14.16	14.16
61	1	2.10	6.90	2.50	51.25
62	0	5.30	7.50	10.00	38.75
63	1	3.40	5.00	2.50	27.50
64	0	11.50	151.25	12.50	50.65
65	1	12.10	152.50	6.25	26.25
66	1	12.10	96.25	0.00	7.50
SUMMATIONS		46.50	419.40	33.75	201.90
MEAN VALUES		7.75	69.90	5.62	33.65
67	1	12.10	23.75	0.00	5.65
68	1	12.10	162.50	0.00	2.50
69	1	12.10	162.50	0.00	2.50
70	1	12.10	160.00	0.00	5.00
71	1	12.10	157.50	0.00	1.90
72	1	12.10	115.00	15.00	7.50
SUMMATIONS		72.60	781.25	15.00	25.05
MEAN VALUES		12.10	130.20	2.50	4.17
73	1	12.10	105.00	1.25	7.50
74	1	12.10	35.00	3.75	10.00
75	1	12.10	57.50	87.50	12.50
76	1	12.10	45.00	11.25	35.00
77	1	12.10	61.25	15.00	12.50
78	1	12.10	33.75	10.00	8.75
SUMMATIONS		72.60	337.50	128.75	86.25
MEAN VALUES		12.10	56.25	21.45	14.37
79	1	12.10	25.00	6.25	6.25
80	1	12.10	25.00	6.25	2.50
81	1	12.10	70.00	5.00	5.00
82	1	12.10	61.25	2.50	2.50
83	1	12.10	55.00	2.50	1.90
84	1	12.10	43.75	2.50	5.00
SUMMATIONS		72.60	280.00	25.00	23.15
MEAN VALUES		12.10	46.66	4.16	3.85

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
85	1	12.10	32.50	40.00	17.50
86	1	12.10	15.00	5.00	13.75
87	1	9.00	31.25	5.00	7.50
88	1	3.20	10.00	1.25	2.50
89	1	2.50	1.90	1.25	5.00
90	1	2.90	2.50	0.00	2.50
SUMMATIONS		41.80	93.15	52.50	48.75
MEAN VALUES		6.96	15.52	8.75	8.12
91	1	11.50	37.50	7.50	25.00
92	1	8.00	10.00	0.00	20.00
93	1	12.10	17.50	0.00	8.75
94	1	12.10	50.00	3.75	8.75
95	1	12.10	65.00	0.00	8.75
96	1	5.20	16.25	0.00	3.75
SUMMATIONS		61.00	196.25	11.25	75.00
MEAN VALUES		10.16	32.70	1.87	12.50
97	1	11.70	58.75	0.00	27.50
98	1	12.10	27.50	2.50	7.50
99	1	12.10	108.75	30.00	85.00
100	1	12.10	105.00	0.00	57.50
101	1	12.10	80.00	105.00	8.75
102	1	12.10	45.00	0.00	7.50
SUMMATIONS		72.20	425.00	137.50	193.75
MEAN VALUES		12.03	70.83	22.91	32.29
103	1	12.10	25.00	0.00	10.00
104	1	12.10	35.00	13.75	7.50
105	1	12.10	30.00	0.00	10.00
106	1	11.10	82.50	0.00	17.50
107	1	12.10	61.25	0.00	27.50
108	1	7.50	38.75	0.00	20.00
SUMMATIONS		67.00	272.50	13.75	92.50
MEAN VALUES		11.16	45.41	2.29	15.41
109	1	12.10	61.25	0.00	55.00
110	1	12.10	160.00	0.00	58.75
111	1	12.10	45.00	1.90	47.50
112	1	12.10	28.75	0.00	7.50
113	1	6.30	10.00	0.00	32.50
114	1	4.50	2.50	5.00	10.00
SUMMATIONS		59.20	307.50	6.90	211.25
MEAN VALUES		9.86	51.25	1.15	35.20

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
115	1	10.40	45.00	1.25	17.50
116	1	3.90	26.25	2.50	8.15
117	1	11.70	23.75	0.00	6.25
118	1	3.60	5.00	0.00	45.00
119	1	3.70	16.25	0.00	22.50
120	1	5.70	6.25	0.00	83.75
SUMMATIONS		39.00	122.50	3.75	183.15
MEAN VALUES		6.50	20.41	.62	30.52
121	1	4.80	6.25	5.00	18.75
122	1	2.50	.65	2.50	10.00
123	1	5.60	7.50	1.90	11.25
124	1	11.70	38.75	7.50	7.50
125	1	12.10	20.00	1.25	10.00
126	1	5.00	38.75	65.00	90.00
SUMMATIONS		41.70	111.90	83.15	147.50
MEAN VALUES		6.95	18.65	13.85	24.58
127	1	12.10	30.00	0.00	95.00
128	1	11.40	20.00	0.00	45.00
129	1	11.60	17.50	0.00	15.00
130	1	11.50	78.75	0.00	13.75
131	1	12.10	110.00	0.00	10.00
132	1	12.10	105.00	0.00	10.00
SUMMATIONS		70.80	361.25	0.00	188.75
MEAN VALUES		11.80	60.20	0.00	31.45
133	1	11.10	17.50	0.00	8.75
134	1	4.00	11.25	23.75	35.00
135	1	3.30	1.90	5.00	82.50
136	1	2.80	5.00	2.50	47.50
137	1	1.80	1.25	0.00	7.50
138	1	3.20	35.00	70.00	20.00
SUMMATIONS		26.20	71.90	101.25	201.25
MEAN VALUES		4.36	11.98	16.87	33.54
139	1	12.10	23.75	40.00	27.50
140	1	12.10	70.00	7.50	65.00
141	1	7.50	7.50	2.50	81.25
142	1	11.80	57.50	20.00	28.75
143	1	11.60	7.50	0.00	10.00
144	1	11.00	33.15	13.75	25.00
SUMMATIONS		66.10	199.40	83.75	237.50
MEAN VALUES		11.01	33.23	13.95	39.58

SUBJECT NO. 2. PAIR LEARNING

RESPONSE DURATION IN SECONDS
ELECTROPHYSIOLOGICAL MEASUREMENTS IN MICRO-VOLTS

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
PRE-EXPERIMENTAL BASE LEVELS			2.50	5.00	10.00
1	0	12.10	150.00	1.25	10.00
2	0	12.10	83.75	2.50	12.50
3	0	12.10	127.50	5.00	16.25
4	0	12.10	51.25	3.75	18.75
5	0	12.10	61.25	6.90	12.50
6	0	12.10	43.75	1.25	11.25
SUMMATIONS		72.60	517.50	20.65	81.25
MEAN VALUES		12.10	86.25	3.44	13.54
7	0	12.10	36.25	11.25	10.00
8	0	12.10	8.75	7.50	15.00
9	0	12.10	22.50	5.00	10.00
10	0	5.90	55.00	8.75	15.00
11	1	8.50	0.00	15.00	12.50
12	0	11.40	10.00	10.00	10.00
SUMMATIONS		62.10	132.50	57.50	72.50
MEAN VALUES		10.35	22.08	9.58	12.08
13	0	12.10	7.50	35.00	10.00
14	0	12.10	42.50	65.00	16.25
15	0	6.40	62.50	10.00	6.25
16	1	6.00	3.75	8.75	8.75
17	0	11.70	10.00	35.00	10.00
18	1	12.10	17.50	32.50	10.00
SUMMATIONS		60.40	143.75	186.25	61.25
MEAN VALUES		10.06	23.95	31.04	10.20
19	0	12.10	38.75	30.00	7.50
20	1	12.10	12.50	30.00	5.00
21	1	5.80	0.00	15.00	5.00
22	1	3.30	1.25	15.00	7.50
23	0	11.40	55.00	15.00	10.00
24	1	3.80	1.25	15.00	10.00
SUMMATIONS		48.50	108.75	120.00	45.00
MEAN VALUES		8.08	18.12	20.00	7.50

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
25	1	2.90	4.40	15.00	7.50
26	1	2.50	2.50	12.50	6.25
27	1	2.30	55.00	11.25	7.50
28	0	11.20	7.50	15.00	12.50
29	0	1.90	5.00	22.50	11.25
30	1	2.60	4.40	10.00	5.00
SUMMATIONS		23.40	78.80	86.25	50.00
MEAN VALUES		3.90	13.13	14.37	8.33
31	1	2.80	1.90	10.00	5.00
32	1	3.50	2.50	7.50	10.00
33	1	3.50	7.50	7.50	7.50
34	0	6.60	30.00	17.50	8.75
35	1	4.30	11.25	2.50	-2.50
36	1	5.10	3.75	17.50	2.50
SUMMATIONS		25.80	56.90	62.50	31.25
MEAN VALUES		4.30	9.48	10.41	5.20
37	1	2.20	7.50	15.00	5.00
38	1	5.00	10.00	2.50	5.00
39	1	3.00	31.25	3.75	7.50
40	1	2.00	22.50	3.15	10.00
41	1	2.60	8.15	5.00	10.00
42	1	7.00	0.00	7.50	10.00
SUMMATIONS		21.80	79.40	36.90	47.50
MEAN VALUES		3.63	13.23	6.15	7.91
43	0	4.00	0.00	2.50	10.00
44	0	4.50	108.75	7.50	7.50
45	1	6.00	.65	15.00	6.25
46	1	2.60	0.00	15.00	7.50
47	1	2.60	9.40	15.00	7.50
48	0	3.00	2.50	15.00	8.75
SUMMATIONS		22.70	121.30	70.00	47.50
MEAN VALUES		3.78	20.21	11.66	7.91
49	1	2.10	2.50	25.00	6.25
50	0	4.10	57.50	5.00	7.50
51	0	12.10	77.50	1.25	8.75
52	1	2.80	10.00	2.50	11.25
53	0	12.10	147.50	1.25	8.75
54	0	5.90	115.00	0.00	20.00
SUMMATIONS		39.10	410.00	35.00	62.50
MEAN VALUES		6.51	68.33	5.83	10.41

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
55	0	5.00	65.00	0.00	5.00
56	1	3.20	10.00	1.25	5.00
57	1	5.20	46.25	0.00	8.75
58	1	12.10	41.25	2.50	10.00
59	1	12.10	13.75	1.25	10.00
60	0	4.70	2.50	2.50	10.00
SUMMATIONS		42.30	178.75	7.50	48.75
MEAN VALUES		7.05	29.79	1.25	8.12
61	1	1.90	3.15	2.50	7.50
62	1	3.00	87.50	2.50	7.50
63	1	4.50	57.50	0.00	10.00
64	1	12.10	53.75	0.00	10.00
65	0	12.10	140.00	0.00	12.50
66	1	12.10	46.25	2.50	10.00
SUMMATIONS		45.70	388.15	7.50	57.50
MEAN VALUES		7.61	64.69	1.25	9.58
67	1	12.10	63.75	0.00	10.00
68	1	12.10	33.75	2.50	10.00
69	1	12.10	125.00	2.50	10.00
70	1	12.10	57.50	1.25	7.50
71	1	12.10	122.50	1.25	7.50
72	1	2.80	97.50	1.25	7.50
SUMMATIONS		63.30	500.00	8.75	52.50
MEAN VALUES		10.55	83.33	1.45	8.75
73	0	11.00	0.00	2.50	20.00
74	1	11.50	117.50	5.00	5.00
75	1	6.20	12.50	5.00	2.50
76	1	2.10	-.60	1.25	7.50
77	1	2.10	-1.25	1.25	5.00
78	1	2.80	-1.25	2.50	6.25
SUMMATIONS		35.70	126.90	17.50	46.25
MEAN VALUES		5.95	21.15	2.91	7.70
79	1	1.90	2.50	2.50	5.00
80	1	3.50	-1.25	2.50	8.75
81	1	1.90	0.00	2.50	3.75
82	1	2.40	-1.25	2.50	2.50
83	1	2.00	-1.25	3.75	10.00
84	0	3.80	-1.25	2.50	5.00
SUMMATIONS		15.50	-2.50	16.25	35.00
MEAN VALUES		2.58	-.41	2.70	5.83

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
85	1	3.00	0.00	2.50	7.50
86	1	2.50	0.00	5.00	7.50
87	1	2.90	0.00	2.50	7.50
88	1	2.20	-1.25	2.50	8.75
89	1	2.20	-1.25	5.00	10.00
90	1	2.00	-1.25	5.00	6.25
SUMMATIONS		14.80	-3.75	22.50	47.50
MEAN VALUES		2.46	-.62	3.75	7.91
91	1	1.80	-1.25	2.50	5.00
92	1	2.40	-1.25	5.00	7.50
93	1	2.30	-1.25	3.75	10.00
94	1	2.20	-1.25	5.00	12.50
95	1	2.10	36.25	2.50	5.00
96	1	1.40	127.50	2.50	7.50
SUMMATIONS		12.20	158.75	21.25	47.50
MEAN VALUES		2.03	26.45	3.54	7.91
97	1	12.10	45.00	2.50	7.50
98	1	12.10	157.50	5.00	7.50
99	1	12.10	140.00	7.50	7.50
100	1	12.10	152.50	2.50	7.50
101	1	12.10	152.50	2.50	7.50
102	1	12.10	102.50	5.00	10.00
SUMMATIONS		72.60	750.00	25.00	47.50
MEAN VALUES		12.10	125.00	4.16	7.91
103	1	12.10	95.00	4.40	7.50
104	1	12.10	93.75	2.50	10.00
105	1	3.00	32.50	3.75	21.25
106	1	5.60	157.50	2.50	10.00
107	0	10.60	145.00	8.75	11.25
108	1	12.10	125.00	7.50	5.00
SUMMATIONS		55.50	648.75	29.40	65.00
MEAN VALUES		9.25	108.12	4.90	10.83
109	1	12.10	100.00	20.00	7.50
110	1	12.10	57.50	15.00	12.50
111	1	12.10	102.50	10.00	10.00
112	1	12.10	120.00	12.50	10.00
113	1	12.10	122.50	12.50	10.00
114	1	12.10	72.50	5.00	10.00
SUMMATIONS		72.60	575.00	75.00	60.00
MEAN VALUES		12.10	95.83	12.50	10.00

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
115	1	3.00	105.00	12.50	11.25
116	1	12.10	6.25	5.00	10.00
117	1	2.10	12.50	7.50	13.75
118	1	2.80	47.50	2.50	11.25
119	1	8.50	11.25	5.00	8.75
120	1	2.90	15.00	5.00	13.75
SUMMATIONS		31.40	197.50	37.50	68.75
MEAN VALUES		5.23	32.91	6.25	11.45
121	1	1.80	47.50	2.50	10.00
122	1	12.10	12.50	7.50	10.00
123	1	2.90	67.50	1.25	13.75
124	1	12.10	111.25	7.50	15.00
125	1	12.10	17.50	7.50	12.50
126	1	3.10	97.50	5.00	10.00
SUMMATIONS		44.10	353.75	31.25	71.25
MEAN VALUES		7.35	58.95	5.20	11.87
127	1	5.70	2.50	7.50	13.75
128	1	4.90	11.25	5.00	12.50
129	1	2.80	26.25	1.25	12.50
130	1	7.80	7.50	2.50	12.50
131	1	3.30	63.75	10.00	10.00
132	1	5.50	3.75	1.25	10.00
SUMMATIONS		30.00	115.00	27.50	71.25
MEAN VALUES		5.00	19.16	4.58	11.87
133	1	2.80	12.50	2.50	6.25
134	1	2.40	80.00	2.50	7.50
135	1	2.10	22.50	5.00	11.25
136	1	10.00	23.75	25.00	11.25
137	1	3.30	27.50	7.50	7.50
138	1	6.00	36.25	7.50	10.00
SUMMATIONS		26.60	202.50	50.00	53.75
MEAN VALUES		4.43	33.75	8.33	8.95
139	1	2.00	42.50	2.50	8.75
140	1	3.20	7.50	2.50	10.00
141	1	2.10	83.75	2.50	10.00
142	1	12.10	17.50	7.50	7.50
143	1	2.60	17.50	1.25	10.00
144	1	2.20	15.00	20.00	10.00
SUMMATIONS		24.20	183.75	36.25	56.25
MEAN VALUES		4.03	30.62	6.04	9.37

SUBJECT NO. 3. PAIR LEARNING

RESPONSE DURATION IN SECONDS
ELECTROPHYSIOLOGICAL MEASUREMENTS IN MICRO-VOLTS

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
PRE-EXPERIMENTAL BASE LEVELS			5.00	5.00	7.50
1	0	2.90	0.00	-1.25	35.00
2	0	4.90	1.90	-1.25	28.75
3	1	12.10	5.00	-2.50	25.00
4	0	4.20	0.00	-2.50	27.50
5	0	5.70	0.00	-2.50	22.50
6	0	2.70	0.00	-2.50	21.25
SUMMATIONS		32.50	6.90	-12.50	160.00
MEAN VALUES		5.41	1.15	-2.08	26.66
7	0	3.50	3.15	-2.50	25.00
8	0	4.30	0.00	-2.50	25.00
9	1	2.70	-.60	-2.50	27.50
10	1	2.60	-1.25	-2.50	21.25
11	0	3.40	-2.50	-2.50	30.00
12	0	3.70	-2.50	-3.75	27.50
SUMMATIONS		20.20	-3.70	-16.25	156.25
MEAN VALUES		3.36	-.61	-2.70	26.04
13	0	3.30	-2.50	-3.75	36.25
14	1	3.90	-1.25	-3.75	27.50
15	1	4.10	145.00	-2.50	22.50
16	0	8.30	3.15	-2.50	30.00
17	1	5.20	-.60	-2.50	23.75
18	1	3.80	-1.85	-2.50	36.25
SUMMATIONS		28.60	141.95	-17.50	176.25
MEAN VALUES		4.76	23.65	-2.91	29.37
19	0	4.10	-1.25	-2.50	57.50
20	0	3.70	-.60	-2.50	56.25
21	0	4.20	-.60	-2.50	51.25
22	0	4.10	0.00	-2.50	48.75
23	1	2.40	0.00	-2.50	28.75
24	1	2.60	0.00	-2.50	27.50
SUMMATIONS		21.10	-2.45	-15.00	270.00
MEAN VALUES		3.51	-.40	-2.50	45.00

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
25	0	6.50	0.00	-2.50	31.25
26	1	4.30	0.00	-2.50	30.00
27	1	2.90	0.00	-2.50	23.75
28	1	2.70	0.00	-1.25	82.50
29	1	11.20	5.00	-2.50	22.50
30	1	6.00	1.25	-2.50	22.50
SUMMATIONS		33.60	6.25	-13.75	212.50
MEAN VALUES		5.60	1.04	-2.29	35.41
31	1	11.20	17.50	-2.50	22.50
32	0	7.20	-.60	-2.50	30.00
33	1	3.10	0.00	-2.50	26.25
34	1	10.80	7.50	-2.50	40.00
35	0	7.50	2.50	-2.50	37.50
36	1	12.10	5.00	-2.50	22.50
SUMMATIONS		51.90	31.90	-15.00	178.75
MEAN VALUES		8.65	5.31	-2.50	29.79
37	1	3.70	10.00	0.00	47.50
38	1	12.10	7.50	-2.50	30.00
39	1	3.90	-.60	-2.50	21.25
40	1	3.00	-1.25	-2.50	20.00
41	1	3.20	0.00	-1.25	35.00
42	1	2.90	7.50	-2.50	21.25
SUMMATIONS		28.80	23.15	-11.25	175.00
MEAN VALUES		4.80	3.85	-1.87	29.16
43	1	4.00	0.00	-2.50	22.50
44	1	4.10	-1.25	-2.50	25.00
45	1	11.60	7.50	-1.25	22.50
46	1	3.90	1.25	-2.50	56.25
47	1	3.70	-.60	-2.50	26.25
48	1	4.60	2.50	-2.50	26.25
SUMMATIONS		31.90	9.40	-13.75	178.75
MEAN VALUES		5.31	1.56	-2.29	29.79
49	1	2.80	1.25	-2.50	20.00
50	1	2.80	0.00	-2.50	23.75
51	0	6.00	0.00	-2.50	31.25
52	1	2.70	0.00	-2.50	23.75
53	1	4.80	60.00	-1.25	42.50
54	1	2.50	-1.25	-2.50	25.00
SUMMATIONS		21.60	60.00	-13.75	166.25
MEAN VALUES		3.60	10.00	-2.29	27.70

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
55	1	3.20	-1.25	-2.50	22.50
56	1	4.80	-.60	-2.50	22.50
57	1	6.30	0.00	-1.25	42.50
58	1	4.60	3.75	-2.50	23.75
59	1	11.30	7.50	-2.50	17.50
60	1	3.90	1.25	-2.50	26.25
SUMMATIONS		34.10	10.65	-13.75	155.00
MEAN VALUES		5.68	1.77	-2.29	25.83
61	1	3.20	0.00	-2.50	20.00
62	1	11.40	15.00	-2.50	25.00
63	1	3.70	-.60	-2.50	22.50
64	1	3.20	-1.25	-2.50	23.75
65	1	3.30	.65	-2.50	40.00
66	1	10.80	15.00	-2.50	30.00
SUMMATIONS		35.60	28.80	-15.00	161.25
MEAN VALUES		5.93	4.80	-2.50	26.87
67	1	12.10	15.00	-2.50	22.50
68	1	5.00	-1.25	-2.50	21.25
69	1	3.10	-1.25	-2.50	22.50
70	1	3.00	-1.25	-2.50	17.50
71	1	3.40	-1.25	-2.50	15.00
72	1	3.30	-1.25	-2.50	15.00
SUMMATIONS		29.90	8.75	-15.00	113.75
MEAN VALUES		4.98	1.45	-2.50	18.95
73	1	4.20	7.50	7.50	12.50
74	1	3.00	0.00	-2.50	20.00
75	1	3.50	0.00	-2.50	16.25
76	1	3.50	5.00	-2.50	28.75
77	1	6.00	1.25	-2.50	17.50
78	1	5.00	0.00	-2.50	20.00
SUMMATIONS		25.20	13.75	-5.00	115.00
MEAN VALUES		4.20	2.29	-.83	19.16
79	1	4.20	0.00	-2.50	21.25
80	1	3.40	.65	-2.50	20.00
81	1	4.30	-1.25	-2.50	23.75
82	1	4.10	0.00	-2.50	30.00
83	1	3.90	1.25	-2.50	21.25
84	1	3.90	2.50	-2.50	21.25
SUMMATIONS		23.80	3.15	-15.00	137.50
MEAN VALUES		3.96	.52	-2.50	22.91

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
85	1	3.20	0.00	-2.50	18.75
86	1	3.30	0.00	-2.50	18.75
87	1	3.50	0.00	-2.50	28.75
88	1	11.50	7.50	-3.75	26.25
89	1	4.10	0.00	-3.75	22.50
90	1	3.40	0.00	-2.50	20.00
SUMMATIONS		29.00	7.50	-17.50	135.00
MEAN VALUES		4.83	1.25	-2.91	22.50
91	1	11.40	7.50	-3.75	23.75
92	1	4.90	5.00	-3.75	20.00
93	1	12.10	10.00	-3.75	20.00
94	1	12.10	10.00	-3.75	17.50
95	1	4.00	0.00	-3.75	23.75
96	1	4.50	-1.25	-3.75	18.75
SUMMATIONS		49.00	31.25	-22.50	123.75
MEAN VALUES		8.16	5.20	-3.75	20.62
97	1	5.10	0.00	-2.50	42.50
98	1	3.40	0.00	-2.50	22.50
99	1	4.10	0.00	-2.50	23.75
100	1	3.40	0.00	-2.50	17.50
101	1	5.50	0.00	-3.75	23.75
102	1	4.50	1.25	-2.50	17.50
SUMMATIONS		26.00	1.25	-16.25	147.50
MEAN VALUES		4.33	.20	-2.70	24.58
103	1	3.70	0.00	-3.75	22.50
104	1	4.20	0.00	-3.75	15.00
105	1	3.10	0.00	-3.75	18.75
106	1	4.60	0.00	-2.50	26.25
107	1	3.90	0.00	-2.50	22.50
108	1	3.50	1.25	-2.50	20.00
SUMMATIONS		23.00	1.25	-18.75	125.00
MEAN VALUES		3.83	.20	-3.12	20.83
109	1	3.70	0.00	0.00	20.00
110	1	3.90	0.00	-2.50	18.75
111	1	4.00	1.25	-2.50	18.75
112	1	3.70	1.90	-2.50	12.50
113	1	4.00	21.25	-2.50	20.00
114	1	3.90	0.00	-2.50	17.50
SUMMATIONS		23.20	24.40	-12.50	107.50
MEAN VALUES		3.86	4.06	-2.08	17.91

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
115	1	6.80	.65	-2.50	21.25
116	1	4.10	-1.25	-2.50	25.00
117	1	5.10	2.50	-3.75	15.00
118	1	3.90	1.25	-3.75	17.50
119	1	3.40	-1.25	-2.50	15.00
120	1	4.90	-.60	2.50	35.00
SUMMATIONS		28.20	1.30	-12.50	128.75
MEAN VALUES		4.70	.21	-2.08	21.45
121	1	3.90	-2.50	2.50	17.50
122	1	4.60	-1.25	2.50	20.00
123	1	3.80	-1.25	2.50	16.25
124	1	3.40	45.00	2.50	20.00
125	1	6.60	35.00	1.25	10.00
126	1	7.90	-1.25	0.00	10.00
SUMMATIONS		30.20	73.75	11.25	93.75
MEAN VALUES		5.03	12.29	1.87	15.62
127	1	3.90	0.00	0.00	10.00
128	1	3.90	-1.25	0.00	13.75
129	1	3.70	0.00	0.00	10.00
130	1	2.90	7.50	5.00	18.75
131	1	3.00	-1.25	5.00	13.75
132	1	3.20	-.60	1.25	12.50
SUMMATIONS		20.60	4.40	11.25	78.75
MEAN VALUES		3.43	.73	1.87	13.12
133	1	3.40	0.00	-1.25	16.25
134	1	3.50	0.00	-2.50	10.00
135	1	4.00	0.00	-2.50	10.00
136	1	3.20	0.00	-2.50	17.50
137	1	3.60	0.00	-2.50	12.50
138	1	4.20	1.25	5.00	10.00
SUMMATIONS		21.90	1.25	-6.25	76.25
MEAN VALUES		3.65	.20	-1.04	12.70
139	1	3.90	0.00	-2.50	10.00
140	1	5.80	0.00	-2.50	7.50
141	1	3.90	-1.25	-2.50	7.50
142	1	4.80	-1.25	-2.50	28.75
143	1	3.70	2.50	-2.50	22.50
144	1	3.30	0.00	-2.50	12.50
SUMMATIONS		25.40	0.00	-15.00	88.75
MEAN VALUES		4.23	0.00	-2.50	14.79

SUBJECT NO. 1. PROBLEM SOLVING

RESPONSE DURATION IN SECONDS
ELECTROPHYSIOLOGICAL MEASUREMENTS IN MICRO-VOLTS

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
PRE-EXPERIMENTAL BASE LEVELS			50.00	5.00	7.50
1	0	11.20	115.00	52.50	17.50
2	0	12.10	115.00	62.50	48.75
3	1	12.10	105.00	65.00	41.25
4	0	12.10	100.00	62.50	16.25
5	0	11.00	77.50	65.00	27.50
6	1	10.90	115.00	65.00	41.25
SUMMATIONS		69.40	627.50	372.50	192.50
MEAN VALUES		11.56	104.58	62.08	32.08
7	1	12.10	80.00	62.50	41.25
8	1	12.10	105.00	65.00	38.75
9	0	12.10	100.00	65.00	43.75
10	1	10.50	61.25	65.00	45.00
11	0	10.60	87.50	67.50	47.50
12	0	7.50	7.50	63.75	63.75
SUMMATIONS		64.90	441.25	388.75	280.00
MEAN VALUES		10.81	73.54	64.79	46.66
13	0	6.30	7.50	62.50	82.50
14	1	6.70	11.25	70.00	65.00
15	1	12.10	58.75	65.00	53.75
16	0	10.20	37.50	70.00	47.50
17	1	10.60	42.50	62.50	45.00
18	0	12.10	20.00	62.50	70.00
SUMMATIONS		58.00	177.50	392.50	363.75
MEAN VALUES		9.66	29.58	65.41	60.62
19	0	6.70	7.50	65.00	76.25
20	0	10.00	25.00	65.00	52.50
21	0	6.70	7.50	65.00	61.25
22	1	9.70	15.00	65.00	27.50
23	0	12.10	22.50	70.00	51.25
24	0	7.80	10.00	70.00	57.50
SUMMATIONS		53.00	87.50	400.00	326.25
MEAN VALUES		8.83	14.58	66.66	54.37

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
25	1	6.00	12.50	75.00	41.25
26	0	10.60	72.50	67.50	37.50
27	0	7.60	10.00	67.50	55.00
28	1	11.10	15.00	70.00	45.00
29	0	12.10	110.00	67.50	27.50
30	1	5.00	7.50	65.00	23.75
SUMMATIONS		52.40	227.50	412.50	230.00
MEAN VALUES		8.73	37.91	68.75	38.33
31	0	10.70	95.00	65.00	26.25
32	0	12.10	75.00	65.00	42.50
33	0	11.70	32.50	67.50	55.00
34	1	9.70	97.50	65.00	28.75
35	0	12.10	11.25	65.00	52.50
36	0	12.10	37.50	65.00	35.00
SUMMATIONS		68.40	348.75	392.50	240.00
MEAN VALUES		11.40	58.12	65.41	40.00
37	1	8.90	115.00	65.00	40.00
38	1	12.10	15.00	62.50	47.50
39	0	12.10	15.00	65.00	52.50
40	0	7.10	5.00	62.50	61.25
41	0	10.80	100.00	62.50	40.00
42	1	8.00	10.00	65.00	27.50
SUMMATIONS		59.00	260.00	382.50	268.75
MEAN VALUES		9.83	43.33	63.75	44.79
43	1	4.60	7.50	67.50	25.00
44	1	8.50	15.00	65.00	31.25
45	1	5.80	7.50	67.50	35.00
46	1	5.60	5.00	65.00	26.25
47	1	3.80	5.00	65.00	40.00
48	1	5.90	5.00	62.50	37.50
SUMMATIONS		34.20	45.00	392.50	195.00
MEAN VALUES		5.70	7.50	65.41	32.50
49	1	6.00	5.00	62.50	42.50
50	1	5.20	5.00	65.00	30.00
51	1	11.30	72.50	78.75	25.00
52	1	5.70	7.50	65.00	37.50
53	1	3.40	5.00	65.00	30.00
54	1	3.20	5.00	62.50	33.75
SUMMATIONS		34.80	100.00	398.75	198.75
MEAN VALUES		5.80	16.66	66.45	33.12

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
55	1	4.50	5.00	62.50	47.50
56	1	2.60	2.50	61.25	95.00
57	1	2.90	2.50	60.00	31.25
58	1	2.60	5.00	62.50	7.50
59	1	2.00	65.00	60.00	12.50
60	1	12.10	70.00	65.00	17.50
SUMMATIONS		26.70	150.00	371.25	211.25
MEAN VALUES		4.45	25.00	61.87	35.20
61	1	3.10	7.50	65.00	12.50
62	1	3.50	7.50	70.00	37.50
63	1	2.50	115.00	62.50	55.00
64	1	4.90	6.25	80.00	17.50
65	1	5.00	7.50	87.50	16.25
66	1	4.50	7.50	81.25	13.75
SUMMATIONS		23.50	151.25	446.25	152.50
MEAN VALUES		3.91	25.20	74.37	25.41
67	1	11.30	115.00	62.50	28.75
68	1	7.00	2.50	60.00	27.50
69	1	11.30	65.00	100.00	8.75
70	1	5.20	2.50	57.50	5.00
71	1	3.30	1.25	56.90	82.50
72	1	11.00	115.00	70.00	6.25
SUMMATIONS		49.10	301.25	406.90	158.75
MEAN VALUES		8.18	50.20	67.81	26.45
73	1	4.50	2.50	60.00	15.00
74	1	3.80	16.25	57.50	5.00
75	1	4.30	13.75	57.50	6.25
76	1	3.30	0.00	55.00	8.75
77	1	2.10	97.50	56.25	62.50
78	1	5.60	0.00	57.50	40.00
SUMMATIONS		23.60	130.00	343.75	137.50
MEAN VALUES		3.93	21.66	57.29	22.91
79	1	2.00	40.00	55.00	72.50
80	1	12.10	20.00	60.00	57.50
81	1	3.80	0.00	57.50	22.50
82	1	7.30	0.00	60.00	82.50
83	1	5.50	2.50	60.00	13.75
84	1	10.70	35.00	57.50	33.75
SUMMATIONS		41.40	97.50	350.00	282.50
MEAN VALUES		6.90	16.25	58.33	47.08

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
85	1	12.10	103.75	60.00	82.50
86	1	2.20	0.00	57.50	25.00
87	1	10.90	111.25	60.00	25.00
88	1	8.00	1.25	57.50	32.50
89	1	10.50	82.50	67.50	16.25
90	1	11.40	82.50	91.25	10.00
SUMMATIONS		55.10	381.25	393.75	191.25
MEAN VALUES		9.18	63.54	65.62	31.87
91	1	10.10	48.75	98.75	12.50
92	1	2.80	0.00	57.50	10.00
93	1	10.90	112.50	57.50	53.75
94	1	4.50	0.00	57.50	42.50
95	1	11.10	115.00	62.50	57.50
96	1	6.00	0.00	57.50	35.00
SUMMATIONS		45.40	276.25	391.25	211.25
MEAN VALUES		7.56	46.04	65.20	35.20
97	1	2.30	0.00	60.00	16.25
98	1	2.60	0.00	60.00	31.25
99	1	11.30	40.00	60.00	10.00
100	1	4.00	5.00	57.50	13.75
101	1	12.10	45.00	57.50	3.15
102	1	6.50	5.00	120.00	2.50
SUMMATIONS		38.80	95.00	415.00	76.90
MEAN VALUES		6.46	15.83	69.16	12.81
103	1	6.30	115.00	68.75	0.00
104	1	10.20	43.75	80.00	5.00
105	1	4.30	35.00	60.00	7.50
106	1	11.20	62.50	101.25	32.50
107	1	2.20	2.50	60.00	40.00
108	1	2.80	6.25	92.50	16.25
SUMMATIONS		37.00	265.00	462.50	101.25
MEAN VALUES		6.16	44.16	77.08	16.87
109	1	3.50	5.00	65.00	26.25
110	1	9.90	6.25	57.50	25.00
111	1	3.20	0.00	57.50	17.50
112	1	10.80	10.00	57.50	20.00
113	1	4.90	50.00	58.75	22.50
114	1	5.20	0.00	57.50	22.50
SUMMATIONS		37.50	71.25	353.75	133.75
MEAN VALUES		6.25	11.87	58.95	22.29

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
115	1	3.80	5.00	65.00	42.50
116	1	10.30	105.00	62.50	37.50
117	1	12.10	110.00	70.00	37.50
118	1	12.10	115.00	85.00	37.50
119	1	12.10	115.00	58.75	37.50
120	1	8.00	0.00	55.00	67.50
SUMMATIONS		58.40	450.00	396.25	260.00
MEAN VALUES		9.73	75.00	66.04	43.33
121	1	4.70	-2.50	75.00	107.50
122	1	2.60	30.00	52.50	17.50
123	1	4.50	-2.50	56.25	17.50
124	1	5.20	115.00	50.00	12.50
125	1	12.10	110.00	50.00	8.75
126	1	12.10	102.50	55.00	16.25
SUMMATIONS		41.20	352.50	338.75	180.00
MEAN VALUES		6.86	58.75	56.45	30.00
127	1	12.10	112.50	145.00	10.00
128	1	12.10	105.00	140.00	11.25
129	1	6.20	100.00	55.00	13.75
130	1	5.20	-5.00	51.25	25.00
131	1	3.90	-5.00	50.00	41.25
132	1	2.60	113.75	50.00	35.00
SUMMATIONS		42.10	421.25	491.25	136.25
MEAN VALUES		7.01	70.20	81.87	22.70
133	1	4.70	75.00	51.25	40.00
134	1	12.10	115.00	55.00	11.25
135	1	12.10	115.00	55.00	11.25
136	1	12.10	115.00	55.00	2.50
137	1	12.10	57.50	80.00	13.75
138	1	4.70	-2.50	57.50	40.00
SUMMATIONS		57.80	475.00	353.75	118.75
MEAN VALUES		9.63	79.16	58.95	19.79
139	1	10.70	115.00	55.00	3.75
140	1	12.10	115.00	56.25	5.00
141	1	12.10	65.00	120.00	10.00
142	1	5.30	-5.00	50.00	10.00
143	1	2.90	47.50	50.00	56.25
144	1	3.20	-7.50	47.50	22.50
SUMMATIONS		46.30	330.00	378.75	107.50
MEAN VALUES		7.71	55.00	63.12	17.91

SUBJECT NO. 2. PROBLEM SOLVING

RESPONSE DURATION IN SECONDS
ELECTROPHYSIOLOGICAL MEASUREMENTS IN MICRO-VOLTS

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
PRE-EXPERIMENTAL BASE LEVELS			12.50	7.50	10.00
1	0	12.10	150.00	3.75	35.00
2	0	12.10	150.00	-1.25	41.25
3	1	12.10	147.50	3.75	37.50
4	0	7.60	87.50	17.50	37.50
5	0	4.30	37.50	32.50	28.75
6	0	10.40	147.50	42.50	37.50
SUMMATIONS		58.60	720.00	98.75	217.50
MEAN VALUES		9.76	120.00	16.45	36.25
7	0	12.10	135.00	47.50	25.00
8	0	6.90	102.50	60.00	17.50
9	0	6.80	102.50	67.50	30.00
10	1	10.80	147.50	72.50	46.25
11	0	12.10	142.50	67.50	25.00
12	0	12.10	121.25	67.50	17.50
SUMMATIONS		60.80	751.25	382.50	161.25
MEAN VALUES		10.13	125.20	63.75	26.87
13	0	12.10	123.75	80.00	27.50
14	1	6.90	87.50	80.00	33.75
15	0	10.30	147.50	80.00	23.75
16	0	5.00	72.50	75.00	15.00
17	0	10.70	137.50	77.50	22.50
18	1	12.10	130.00	75.00	21.25
SUMMATIONS		57.10	698.75	467.50	143.75
MEAN VALUES		9.51	116.45	77.91	23.95
19	1	12.10	147.50	77.50	16.25
20	1	12.10	147.50	77.50	16.25
21	0	12.10	132.50	80.00	21.25
22	0	6.50	112.50	77.50	11.25
23	0	9.30	132.50	87.50	22.50
24	0	5.80	95.00	92.50	16.25
SUMMATIONS		57.90	767.50	492.50	103.75
MEAN VALUES		9.65	127.91	82.08	17.29

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
25	1	12.10	135.00	82.50	16.25
26	0	12.10	147.50	82.50	17.50
27	0	12.10	147.50	87.50	22.50
28	1	12.10	136.25	92.50	15.00
29	0	12.10	147.50	95.00	22.50
30	1	12.10	137.50	92.50	23.75
SUMMATIONS		72.60	851.25	532.50	117.50
MEAN VALUES		12.10	141.87	88.75	19.58
31	1	6.40	148.75	95.00	18.75
32	1	5.50	115.00	97.50	32.50
33	1	4.50	83.75	95.00	23.75
34	1	9.90	87.50	95.00	23.75
35	1	12.10	138.75	97.50	33.75
36	0	12.10	136.25	102.50	28.75
SUMMATIONS		50.50	710.00	582.50	161.25
MEAN VALUES		8.41	118.33	97.08	26.87
37	0	12.10	135.00	102.50	76.25
38	0	4.20	110.00	100.00	36.25
39	0	10.30	87.50	102.50	42.50
40	0	9.70	112.50	107.50	22.50
41	1	12.10	142.50	110.00	25.00
42	1	12.10	138.75	107.50	23.75
SUMMATIONS		60.50	726.25	630.00	226.25
MEAN VALUES		10.08	121.04	105.00	37.70
43	0	12.10	132.50	102.50	32.50
44	1	7.70	135.00	102.50	21.25
45	1	5.10	87.50	105.00	36.25
46	0	7.00	102.50	102.50	41.25
47	0	3.00	107.50	105.00	17.50
48	0	4.60	108.75	102.50	21.25
SUMMATIONS		39.50	673.75	620.00	170.00
MEAN VALUES		6.58	112.29	103.33	28.33
49	0	4.00	92.50	102.50	20.00
50	1	9.60	130.00	105.00	20.00
51	1	6.50	145.00	107.50	20.00
52	0	3.00	96.25	107.50	23.75
53	1	2.80	90.00	105.00	21.25
54	1	7.00	117.50	107.50	13.75
SUMMATIONS		32.90	671.25	635.00	118.75
MEAN VALUES		5.48	111.87	105.83	19.79

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
55	1	2.70	108.75	107.50	16.25
56	1	2.80	85.00	105.00	13.75
57	1	3.00	82.50	102.50	25.00
58	0	3.60	97.50	102.50	21.25
59	0	3.00	120.00	105.00	16.25
60	0	5.50	87.50	97.50	12.50
SUMMATIONS		20.60	581.25	620.00	105.00
MEAN VALUES		3.43	96.87	103.33	17.50
61	1	2.30	117.50	117.50	12.50
62	0	12.10	135.00	105.00	10.00
63	1	5.90	87.50	105.00	10.00
64	1	3.70	140.00	107.50	6.90
65	1	3.20	90.00	110.00	15.00
66	1	4.30	88.75	108.75	13.75
SUMMATIONS		31.50	658.75	653.75	68.15
MEAN VALUES		5.25	109.79	108.95	11.35
67	1	7.00	102.50	110.00	12.50
68	1	3.10	128.75	115.00	12.50
69	1	4.50	97.50	117.50	15.00
70	1	2.60	95.00	115.00	17.50
71	0	2.00	92.50	112.50	15.00
72	0	2.20	110.00	110.00	13.75
SUMMATIONS		21.40	626.25	680.00	86.25
MEAN VALUES		3.56	104.37	113.33	14.37
73	1	5.10	145.00	112.50	6.25
74	0	4.20	96.25	112.50	15.00
75	1	7.00	117.50	110.00	11.25
76	1	7.00	112.50	107.50	12.50
77	1	3.30	91.25	107.50	7.50
78	0	5.50	126.25	105.00	18.75
SUMMATIONS		32.10	688.75	655.00	71.25
MEAN VALUES		5.35	114.79	109.16	11.87
79	1	5.50	112.50	102.50	15.00
80	0	4.00	106.25	117.50	16.25
81	1	2.30	86.25	98.75	12.50
82	0	10.30	125.00	97.50	12.50
83	0	10.50	122.50	102.50	15.00
84	1	1.50	83.75	97.50	13.75
SUMMATIONS		34.10	636.25	616.25	85.00
MEAN VALUES		5.68	106.04	102.70	14.16

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
85	1	2.00	81.25	97.50	12.50
86	1	2.00	80.00	95.00	7.50
87	0	2.10	82.50	95.00	12.50
88	1	1.70	103.75	97.50	15.00
89	1	2.70	82.50	98.75	20.00
90	1	2.10	82.50	100.00	7.50
SUMMATIONS		12.60	512.50	583.75	75.00
MEAN VALUES		2.10	85.41	97.29	12.50
91	0	2.10	112.50	97.50	10.00
92	1	11.00	137.50	98.75	10.00
93	1	12.10	130.00	97.50	0.00
94	0	5.20	80.00	95.00	5.00
95	1	1.60	77.50	95.00	12.50
96	0	1.80	77.50	92.50	5.00
SUMMATIONS		33.80	615.00	576.25	42.50
MEAN VALUES		5.63	102.50	96.04	7.08
97	1	4.50	87.50	92.50	8.75
98	1	2.90	80.00	95.00	10.00
99	1	10.80	150.00	97.50	5.00
100	1	12.10	150.00	97.50	5.00
101	1	12.10	147.50	97.50	11.25
102	1	12.10	147.50	98.75	10.00
SUMMATIONS		54.50	762.50	578.75	50.00
MEAN VALUES		9.08	127.08	96.45	8.33
103	0	9.30	127.50	103.75	11.25
104	1	6.20	83.75	97.50	10.00
105	1	3.00	80.00	97.50	7.50
106	1	10.70	142.50	102.50	13.75
107	0	6.50	83.75	97.50	7.50
108	1	2.10	91.25	102.50	10.00
SUMMATIONS		37.80	608.75	601.25	60.00
MEAN VALUES		6.30	101.45	100.20	10.00
109	1	3.00	82.50	97.50	5.00
110	1	3.00	71.25	92.50	6.25
111	1	2.30	67.50	87.50	10.00
112	1	2.40	77.50	90.00	0.00
113	1	2.00	72.50	95.00	5.00
114	1	2.30	72.50	90.00	0.00
SUMMATIONS		15.00	443.75	552.50	26.25
MEAN VALUES		2.50	73.95	92.08	4.37

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
115	1	10.80	92.50	92.50	5.00
116	1	12.10	107.50	90.00	2.50
117	1	4.20	65.00	112.50	0.00
118	1	2.60	65.00	82.50	8.75
119	1	6.30	71.25	82.50	0.00
120	1	9.40	145.00	107.50	8.75
SUMMATIONS		45.40	546.25	567.50	25.00
MEAN VALUES		7.56	91.04	94.58	4.16
121	1	12.10	128.75	87.50	15.00
122	1	12.10	126.25	115.00	12.50
123	0	12.10	136.25	87.50	16.25
124	1	12.10	138.75	102.50	16.25
125	1	9.50	85.00	92.50	20.00
126	1	10.60	136.25	92.50	17.50
SUMMATIONS		68.50	751.25	577.50	97.50
MEAN VALUES		11.41	125.20	96.25	16.25
127	1	8.20	83.75	85.00	15.00
128	1	10.80	136.25	82.50	12.50
129	1	6.90	75.00	77.50	10.00
130	1	10.00	147.50	82.50	12.50
131	1	12.10	115.00	80.00	10.00
132	1	6.20	58.75	77.50	10.00
SUMMATIONS		54.20	616.25	485.00	70.00
MEAN VALUES		9.03	102.70	80.83	11.66
133	1	5.20	112.50	70.00	10.00
134	1	7.30	80.00	67.50	10.00
135	1	2.70	60.00	82.50	10.00
136	1	2.80	52.50	97.50	12.50
137	1	2.30	57.50	70.00	20.00
138	1	4.60	55.00	70.00	15.00
SUMMATIONS		24.90	417.50	457.50	77.50
MEAN VALUES		4.15	69.58	76.25	12.91
139	1	7.80	75.00	70.00	65.00
140	1	2.50	52.50	67.50	7.50
141	1	3.00	55.00	62.50	27.50
142	1	2.10	55.00	65.00	11.25
143	1	1.60	72.50	67.50	7.50
144	1	1.80	50.00	65.00	7.50
SUMMATIONS		18.80	360.00	397.50	126.25
MEAN VALUES		3.13	60.00	66.25	21.04

SUBJECT NO. 3. PROBLEM SOLVING

RESPONSE DURATION IN SECONDS
ELECTROPHYSIOLOGICAL MEASUREMENTS IN MICRO-VOLTS

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
PRE-EXPERIMENTAL BASE LEVELS			8.75	8.75	12.50
1	0	3.30	2.50	7.50	95.00
2	1	4.40	3.15	6.25	72.50
3	0	3.00	3.75	6.25	42.50
4	0	3.50	2.50	6.25	56.25
5	0	3.00	2.50	6.90	77.50
6	1	4.20	3.75	8.75	62.50
SUMMATIONS		21.40	18.15	41.90	406.25
MEAN VALUES		3.56	3.02	6.98	67.70
7	1	3.50	16.25	8.75	53.75
8	0	4.70	2.50	6.25	47.50
9	0	2.90	3.75	6.25	55.00
10	0	3.50	3.75	7.50	43.25
11	0	4.90	2.50	6.25	42.50
12	0	6.20	2.50	6.90	18.75
SUMMATIONS		25.70	31.25	41.90	260.75
MEAN VALUES		4.28	5.20	6.98	43.45
13	1	3.50	2.50	6.25	23.75
14	0	4.20	3.75	8.75	22.50
15	1	2.70	6.25	8.75	20.00
16	1	2.70	2.50	8.75	25.00
17	1	10.60	66.25	10.00	72.50
18	1	4.20	3.75	10.00	67.50
SUMMATIONS		27.90	85.00	52.50	231.25
MEAN VALUES		4.65	14.16	8.75	38.54
19	1	2.20	3.75	11.25	52.50
20	1	2.30	3.75	10.65	72.50
21	1	1.90	3.15	8.75	37.50
22	1	2.70	3.15	10.00	117.50
23	1	2.70	2.50	10.65	75.00
24	1	2.20	2.50	8.75	37.50
SUMMATIONS		14.00	18.80	60.05	392.50
MEAN VALUES		2.33	3.13	10.00	65.41

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
25	1	2.20	46.25	8.75	25.00
26	1	2.60	3.75	6.25	25.00
27	1	3.40	3.75	6.25	32.50
28	1	2.00	3.75	6.25	5.00
29	1	2.80	3.75	6.25	7.50
30	1	2.00	55.00	6.25	6.25
SUMMATIONS		15.00	116.25	40.00	101.25
MEAN VALUES		2.50	19.37	6.66	16.87
31	1	12.10	66.25	7.50	8.75
32	1	4.20	6.25	6.90	7.50
33	1	6.80	6.25	7.50	30.00
34	1	7.50	10.00	7.50	23.75
35	1	12.10	96.25	6.90	18.75
36	1	2.90	3.75	6.25	20.00
SUMMATIONS		45.60	188.75	42.55	108.75
MEAN VALUES		7.60	31.45	7.09	18.12
37	1	2.40	12.50	8.75	17.50
38	1	12.10	61.25	7.50	21.25
39	1	2.60	38.75	8.75	26.25
40	1	3.00	3.15	6.25	72.50
41	1	2.10	3.15	6.25	40.00
42	1	1.70	3.75	6.25	8.75
SUMMATIONS		23.90	122.55	43.75	186.25
MEAN VALUES		3.98	20.42	7.29	31.04
43	1	3.60	51.25	7.50	13.75
44	1	3.50	6.25	6.25	17.50
45	1	3.00	3.75	6.25	20.00
46	1	2.80	31.25	7.50	15.00
47	1	3.50	5.00	8.75	17.50
48	1	2.90	3.75	7.50	17.50
SUMMATIONS		19.30	101.25	43.75	101.25
MEAN VALUES		3.21	16.87	7.29	16.87
49	1	2.40	3.75	7.50	17.50
50	1	2.70	2.50	7.50	12.50
51	1	5.80	10.00	7.50	21.25
52	1	2.20	23.75	7.50	17.50
53	1	12.10	21.25	6.25	21.25
54	1	12.10	21.25	6.25	21.25
SUMMATIONS		37.30	82.50	42.50	111.25
MEAN VALUES		6.21	13.75	7.08	18.54

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
55	1	12.10	16.25	7.50	26.25
56	1	2.80	3.75	7.50	25.00
57	1	3.50	6.25	7.50	20.00
58	1	2.20	3.75	26.25	10.00
59	1	3.20	13.75	8.75	17.50
60	1	12.10	11.25	8.75	22.50
SUMMATIONS		35.90	55.00	66.25	121.25
MEAN VALUES		5.98	9.16	11.04	20.20
61	1	8.80	12.50	8.75	23.75
62	1	2.00	3.75	7.50	17.50
63	1	2.10	3.75	7.50	22.50
64	1	3.40	3.75	7.50	62.50
65	1	3.00	6.25	7.50	8.75
66	1	2.00	3.75	7.50	2.50
SUMMATIONS		21.30	33.75	46.25	137.50
MEAN VALUES		3.55	5.62	7.70	22.91
67	1	1.90	3.75	8.75	2.50
68	1	1.50	3.75	8.75	2.50
69	1	2.10	3.75	86.25	10.00
70	1	1.80	3.75	7.50	11.25
71	1	2.30	3.75	8.75	15.00
72	1	1.80	3.75	7.50	17.50
SUMMATIONS		11.40	22.50	127.50	58.75
MEAN VALUES		1.90	3.75	21.25	9.79
73	1	1.80	3.75	8.75	17.50
74	1	1.60	3.75	7.50	20.00
75	1	1.60	3.75	7.50	22.50
76	1	5.20	3.75	7.50	18.75
77	1	1.70	3.75	7.50	17.50
78	1	8.30	36.25	7.50	17.50
SUMMATIONS		20.20	55.00	46.25	113.75
MEAN VALUES		3.36	9.16	7.70	18.95
79	1	1.60	3.75	7.50	16.25
80	1	3.00	3.75	7.50	37.50
81	1	2.00	3.75	7.50	13.75
82	1	2.10	2.50	7.50	10.00
83	1	1.80	2.50	7.50	12.50
84	1	1.70	2.50	7.50	18.75
SUMMATIONS		12.20	18.75	45.00	108.75
MEAN VALUES		2.03	3.12	7.50	18.12

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
85	1	1.90	2.50	7.50	21.25
86	1	2.20	2.50	7.50	23.75
87	1	1.70	2.50	7.50	25.00
88	1	1.70	2.50	7.50	27.50
89	1	2.30	2.50	7.50	27.50
90	1	2.10	2.50	8.75	22.50
SUMMATIONS		11.90	15.00	46.25	147.50
MEAN VALUES		1.98	2.50	7.70	24.58
91	1	1.80	3.75	7.50	12.50
92	1	1.70	2.50	8.75	16.25
93	1	2.20	2.50	7.50	26.25
94	1	1.70	3.75	7.50	27.50
95	1	1.60	2.50	7.50	30.00
96	1	1.80	2.50	8.75	26.25
SUMMATIONS		10.80	17.50	47.50	138.75
MEAN VALUES		1.80	2.91	7.91	23.12
97	1	2.00	2.50	7.50	15.00
98	1	3.50	3.75	7.50	10.00
99	1	2.60	10.00	8.75	7.50
100	1	4.50	7.50	8.75	15.00
101	1	8.00	8.75	8.75	22.50
102	1	2.10	36.25	8.75	22.50
SUMMATIONS		22.70	68.75	50.00	92.50
MEAN VALUES		3.78	11.45	8.33	15.41
103	1	3.00	118.75	31.25	25.00
104	1	4.00	42.50	31.25	32.50
105	1	2.50	28.75	31.25	31.25
106	1	2.70	71.25	8.75	33.75
107	1	2.70	5.00	8.75	26.25
108	1	2.40	7.50	8.75	13.75
SUMMATIONS		17.30	273.75	120.00	162.50
MEAN VALUES		2.88	45.62	20.00	27.08
109	1	2.40	8.15	8.75	15.00
110	1	2.70	9.40	8.75	18.75
111	1	2.10	16.25	8.75	22.50
112	1	3.00	8.75	8.75	30.00
113	1	2.00	3.75	8.75	0.00
114	1	2.00	3.15	7.50	0.00
SUMMATIONS		14.20	49.45	51.25	86.25
MEAN VALUES		2.36	8.24	8.54	14.37

TRIAL NO.	RIGHT=1 WRONG=0	RESPONSE DURATION (SEC.)	ACTIVE ARM (MIC-V.)	PASSIVE ARM (MIC-V.)	CHIN POTENTIAL (MIC-V.)
115	1	2.60	2.50	7.50	5.00
116	1	2.30	3.75	8.75	8.75
117	1	1.80	3.75	8.75	0.00
118	1	1.50	41.25	7.50	0.00
119	1	1.90	3.75	7.50	0.00
120	1	3.20	8.75	7.50	10.00
SUMMATIONS		13.30	63.75	47.50	23.75
MEAN VALUES		2.21	10.62	7.91	3.95
121	1	1.20	2.50	7.50	0.00
122	1	3.00	23.75	7.50	3.15
123	1	2.10	26.25	7.50	5.00
124	1	12.10	48.75	7.50	7.50
125	1	2.10	57.50	8.75	7.50
126	1	3.40	13.75	8.75	8.75
SUMMATIONS		23.90	172.50	47.50	31.90
MEAN VALUES		3.98	28.75	7.91	5.31
127	1	2.20	3.75	8.75	2.50
128	1	2.70	3.75	8.75	7.50
129	1	4.00	12.50	8.75	28.75
130	1	2.60	6.25	7.50	2.50
131	1	2.50	3.15	7.50	47.50
132	1	2.40	5.00	8.75	0.00
SUMMATIONS		16.40	34.40	50.00	88.75
MEAN VALUES		2.73	5.73	8.33	14.79
133	1	1.60	3.75	8.75	2.50
134	1	1.40	3.15	7.50	3.75
135	1	1.90	11.25	8.75	7.50
136	1	2.40	2.50	7.50	10.00
137	1	1.80	1.25	8.75	11.25
138	1	1.70	1.25	7.50	8.75
SUMMATIONS		10.80	23.15	48.75	43.75
MEAN VALUES		1.80	3.85	8.12	7.29
139	1	1.80	8.75	7.50	7.50
140	1	2.80	3.75	7.50	12.50
141	1	2.30	13.75	8.75	12.50
142	1	12.10	22.50	8.75	15.00
143	1	2.10	36.25	11.25	22.50
144	1	1.70	51.25	8.75	15.00
SUMMATIONS		22.80	136.25	52.50	85.00
MEAN VALUES		3.80	22.70	8.75	14.16

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