EXTRAVERSION: RECOVERY FROM THE EFFECTS OF SOMATOSENSORY STIMULATION

by L. S. Burgess

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CURRICULUM STUDIORUM

L. S. Burgess was born December 14, 1945, in Ottawa, Ontario. She received the Honors Bachelor of Arts degree in Geography from Carleton University, Ottawa, Ontario, in 1967. The title of her Honors paper was The Great Slave Lake Railway: an Economic Geography. She received the Master of Psychology degree from the University of Ottawa, Ottawa, Ontario, in 1971. The title of her upgrading paper was Hyperactivity in Children.

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INTRODUCTION

Eysenck's dimensions of personality have provided an area fruitful for both theory and research; of these dimensions that of Extraversion is of special interest in this research. The attributes ascribed to the more extreme extravert seem to point towards a more cortically inhibited[1] or a less aroused nervous system.[2] Its counterpart, the extreme introvert, has been described as a more cortically excited[3] or having a more aroused nervous system.[4] Although Eysenck does speak of autonomic activation and other peripheral factors[5] the reference here is being made to Eysenck's hypotheses concerning cortical excitation-inhibition and cortical arousal. It is with this aspect of the Eysenckian Extraversion dimension of personality that this research is concerned.

A very intriguing physiological measure has been found to discriminate significantly between certain groups

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1 H. J. Eysenck, Biological Basis of Personality, Springfield, Illinois, Charles C. Thomas, 1967, p. 75-76.

2 *Ibid.*, p. 241.

3 *Ibid.*, p. 76.

4 *Ibid.*, p. 241.

5 *Ibid.*, p. 233.

of psychiatric patients[6,7,8,9,10,11,12,13,14,15,16] and has been said to describe the "current state of personality

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6 Charles Shagass and Marvin Schwartz, "Cortical Excitability in Psychiatric Disorders--Preliminary Results," Proceedings of the Third World Congress in Psychiatry, Vol. 1, June 4-10, 1961, p. 441-446.

7 --------, "Reactivity Cycle of Somatosensory Cortex in Humans with and without Psychiatric Disorders," Science, Vol. 134, December 1961, p. 1757-1759.

8 --------, "Observations of Somatosensory Cortical Reactivity in Personality Disorders," Journal of Nervous and Mental Diseases, Vol. 135, 1962, p. 44-51.

9 --------, "Cortical Reactivity in Psychotic Depressions," Archives of General Psychiatry, Vol. 6, 1962, p. 235-242.

10 --------, "Cerebral Responsiveness in Psychiatric Patients," Archives of General Psychiatry, Vol. 8, 1963, p. 177-189.

11 --------,"Psychiatric Correlates of Evoked Cerebral Cortical Potentials," American Journal of Psychiatry, Vol. 119, 1963, p. 1055-1061.

12 --------, "Visual Cerebral Evoked Response Characteristics in a Psychiatric Population," American Journal of Psychiatry, Vol. 121, 1964-65, p. 979-987.

13 Charles Shagass, "Age, Personality and Somatosensory Cerebral Evoked Responses," Science, Vol. 148, June 4, 1965, p. 1359-1361.

14 Charles Shagass, Marvin Schwartz and Singa R. Krishnamoortis, "Some Psychologic Correlates of Cerebral Responses Evoked by Light Flash," Journal of Psychosomatic Research, Vol. 9, 1965, p. 223-231.

15 Charles Shagass and Marvin Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," British Journal of Psychiatry, Vol. 12, 1966, p. 799-807.

16 Charles Shagass, "Evoked Potentials in Psychiatry," in Nathan S. Kline and Eugene Laska (eds.), Computers and Electronic Devices in Psychiatry, New York, Grune & Stratton, 1968, p. 141-157.

functioning."[17] Although these demonstrations have been made in the sphere of pathological functioning, because the pathological groups used can be easily classified along the Extraversion dimension, there is reason to believe that such a measure could prove to be a useful index in the study of normal personality differences. This physiological measure, recovery rate from somatosensory stimulation, offers possibilities for further specification of the dimension of Extraversion should they be found to relate in some way.

This research will ask the following question: Are somatosensory recovery rates related to the dimension of Extraversion in the "normal" range of human subjects?

The review of the literature will outline those aspects of Eysenckian theory and somatosensory recovery rates which appear relevant in formulating testable hypotheses.

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17 Shagass and Schwartz, "Cortical Reactivity in Psychotic Depressions," p. 236.

CHAPTER I

REVIEW OF THE LITERATURE

This review will begin by outlining Eysenck's concepts of cortical excitation-inhibition and arousal, in relation to his dimension of Extraversion. Section two will discuss the work of Shagass and Schwartz and others on somatosensory recovery. Section three will outline other electrophysiological measures which have been used to study Extraversion. Section four will be a formulation of a theoretical framework wherein the work of the above groups of researchers may be blended. Section five will consist of the null hypotheses derived to test the relationships elaborated in section four.

1. Eysenckian Concepts and Extraversion.

This section will outline Eysenck's concepts of cortical excitation-inhibition and arousal. In formulating his theory, Eysenck relied heavily on the concept of excitation and inhibition. He postulated individual differences in terms of the excitation-inhibition balance[1] wherein the introvert would be characterized by cortical excitation

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1 H. J. Eysenck, Biological Basis of Personality, Springfield, Illinois, Charles C. Thomas, 1967, p. 80.

where "processes of an unknown character would facilitate learning, conditioning [...] mental processes generally"[2] resulting in increased efficiency in the cortex and in behavior marked by a decrease in behavioral excitation and an increase in behavioral inhibition.[3] The extravert would be characterized as cortically inhibited; cortical processes of unknown character would reduce the efficiency of the extravert's cortex, with the effects of this reduced efficiency being manifested as increasing behavioral excitability and decreasing behavioral inhibition. In discussing the measurement of this balance, Eysenck points out that these components of excitation-inhibition can only be measured in their resultant vector; he further suggests that what is described or explained in terms of cortical inhibition, as decrement in performance "due" to a hypothesized increase in reactive inhibition, could be ascribed equally to the complement concept--the decrement in performance could be "due" to a decrease in cortical excitation.[4] However, Eysenck does express the hope that physiological measures will eventually be capable of isolating measures of these individual components rather than the resultant vector.

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2 Ibid., p. 75.

3 Ibid., p. 76.

4 Ibid., p. 81.

Eysenck states:

> In terms of our excitation-inhibition theory most stress in accounting for extravert-introvert differences has been laid on inhibition [...] in linking up this theory with neurophysiology, stress seems to have shifted to arousal, differences in arousal level, and high arousal threshold.[5]

In the restatement of his theory, Eysenck postulated a higher level of arousal in the introvert and a higher level of inhibition in the extravert.[6] After distinguishing very carefully between the concepts of activation and arousal Eysenck specifies that the cortico-reticular loop concerned with information-processing and "with cortical arousal and inhibition" can theoretically and successfully be applied "to personality differences, within the dimension introversion-extraversion."[7] Therefore, differences in behavior related to the dimension of Introversion-Extraversion are identified with differential thresholds in various parts of the ascending reticular activating system.[8]

Eysenck does not consider that the concept of arousal provides adequate explanation for all phenomena delineated in experimental work. He cites involuntary rest pauses, vigilance decrements and adaptation as such phenomena. He

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6 Ibid., p. 241.

7 Ibid., p. 231.

8 Ibid., p. 230.

feels that a theory of inhibition more adequately copes with these particular facts. "[...] a simple account in terms of arousal is clearly not sufficient."[9]

In summing up his theory, Eysenck states that his theory would benefit from further testing particularly in the area of "neurophysiological study."[10] He further makes reference to the work of Shagass and Schwartz[11] with the somatosensory evoked potential. Eysenck concludes that these "studies present a challenging task for the future" and that there seems to exist a "fairly definite relationship between these potentials and personality, particularly introversion-extraversion."[12]

2. Somatosensory Recovery.

Shagass and Schwartz measured neural recovery rates from somatosensory stimulation in normals and psychiatric patients and found that this physiological measure significantly discriminated certain psychiatric groups from non-patients and other psychiatric groups. In their earlier work, they measured the neural recovery rate by expressing the amplitude of the response to the second of a pair of

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9 _Ibid._, p. 248.

10 _Ibid._, p. 255.

11 _Ibid._, p. 256.

12 _Ibid._, p. 261.

stimuli as a ratio to the amplitude of the response to the first of the same pair of stimuli. The stimulus used was electric stimulation to the ulnar or median nerve at the wrist. The stimulation intensity was gauged to produce a twitch of the little finger but was in no way painful.[13] Following methodological improvements in the intensity of stimulation and the method of measuring recovery, results obtained were substantially replicated.[14]

A. Personality Correlates

The neural recovery rate, also referred to as the cycle of cortical excitability[15] expressed as a ratio, was found to discriminate between a patient group comprising individuals diagnosed as schizophrenics, personality disorders and psychotic depressions,[16] and another group comprising individuals diagnosed as dysthymics. This measure

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13 Charles Shagass and Marvin Schwartz, "Observations of Somatosensory Cortical Reactivity in Personality Disorders," Journal of Nervous and Mental Diseases, Vol. 135, 1962, p. 45.

14 --------, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," British Journal of Psychiatry, Vol. 12, 1966, p. 799-807.

15 *Ibid.*, p. 44.

16 --------, "Cerebral Responsiveness in Psychiatric Patients," Archives of General Psychiatry, Vol. 8, 1963, p. 177.

of the cycle of cortical excitability has not been found to differentiate between dysthymics and non-patient groups. With remission of psychiatric symptoms in the psychotic depressions, the cycle of cortical excitability was found to return to levels similar to those found in the normal-dysthymic range.[17] These findings were interpreted by Shagass and Schwartz as supporting their belief that cortical reactivity cycles reflect the current state of personality functioning,[18] more specifically of the altered "activity of central mechanisms concerned with information transmission and processing."[19] On the basis of effects of changes in consciousness on the recovery cycle found in later work, Shagass further concludes that, "It seems reasonable to suppose that the earliest evoked-response events are related to transmission of information in the CNS, and that later ones may reflect activities concerned with information processing."[20]

In attempting to delineate more closely what aspects of functioning would be especially involved, Shagass and

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17 Charles Shagass and Marvin Schwartz, "Cortical Reactivity in Psychotic Depressions," Archives of General Psychiatry, Vol. 6, 1962, p. 238.

18 Ibid., p. 236.

19 --------, "Visual Cerebral Evoked Response Characteristics in a Psychiatric Population," American Journal of Psychiatry, Vol. 121, 1964-65, p. 986.

20 Charles Shagass, Evoked Brain Potentials in Psychiatry, New York, Plenum Press, 1972, p. 127.

Schwartz found that affect did not appear to be a direct correlate of the cycle of cortical excitability as studied by their methods.[21] This conclusion is supported by other data as well: stimulation of the hippocampus and other areas usually said to be involved in activation[22] of the nervous system had no effect upon neural recovery rates; only stimulation of those structures intimately associated with the reticular formation had effect.[23] In their work on neural recovery rates, King *et al*.[24] found that barbituates increased the length of the neural recovery period in capsular responses. These authors conclude that their observations on recovery cycles suggest that one of the mechanisms of barbituate action is mimicking a functional lesion of the reticular formation.[25] The suggestion that cycles of cortical excitability are affected more by central

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21 Shagass and Schwartz, "Cortical Reactivity in Psychotic Depressions," p. 240.

22 Eysenck, *op. cit*., p. 234.

23 Marvin Schwartz and Charles Shagass, "Reticular Modification of Somatosensory Cortical Recovery Function," *Electroencephalography and Clinical Neurophysiology*, Vol. 15, 1963, p. 269.

24 Ellen Eva King, Robert Naquet and H. W. Magoun, "Alterations in Somatic Afferent Transmission through the Thalamus by Central Mechanisms and Barbituates," *Journal of Pharmacology and Experimental Therapeutics*, Vol. 117, 1957, p. 56.

25 *Ibid*., p. 58.

than peripheral mechanisms has been strongly supported by a 1963 study of Shagass and Schwartz.[26] These authors compared the recovery curves in cats, with and without stimulation of the reticular formation. With reticular stimulation it was found that there was an early augmentation of responsiveness at a very highly significant level. This augmented recovery was found at the levels of the internal capsule and the cortex. Therefore, prior reticular stimulation results in a marked augmentation of responsiveness to the second stimulus early in the somatosensory recovery cycle. These findings "agree with the findings of other authors for other sensory modalities."[27] A later study confirmed the effects of fast mesencephalic reticular formation stimulation on the early components of the somatosensory recovery cycle across all interstimulus intervals. It is interesting to note that changes in the recovery cycles of depressed patients after effective treatment were similar to changes in the recovery cycle after fast MRF stimulation.[28]

The above data and "formulations [...] appear to equate the influence of the brain stem reticular formation

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26 Schwartz and Shagass, "Reticular Modification of Somatosensory Cortical Recovery Function," p. 265-271.

27 Ibid., p. 270.

28 Charles Shagass and Katsumi Ando, "Septal and Reticular Influences on Cortical Evoked Response Recovery Functions," Biological Psychiatry, Vol. 2, 1970, p. 14.

on alerting with its influence on the recovery cycle."[29] But Shagass and Schwartz challenge this equation on the grounds that drowsiness and sleep do "not affect responsiveness and the duration of relative unresponsiveness"[30] as do barbituate drugs[31] and psychiatric conditions.[32] Rather the effect of state of alertness is on another portion of the recovery curve--"peaks of supernormality."[33] They found "alert recovery almost the same as non-alert recovery for the first 50 msec."[34] This corroborates the findings of Uttal and Cook.[35]

Several other experimental findings appear to offer support for this position. Shagass and Ando found that the effects of mesencephalic reticular formation and septal area

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29 Marvin Schwartz, Charles Shagass, Robert Bittle and Marshall Flapan, "Dose Related Effects of Pentobarbital on Somatosensory Evoked Responses and Recovery Cycles," Electroencephalography and Clinical Neurophysiology, Vol. 14, 1962, p. 902.

30 Ibid.

31 King et al., op. cit., p. 67.

32 Shagass and Schwartz, "Observations of Somatosensory Cortical Reactivity in Personality Disorders," p. 44-51.

33 Marvin Schwartz and Charles Shagass, "Effect of Different States of Alertness on Somatosensory and Auditory Recovery Cycles," Electroencephalography and Clinical Neurophysiology, Vol. 14, 1962, p. 17.

34 Ibid.

35 William R. Uttal and Louella Cook, "Systematics of the Evoked Somatosensory Cortical Potential: A Psychophysical-Electrophysiological Comparison," Annals of the New York Academy of Sciences, Vol. 112, 1964, p. 60-80.

stimulation were prolonged.[36] They conclude that the mechanism mediating these effects (increased recovery for early components of the somatosensory recovery function) were separate from mechanisms mediating EEG arousal since the "EEG arousal had gone by the time the recovery measures were taken."[37]

The hypothesis that differential arousal is reflected in later components of evoked brain potentials has been supported empirically by many researchers. Goff and his co-workers have stated that components of somatic evoked responses occurring later than 60-70 msec. "seem modality non-specific and involve little or no sensory information."[38] They do not support or deny that these are associated with arousal as has been stated by Roth _et al_.,[39] but Goff _et al_. do suggest that the bilateral projection of these later components imply "mediation by extralemniscal pathways."[40]

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36 Shagass and Ando, _op. cit_., p. 15.

37 _Ibid_., p. 16.

38 William R. Goff, Burton S. Rosner and Truett Allison, "Distribution of Somatosensory Evoked Responses in Normal Man," _Electroencephalography and Clinical Neurophysiology_, Vol. 14, 1962, p. 711.

39 M. Roth, J. Shaw and J. Green, "The Form, Voltage Distribution and Physiological Significance of the K-complex," _Electroencephalography and Clinical Neurophysiology_, Vol. 8, 1956, p. 385-402.

40 W. R. Goff, Y. Matsumiya, Truett Allison and G. D. Goff, "Cross-modality Comparisons of Averaged Evoked Potentials," in _Averaged Evoked Potentials: Methods, Results and Evaluations_; a conference held at San Francisco, California, September 10-12, 1968, Washington, D. C., National Aeronautics and Space Administration, 1969, p. 109.

In studies of evoked potentials, Shagass found that later events undergo alterations of a similar nature in all states involving major impairment to consciousness;[41] further, he concludes that "early or primary aspects of sensory evoked response are not very susceptible to psychological manipulation," and that "this appears to agree with the idea that early components reflect information transmission activities whereas later ones reflect information processing."[42] Relating the implication of the identification of these later components sometimes with arousal, sometimes with information processing, will be commented on later. Näätänen[43] also concludes that the amplitude of late evoked response components are associated with attentiveness and reflect general arousal. In a study of averaged evoked responses of the somatosensory cortex recorded subdurally, Libet[44] found that subthreshold stimulation did produce evoked brain potentials

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41 Shagass, Evoked Brain Potentials in Psychiatry, p. 127.

42 Ibid., p. 146.

43 R. Näätänen, "Selective Attention and Evoked Potentials," Annals of the Academy of Science Finnicae Helsinki, Vol. 151 [n.d.], p. 1-226, as quoted in Shagass, Evoked Brain Potentials in Psychiatry, p. 151.

44 B. Libet, W. W. Alberts, E. W. Wright, Jr., and B. Feinstein, "Responses of Human Somatosensory Cortex to Stimuli Below Threshold for Conscious Sensation," Science, Vol. 158, December 1967, p. 1598.

but that these were deficient in later components. With suprathreshold stimulation, both early and late components of the somatosensory evoked responses were seen. Further, lesions of the ventroposterolateral nucleus of the thalamus abolish all components[45] and in aphasia, no ipsilateral components are found if there are no contralateral components.[46] In the terminology of Shagass, it could be concluded that there is no information processing without information transmission; in arousal terminology, one could perhaps conclude that information processing requires arousal.

Shagass and Schwartz thus hypothesize that "alerting and recovery represent the functions of at least partially independent mechanisms within the reticular complex,"[47] although they do not entirely rule out the possibility of communality of such mechanisms.[48] Despite uncertainty regarding specifics of the mechanisms affecting recovery function, Schwartz and Shagass conclude that "mechanisms

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45 E. F. Domino, S. Matsuoka, J. Waltz and I. S. Cooper, "Effects of Cryogenic Thalamic Lesions on the Somesthetic Evoked Response in Man," Electroencephalography and Clinical Neurophysiology, Vol. 19, 1965, p. 127-138.

46 W. T. Liberson, "Study of Evoked Potentials in Aphasics," American Journal of Physical Medicine, Vol. 45, 1966, p. 135-142.

47 Schwartz et al., "Dose Related Effects of Pentobarbital on Somatosensory Evoked Responses and Recovery Cycles," p. 902.

48 Ibid., p. 898-903.

underlying recovery cycles exert only a 'loose' influence through the setting of mean response levels"[49] and that although recovery cycles are measured at the cortex, "recovery changes are probably not cortical in origin and reflect generalized changes in the excitability of the central nervous system."[50]

Thus, the reticular formation has been identified as a major, if complex, neurophysiological mechanism influencing recovery function.

B. Reliability

Although neural recovery rates for the first part of the biphasic curve[51] were found to be relatively stable across individuals, reliability of .78,[52] there are indications that individual differences within the normal range do exist. One case history demonstrated that in a state that could be labelled as normal, the individual's cycle of cortical excitability as measured by the recovery cycle ratio

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49 Schwartz and Shagass, "Effect of Different States of Alertness on Somatosensory and Auditory Recovery Cycles," p. 18 and 20.

50 *Ibid*., p. 20.

51 Shagass and Schwartz, "Cortical Reactivity in Psychotic Depressions," p. 235.

52 *Ibid*., p. 240.

was greater[53] than the ratio usually quoted by Shagass and Schwartz.[54] Variations in the recovery ratio within the normal range have been reported in other communications as well.[55,56,57]

Allison found individual differences in recovery functions of central somatic evoked potentials to be significant and indicating differences in responsiveness among normal subjects.[58] The "major features of the response are consistent from subject to subject" but there "are differences between subjects in relative amplitude and peak latencies of various response components."[59]

In their work on cats, Shagass and Schwartz found that recovery curves taken under the same EEG conditions

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53 Ibid., p. 238.

54 Charles Shagass and Marvin Schwartz, "Reactivity Cycle of Somatosensory Cortex in Humans with and without Psychiatric Disorders," Science, Vol. 134, December 1961, p. 1757-1759.

55 Ibid.

56 Shagass and Schwartz, "Cortical Reactivity in Psychotic Depressions," p. 235-242.

57 --------, "Psychiatric Correlates of Evoked Cerebral Cortical Potentials," American Journal of Psychiatry, Vol. 119, 1963, p. 1055-1061.

58 Truett Allison, "Recovery Functions of Somatosensory Evoked Responses in Man," Electroencephalography and Clinical Neurophysiology, Vol. 14, 1962, p. 337-338.

59 Ibid., p. 333.

demonstrated an acceptable degree of stability in any one animal. Whether taken a few hours or a few months apart, reliability estimates were found to be in the range of .67 - .83.[60]

Thus, it seems that sufficient reliability in recovery curve components exists across individuals to allow identification of peaks with some accuracy, that sufficient reliability in the individuality of recovery functions exists to permit the demonstrations of individual differences and, finally, that differences in recovery function across individuals seem to be statistically significant. With the methodological and statistical refinements developed to measure recovery function[61,62] which have been yielding replications of earlier results with a higher level of significance,[63] it would seem that the recovery function is sufficiently sensitive to be used as a measure of individual differences.

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60 Schwartz and Shagass, "Effect of Different States of Alertness on Somatosensory and Auditory Recovery Cycles," p. 16.

61 --------, "Recovery Functions of Human Somatosensory and Visual Evoked Potentials," Annals of the New York Academy of Sciences, Vol. 112, 1964, p. 510-525.

62 --------, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 799-807.

63 *Ibid.*, p. 803-805.

3. Extraversion and Other Electrophysiological Measures.

Other electrophysiological measures have been used to measure or approximate a measure of arousal defined as the "over-all level of wakefulness of any organism at any given moment in time."[64] Among the measures used have been heart rate, blood pressure, breathing rate, skin conduction, pupil size, the orienting reaction and various aspects of the EEG.[65] In the study of Introversion-Extraversion as measured by the Eysenckian test, breathing rate,[66] orienting reaction,[67,68] galvanic skin response,[69] sedation thresholds[70] and various aspects of the EEG[71] have all been used. Eysenck

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64 Kurt Pawlik and Raymond B. Cattell, "The Relationship between Certain Personality Factors and Measures of Cortical Arousal," Neuropsychologia, Vol. 3, 1965, p. 129-151.

65 Eysenck, op. cit., xvii-399 p.

66 Ibid., p. 14.

67 N. F. Quirion, Extraversion, Neuroticism and Habituation of the Orienting Reaction, unpublished doctoral dissertation presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1970, vii-77 p.

68 Robert-Paul Bourgeois, Introversion-Extraversion in Relation to Orienting Reaction Habituation Rate to Chromatic Stimuli, Analytic Ability and Effect of Hue on Apparent Size, unpublished doctoral dissertation presented to the School of Graduate Studies of the University of Ottawa, Ontario, 1972, x-128 p.

69 Eysenck, op. cit., p. 50.

70 Ibid., p. 290.

71 Ibid., p. 67-68, 158, 177, 178, 214.

states that "in all discussions of arousal the EEG emerges as one of the most widely accepted criteria."[72]

EEG studies have left a rather confused picture even though Eysenck maintains that over-all the work undertaken "especially the EEG" has supported his theory.[73] The EEG research with Extraversion can be classified under the following indices: alpha amplitude, alpha blocking (or rate of change of potential), alpha index, alpha frequency and evoked potential measures.

The results with alpha amplitude have been inconclusive. The reasoning predicting the alpha findings goes as follows and was presented by Shagass:[74] strong cortical inhibition was predicted to be associated with reduced reticular formation activity, thus a low level of arousal would mean a high level of alpha activity and, therefore, extraverts would have a higher alpha amplitude than introverts. This hypothesis was supported by the results of Savage[75] who found a positive correlation between alpha rhythm amplitude

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72 *Ibid*., p. 177.

73 *Ibid*., p. 255-256.

74 Charles Shagass, "A Measurable Neuropsychological Factor of Psychiatric Significance," *Electroencephalography and Clinical Neurophysiology*, Vol. 9, 1957, p. 101-108.

75 R. D. Savage, "Electro-cerebral Activity, Extraversion and Neuroticism," *British Journal of Psychiatry*, Vol. 110, 1964, p. 98-100.

and Extraversion. However, these results were not supported by Fenton and Scotton[76] who found no relationship; further Glass and Broadhurst[77] found a significant negative correlation between alpha amplitude, as deduced from a measure of rate of change of potential, and Extraversion. In a broader reinvestigation of these findings, Broadhurst and Glass[78] confirmed the relationship between Extraversion and alpha amplitude found in their 1966 study.

In an effort to explain some of these apparent contradictions, Broadhurst and Glass pointed out that the correlational method used by Fenton and Scotton may not have permitted them to find significant results since only anova was successful in pinpointing significant differences in their own study.[79] As for Savage's results, Broadhurst and Glass felt that his method of analysis would not discriminate between high amplitude constant prevalence and constant amplitude high prevalence.[80] Thus, Savage's conclusion that

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76 G. W. Fenton and L. Scotton, "Personality and the Alpha Rhythm," British Journal of Psychiatry, Vol. 113, 1967, p. 1283-1289.

77 A. Glass and Anne Broadhurst, "Relationship between the EEG as a Measure of Cortical Activity and Personality Measures," Electroencephalography and Clinical Neurophysiology, Vol. 21, 1966, p. 307-309.

78 A. Broadhurst and A. Glass, "A Relationship of Personality Measures to the Alpha Rhythm of the Electroencephalogram," British Journal of Psychiatry, Vol. 115, 1969, p. 199-204.

79 Ibid., p. 201.

80 Ibid., p. 202.

alpha abundance correlated positively with Extraversion did not, in his view, contradict the results of Broadhurst and Glass.[81] Eysenck also concludes that the picture of alpha amplitude and Extraversion is a mixed one with normal populations yielding contradictory results.[82]

Alpha frequency studies are based on the postulate that cortical arousal is reflected in an increase in frequency and a decrease in amplitude of the EEG.[83] The higher frequency in introverts and the lower frequency in extraverts were found in abnormal populations.[84] However, results in the normal population were again contradictory and unresolved[85] and no significant differences were found between groups at opposite ends of the Extraversion continuum within the normal range.[86]

With the alpha index (percent time alpha), the situation is not too different. The extravert is predicted in Eysenckian theory to have a higher alpha index than the

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81 Ibid., p. 202.

82 Eysenck, op. cit., p. 177.

83 Ibid., p. 243.

84 Ibid., p. 67-68, 177.

85 Ibid., p. 177.

86 Broadhurst and Glass, "A Relationship of Personality Measures to the Alpha Rhythm of the Electroencephalogram," p. 201.

introvert.[87] Fenton and Scotton found no significant differences in the alpha index between introverts and extraverts.[88] However, Broadhurst and Glass have twice found a significant negative correlation between the alpha index and Extraversion,[89,90] although they still suggest replication before reaching conclusions.

Studies with alpha blocking, or rate of change of potential (r.c.p.) generally assume that this phenomenon indicates the alerting or arousal of the individual. Thus, alpha blocking, r.c.p., should be more marked in introverts because of the greater degree of excitation.[91] The results again range from no significant difference[92,93,94] to

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87 Eysenck, op. cit., p. 244.

88 Fenton and Scotton, op. cit., p. 1283-1289.

89 Glass and Broadhurst, "Relationship between the EEG as a Measure of Cortical Activity and Personality Measures," p. 307-309.

90 Broadhurst and Glass, "A Relationship of Personality Measures to the Alpha Rhythm of the Electroencephalogram," p. 199-204.

91 Fenton and Scotton, op. cit., p. 1284.

92 Ibid., p. 1283-1289.

93 Broadhurst and Glass, "A Relationship of Personality Measures to the Alpha Rhythm of the Electroencephalogram," p. 199-204.

94 Charles Becker-Carus, "Relationship between EEG, Personality and Vigilance," Electroencephalography and Clinical Neurophysiology, Vol. 30, 1971, p. 519-526.

significant differences where the r.c.p. was found to correlate negatively with Extraversion.[95]

In attempting to relate evoked potential amplitude to personality variables the same kind of confusion seems to prevail. The underlying assumption is that increased cortical inhibition results in increased evoked potential amplitude, and therefore extraverts should be found to produce greater amplitudes in evoked potentials.[96] The positive but complex correlation between evoked potential amplitude and Extraversion found in one study[97] was not replicated in another.[98] Further, no significant differences were found in evoked potential amplitude either between different psychiatric groups or between non-patients and different psychiatric groups.[99] The implications of these last findings will be elaborated further on.

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95 Glass and Broadhurst, "Relationship between the EEG as a Measure of Cortical Activity and Personality Measures," p. 307-309.

96 Kjell Håseth, Charles Shagass and John J. Straumanis, "Perceptual and Personality Correlates of EEG and Evoked Response Measures," Biological Psychiatry, Vol. 1, January 1969, p. 50.

97 Charles Shagass, "Age, Personality and Somatosensory Cerebral Evoked Responses," Science, Vol. 148, June 1965, p. 1359-1361.

98 Håseth et al., op. cit., p. 49-60.

99 Shagass and Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 799-807.

Thus, at best, the results of investigations of the relationship between EEG measures and personality especially in connection with the state of arousal have a "lack of unity and are partly contradictory."[100] Some problems can be traced to choice of statistical techniques[101] and to the interpretation given the particular EEG measure used as well as the limitations within the data collected. The limitations of Savage's measures have already been mentioned. As an example of varying interpretations, the studies of Broadhurst and Glass are cited here: in their 1966 study these authors stated that a high rate of change of potential indicates increased amplitude given a constant frequency.[102] However, in their 1969 study where alpha amplitude differences were found, no r.c.p. differences were found. The interpretation given to r.c.p. results in one study does not seem to be substantiated by results in the other study. Thus, the interpretation of various EEG measures could be a source of further problems.

In predicting what kind of results one might expect to obtain from extraverts and introverts, Shagass makes the

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100 Becker-Carus, op. cit., p. 519.

101 Fenton and Scotton, op. cit., p. 1283-1289.

102 Glass and Broadhurst, "Relationship between the EEG as a Measure of Cortical Activity and Personality Measures," p. 309.

following assumption. Based on Eysenckian theorizing, he states that cortical inhibition is identical with the reticular formation mechanism involved in suppression or control of alpha activity. There are problems with this assumption. Results of experimental and correlational studies have yielded a picture which lacks unity and is contradictory in some aspects. Further, there are findings which associate good vigilance with a slowing of the alpha rhythm, thus with a lower frequency of alpha.[103] Since the work of Moruzzi and Magoun it has "generally been accepted that the degree of alpha desynchronization is a measure of activation of the reticular system" and there is "much evidence for increased excitability during EEG arousal."[104] However, it was shown that stimulation of the brain-stem reticular formation "results in a prompt reduction in the amplitude of the surface evoked dendritic potentials as

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103 Becker-Carus, op. cit., p. 525.

104 Fenton and Scotton, op. cit., p. 1286.

well as causing EEG patterns of activation."[105,106,107,108] There seems to be two kinds of effects of reticular formation activity: the reduction of evoked potential amplitude, and the enstatement of an EEG pattern of cortical activation. Both these effects can perhaps be shown in recovery rate measures. Shagass has demonstrated that mesencephalic reticular formation stimulation "augmented early recovery at the cortex";[109,110] "EEG pattern characterized by low voltage fast activity (arousal) is not a sufficient condition for augmentation of early recovery." Further, these authors found that EEG arousal diminished facilitatory periods following the relative unresponsive period in the recovery cycle of cortical responses.[111] On the basis of their findings,

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105 Ibid., p. 1286.

106 D. P. Purpura, "Observations on Cortical Mechanisms of EEG Activation Accompanying Behavioral Arousal," Science, Vol. 123, 1956, p. 804.

107 --------, "Organization of Excitatory and Inhibitory Synaptic Electrogenesis in the Cerebral Cortex," in H. H. Jasper et al. (eds.), Reticular Formation of the Brain, Toronto, Little, Brown & Co., 1958, p. 435-457.

108 --------, "Nature of Electrocortical Potentials and Synaptic Organizations in Cerebral and Cerebellar Cortex," International Review of Neurobiology, Vol. 1, 1959, p. 47-163.

109 Schwartz and Shagass, "Reticular Modifications of Somatosensory Cortical Recovery Function," p. 268.

110 Shagass and Ando, op. cit., p. 14.

111 Schwartz and Shagass, "Effect of Different States of Alertness on Somatosensory and Auditory Recovery Cycles," p. 11-20.

Shagass and Schwartz hypothesize that:

> At least two mechanisms, both within the reticular activating system, can affect somatosensory recovery function. One mechanism [...] affects the facilitatory periods following completion of the relatively unresponsive period, the other [...] affects the relative unresponsive period itself.[112]

They also add that these mechanisms are at least partially independent.

Thus, other studies with electrophysiological measures have left a confused picture of contradictory results in the process of attempting to relate to the Extraversion dimension.

4. Extraversion and Somatosensory Recovery.

This section will attempt to formulate a theoretical framework within which the work of Eysenck and of Shagass and Schwartz can be blended.

Although Eysenck mentions that the indices used in the work of Shagass and Schwartz are related to the Extraversion dimension of personality,[113] the relationship has been elaborated for the intensity-response curve,[114] the

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112 Schwartz and Shagass, "Reticular Modification of Somatosensory Cortical Recovery Function," p. 268.

113 Eysenck, <u>op. cit</u>., p. 256-261.

114 Charles Shagass, Marvin Schwartz and Singa R. Krishnamoortis, "Some Psychologic Correlates of Cerebral Responses Evoked by Light Flash," <u>Journal of Psychosomatic Research</u>, Vol. 9, 1965, p. 223-231.

response amplitude for unpaired stimuli,[115,116] but not for the recovery measures used as indices for the cycle of cortical excitability, at least not before this project was underway.

There are reasons to believe that the measures of recovery from somatosensory stimulation could be profitably utilized in the study of the Eysenckian dimensions of personality, particularly that of Extraversion. The psychiatric groups chosen by Shagass and Schwartz have been located on the Eysenckian personality dimensions. The personality disorders have been located at the Extraversion end of the continuum, and the dysthymics at the Introversion end. Other psychiatric groups were involved and tend to complicate the situation being presented here. Problems raised by the findings with other psychiatric groups will be introduced later in the discussion. It was found that the recovery ratio for personality disorders was significantly different from that of the dysthymics; personality disorders appeared to recover more slowly than dysthymics. In the words of Shagass and Schwartz, "diminished recovery implies that stimuli following the first of a sequence do not elicit the

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115 Shagass, "Age, Personality and Somatosensory Cerebral Evoked Responses," p. 1359-1361.

116 Häseth _et al_., _op. cit_., p. 49-60.

same cerebral responses until some time has elapsed."[117] This would mean that individuals having a diminished recovery rate would miss cues for behavior in their environment. Extraverts have been found to perform more poorly in vigilance tasks,[118] thus missing environmental information. A slower recovery rate would account for such lapses in performance; the slower recovery rate could be seen, at least partially, as a resultant of a less active reticular formation. It is useful to remember here that stimulation of the RAS results in shortened recovery rates especially a shortened period of relative refractoriness.[119,120] It is also interesting that the recovery cycle appears to be related to phylogeny with faster neural recovery as the phylogenetic scale is ascended.[121,122,123] Reference has

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117 Charles Shagass and Marvin Schwartz, "Psychiatric Correlates of Evoked Cerebral Cortical Potentials," American Journal of Psychiatry, Vol. 119, 1963, p. 1060.

118 Eysenck, op. cit., p. 248.

119 Schwartz and Shagass, "Reticular Modification of Somatosensory Cortical Recovery Function," p. 266.

120 Shagass and Ando, op. cit., p. 14.

121 Shagass and Schwartz, "Reactivity Cycle of Somatosensory Cortex in Humans with and without Psychiatric Disorders," p. 1759.

122 Schwartz and Shagass, "Effect of Different States of Alertness on Somatosensory and Auditory Recovery Cycles," p. 19.

123 --------, "Reticular Modification of Somatosensory Cortical Recovery Function," p. 266.

been made to the immature nervous system in the extravert.[124]

Further, supporting an extension of the recovery cycle work into the normal range of personality differences are the results of work relating the dimension of Extraversion to the somatosensory evoked potential. Complex relationships between Extraversion and the amplitude of the somatosensory potential evoked by unpaired stimuli have been found by Shagass.[125] Similarly, a relationship has been established between Extraversion and the amplitude of cerebral responses evoked by light flashes as unpaired stimuli.[126] Although the results obtained with somatosensory evoked potentials were not replicated,[127] it would seem that the possibility of empirically finding personality differences in somatosensory recovery cycles has not been eliminated. The measure of recovery cycles where the amplitude and latency of the second response adjusted for correlation with the first response has been shown to give a different,[128]

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124 Eysenck, op. cit., p. 214.

125 Shagass, "Age, Personality and Somatosensory Cerebral Evoked Responses," p. 1359-1361.

126 Shagass et al., "Some Psychologic Correlates of Cerebral Responses Evoked by Light Flash," p. 223-231.

127 Häseth et al., op. cit., p. 49-60.

128 Shagass and Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 803-805.

perhaps more sensitive,[129] index of the over-all excitability of the central nervous system;[130] more sensitive because:

> Data indicate that the recovery cycle of primary somatosensory evoked response reflect the effect of increasing doses of pentobarbital sodium to a greater extent than amplitude of evoked responses. Amplitude showed reliable decrements only at dose levels sufficient to depress severely brain function.[131]

After this study was set in motion, it became known that Shagass had found that extraverts evidenced less recovery than introverts in the early portion of the recovery measure.[132,133] In later portions of the recovery curve the differences found became difficult to interpret and "contradictory" as Shagass saw them. The difficulties seem to surround the interpretation of the effects of the Eysenckian Neuroticism factor on that portion of the curve. This study had been designed to control the Neuroticism factor and to deal only with differences on the Extraversion dimension.

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129 Schwartz et al., "Dose Related Effects of Pentobarbital on Somatosensory Evoked Responses and Recovery Cycles," p. 901.

130 Schwartz and Shagass, "Effect of Different States of Alertness on Somatosensory and Auditory Recovery Cycles," p. 20.

131 Shagass and Schwartz, "Cerebral Responsiveness in Psychiatric Patients," p. 177.

132 Shagass, Evoked Brain Potentials in Psychiatry, p. 165.

133 Charles Shagass and A. Canter, "Cerebral Evoked Responses and Personality," in V. D. Nebylitsyn and J. A. Gray (eds.), Biological Bases of Individual Behavior, New York, Academic Press, 1972, p. 111-127.

The bulk of the Shagass and Schwartz research has been carried out on the initial components of the recovery cycle and it is in these components that differences between psychiatric groups have been repeatedly found. It is largely on the basis of this work on initial components that this research extends the study into the normal range of personality differences, and to later components of the somatosensory recovery curves.

However, the situation is not so straightforward. There are certain data which complicate the derived theoretical position. The psychiatric groups studied by Shagass and Schwartz included psychotic depressions, schizophrenics, and several others[134] which are not classified along the Eysenckian dimension of Extraversion but rather along an orthogonal one, i.e., Psychoticism.[135] In the process of recovery from psychotic depression the recovery ratio of patients appears to return to values similar to those found in the normal range.[136] Finally, in their results Shagass

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134 Shagass and Schwartz, "Cerebral Responsiveness in Psychiatric Patients," p. 177.

135 H. J. Eysenck, "Psychiatric Diagnosis as a Psychological and Statistical Problem," Psychological Report, Vol. 1, 1955, p. 3-17.

136 Shagass and Schwartz, "Cortical Reactivity in Psychotic Depressions," p. 238.

Schwartz report no significant difference in the recovery ratio between dysthymics and normals or non-patients.[137,138,139]

The orthogonality of Extraversion and Psychoticism and Extraversion and Neuroticism, though established empirically, was established with the use of certain test data analyzed by a factor analytic method. It is quite possible that another measure not included could cut across these dimensions or show interrelationships among them.

There is still strong belief that abnormal behavior is an exaggeration and a crystallization of basic normal personality patterns, and that as the deviations increase the "boundaries" of Neuroticism and then Psychoticism are crossed.[140] A return to a more normal functioning within the variations of personality types seems hinted at in some of the recovery results. The recovery rates of psychotically depressed individuals in remission were found to be similar to that of

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137 Charles Shagass and Marvin Schwartz, "Cortical Excitability in Psychiatric Disorders--Preliminary Results," Proceedings of the Third World Congress of Psychiatry, Vol. 1, June 4-10, 1961, p. 441-446.

138 --------, "Reactivity Cycle of Somatosensory Cortex in Humans with and without Psychiatric Disorders," p. 1757-1759.

139 --------, "Psychiatric Correlates of Evoked Cerebral Cortical Potentials," p. 1055-1061.

140 Theodore Millon, Modern Psychopathology: A Biosocial Approach to Maladaptive Learning and Functioning, Philadelphia, W. B. Saunders Co., 1970, p. 1-3.

the normal-dysthymic group but the relationship was not tested for significant differences.[141]

It could well be that the recovery measures as studied by Shagass and Schwartz cut across Eysenckian dimensions and provide support for the continuum theory of abnormal behavior.

The fact that no significant difference in recovery rate was found between normals and dysthymics is a puzzle. It is possible that the selection of normals was such that it yielded a majority of individuals at the introversion end of the Extraversion dimension. However, what appears more likely is that the methods and statistical tests used were not sensitive enough. Methodological approaches designated to "overcome the faults of previous investigations"[142] were applied to verify"previous results showing that the amplitude and recovery functions of averaged somatosensory cerebral evoked responses differ from normal in patients with psychotic depressions."[143] The differences among other psychiatric groups found with the earlier less refined measures were not rechecked. The new procedures appear to be increasing the sensitivity and power of the measure permitting more significant

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141 Shagass and Schwartz, "Cortical Reactivity in Psychotic Depressions," p. 235-242.

142 --------, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 806.

143 _Ibid_.

differences to be found.[144] Differences already found to be statistically significant would probably be found at an even higher level of statistical significance, and further differences, as perhaps between dysthymics and normals, could be pinpointed.

Sufficient variation among the normal groups appears to exist[145,146,147] in order to justify differences in the normal range. Further, with the improved methods, the outlook for positive results appears favorable. Other physiological measures such as EEG variations have proven to be effective in discriminating groups of normals according to the dimension of Extraversion.

Theoretically, one should expect differences in the earlier components of recovery measures between individuals classified along the dimension of Extraversion.

In his theory, Eysenck has tentatively associated the effects of the ARAS with internal excitation and the

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144 _Ibid_., p. 803-805.

145 Shagass and Schwartz, "Reactivity Cycle of Somatosensory Cortex in Humans with and without Psychiatric Disorders," p. 1757-1759.

146 --------, "Cortical Reactivity in Psychotic Depressions," p. 235-242.

147 --------, "Cerebral Responsiveness in Psychiatric Patients," p. 177-189.

effects of a thalamo-cortical mechanism with internal inhibition.[148] In the process of investigation of the Eysenckian theory, emphasis has shifted to arousal but Eysenck maintains that several findings are left unexplained by differences in arousal levels, arousal thresholds. He cites as examples of unexplained findings the phenomena of involuntary rest pauses, vigilance decrement and adaptation.[149]

In the work on recovery cycles, it has been found that different levels of arousal in the cat are associated with changes in the later components of the recovery measures, those corresponding to the period of supernormality or facilitatory period.[150] This period usually was delineated in the cat by beginning at an interstimulus separation of 50 msec.[151] Giving that phylogeny appears to decrease the latency of recovery cycle components,[152] effects of differential arousal levels in humans could perhaps be expected in the later components of the recovery curve as defined by Shagass and Schwartz, and for the relatively longer interstimulus intervals, perhaps those over 40 msec.

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148 Eysenck, <u>Biological Basis of Personality</u>, p. 158.

149 <u>Ibid</u>., p. 249.

150 <u>Ibid</u>., p. 248.

151 Schwartz and Shagass, "Observations of Somatosensory Cortical Reactivity in Personality Disorders," p. 17.

152 <u>Ibid</u>., p. 19.

Thus, one can deduce that different levels of arousal and arousal thresholds in the human should not affect the initial components of the recovery cycle but rather affect the later components corresponding to the period of supernormality, as has been found in the cat.[153]

It may be possible, then, to expect that the recovery function could yield two kinds of data.

Firstly, that recovery of initial components of the recovery curve could be an indication of the internal inhibition of the central nervous system; that these components are the resultant of action by the thalamo-cortical mechanism described by Eysenck[154] and that these components in some way are affected by the reticular activating system or some portion of it. These components would provide an indication of the "relative location" of the setting of the response level, and some elucidation of information transmission in the system.[155,156,157] Differences in this system could

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153 Ibid., p. 20.

154 Eysenck, Biological Basis of Personality, p. 249.

155 Schwartz and Shagass, "Observations of Somatosensory Cortical Reactivity in Personality Disorders," p. 20.

156 Charles Shagass and Marvin Schwartz, "Visual Cerebral Evoked Response Characteristics in a Psychiatric Population," American Journal of Psychiatry, Vol. 121, 1964-65, p. 986.

157 Shagass, Evoked Brain Potentials in Psychiatry, p. 127.

account for the performance of extraverts on vigilance tasks, reactive inhibition, involuntary rest pauses and habituation.

Secondly, the later components of the recovery curve could be an indication of the over-all states of alertness or arousal in the organism, the source of internal excitation for the central nervous system; these later components could be the results of action by the ascending reticular formation as described by Eysenck. Differences in these later components of the recovery curve could account for differential arousal in extraverts and introverts.

5. Formulation of Null Hypotheses.

In their latest work where improved equipment methodology and statistical analysis were all applied,[158,159] Shagass and Schwartz found that certain measures and peaks especially yielded highly significant differences.[160] In their numbering system for peaks,[161] employed in this study, peak 4 (amplitude), and the amplitude from peak 1 to peak 4

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158 Schwartz and Shagass, "Recovery Functions of Human Somatosensory and Visual Evoked Potentials," p. 510-525.

159 Shagass and Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 709-807.

160 Ibid., p. 804.

161 Shagass and Schwartz, "Visual Cerebral Evoked Response Characteristics in a Psychiatric Population," p. 981.

yielded results at the .001 level of significance.[162] Measurement of peak amplitude covered the first 120 msec of the recovery curve.

With these empirical findings in mind, adding the background derived from Eysenckian theory as well as the theorizing of Shagass, the following null hypotheses were formulated:

I. There is no significant difference between groups of Introverted, Middle and Extraverted subjects across all interstimulus intervals on measures of amplitude of peak 4 of the recovery function as operationally defined by Shagass.

II. There is no significant difference between groups of Introverted, Middle and Extraverted subjects across all stimulus intervals on measures of amplitude of peaks 1 - 4 of the recovery function as operationally defined by Shagass.

As a corollary to the work on recovery function later peaks, 6 and 7, will be tested specifically for significant differences. In their research Shagass and Schwartz have found some aspects related to these later peaks significantly different across certain psychiatric groups[163] and in Extraversion.[164] The activity in later components, which was tentatively identified as extralemniscal activity by

162 Shagass and Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 802.

163 Ibid.

164 Shagass, Evoked Brain Potentials in Psychiatry, p. 165.

Goff, was described as occurring after 60-70 msec. for the somatosensory evoked response.[165] This activity is labelled by him as component IV at 65-85 msec. Component IV of the Goff system appears to correspond to peaks 6 and 7 in the Shagass peak numbering system.[166]

The measure of amplitude for peaks 6 and 7 will be utilized since the effect of arousal can be predicted on the basis of work done.[167] Latency measures will also be utilized since it seems that variations in consciousness affect peak latency of later components, more specifically that impaired consciousness increases later component latency.[168]

III. There is no significant difference between groups of Introverted, Middle and Extraverted subjects for interstimulus intervals of 40 msec. to 120 msec. inclusive on measures of amplitude of peak 6 of the recovery function as operationally defined by Shagass.

IV. There is no significant difference between groups of Introverted, Middle and Extraverted subjects, for interstimulus intervals of 40 to 120.0 msec. inclusive on measures of amplitude for peak 7 of the recovery function as operationally defined by Shagass.

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165 Goff _et al._, _op. cit._, p. 711.

166 Shagass, _Evoked Brain Potentials in Psychiatry_, p. 51.

167 Schwartz and Shagass, "Effects of Different States of Alertness on Somatosensory and Auditory Recovery Cycles," p. 20.

168 Shagass, _Evoked Brain Potentials in Psychiatry_, p. 127.

V. There is no significant difference between groups of Introverted, Middle and Extraverted subjects for interstimulus intervals of 40 to 120.0 msec. inclusive on measures of latency of peak 6 of the recovery function as operationally defined by Shagass.

VI. There is no significant difference between groups of Introverted, Middle and Extraverted subjects for interstimulus intervals of 40 to 120.0 msec. inclusive for measures of latency of peak 7 of the recovery function as operationally defined by Shagass.

The experimental design, procedures and statistical techniques utilized to test these hypotheses are presented in chapter two.

CHAPTER II

EXPERIMENTAL DESIGN

This chapter presents the methodology of the experiment. It describes the subjects involved, the procedure employed for the classification of subjects into groups of low, middle, and high Extraversion, one of the independent variables of this study. The methods and instrumentation utilized in the collection of the measures of recovery from somatosensory stimulation, essentially the dependent variable, are specified. Treatment of the data and statistical analyses employed to test the hypotheses in chapter one are described.

1. The Subjects.

The subjects were thirty male students, whose ages ranged from 18 to 28 years, mean 20.8 years. From adolescence to the age of thirty, all peaks of the somatosensory recovery curve appear in the great majority of subjects.[1,2] All were undergraduate students at the University of Ottawa.

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1 Charles Shagass, "Evoked Potentials in Psychiatry," in Nathan S. Kline and Eugene Laska (eds.), <u>Computers and Electronic Devices in Psychiatry</u>, New York, Grune & Stratton, 1968, p. 144.

2 --------, <u>Evoked Brain Potentials in Psychiatry</u>, New York, Plenum Press, 1972, p. 90-91.

Sample selection proceeded in three stages. In the first stage, the initial sample of 117 volunteers was classified on the basis of scores obtained on the _Eysenck Personality Inventory_ (_EPI_), Form A.[3] The _EPI_ purports to measure two distinct and orthogonal personality dimensions, i.e., Extraversion-Introversion and Neuroticism-Stability. Two parallel forms of the test are available (Form A and Form B), each consisting of fifty-seven items to which the subject must answer true or false. A Lie scale is also included to pick out attempts on the part of subjects to answer the questions in a socially desirable manner. The validity and reliability data[4] presented in the manual appeared appropriate for use of the test in this study. The _EPI_ (Form A) appears in Appendix 1.

In the second stage, utilizing the normative data included in the _EPI_ manual, twenty subjects were classified as extreme introverts, 77 as middle, and 20 as extreme extraverts. The percentile scores for the introverts were all below the 16th; for the middle individuals, scores ranged from the 34th to the 78th percentile; and for the extraverts all scores were above the 91st percentile. In

3 H. J. Eysenck and S. B. G. Eysenck, _Manual for the Eysenck Personality Inventory_, San Diego, California, Educational and Industrial Testing Service, 1968, 5-57 p.

4 _Ibid_.

the third stage of the sample selection, groups of ten Introverted, 10 Middle, and 10 Extraverted subjects were selected at random within each subgroup of the initial sample of 117 subjects. Random selection was such that the average score on the Neuroticism dimension was as low as possible for each group. Means on Neuroticism for the Introverted, Middle and Extraverted groups were 9.00, 9.50 and 8.70, respectively.

These groups were designated as the Introverted group, the Middle group and the Extraverted group, respectively. For this experiment, subjects attended one 2-1/2 hour session, for which they were paid.

2. Instrumentation and Procedure.

The instrumentation and procedure are very closely based upon one evolved by Shagass and Schwartz and utilized recently by Shagass.[5,6]

The subjects were taken to a psychophysiological laboratory where their height was measured on a physician's scale, utilizing the height attachment. Height is considered

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5 Charles Shagass and Marvin Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," British Journal of Psychiatry, Vol. 12, 1966, p. 799-807.

6 Shagass, Evoked Brain Potentials in Psychiatry, xi-274 p.

by Shagass to be a possible variable in latency measures. Greater height would increase the time required for a sensory impulse to reach the sensory brain.[7] Groups of subjects in this research were to be checked for any statistically significant difference in height. The electrodes were placed on the median nerve of the right wrist. The median nerve was chosen because it was in this manner that the intensity-response curves were determined by Shagass and Schwartz,[8] and later used to gauge the intensity of stimulation to be utilized in experimentation.[9] Further, the median nerve was found to give larger, more distinct potentials.[10] The right wrist was chosen, regardless of the subject-reported handedness, in order to follow closely Shagass' procedure[11] and because the right hand projects less diffusely to the contralateral hemisphere than does the left hand.[12]

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7 Ibid., p. 55.

8 Marvin Schwartz, John W. Emde and Charles Shagass, "Comparison of Constant Current and Constant Voltage Stimulators for Scalp-recorded Somatosensory Responses," Electroencephalography and Clinical Neurophysiology, Vol. 17, 1964, p. 82.

9 Shagass and Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 800.

10 William R. Goff, Burton S. Rosner and Truett Allison, "Distribution of Somatosensory Evoked Responses in Normal Man," Electroencephalography and Clinical Neurophysiology, Vol. 14, 1962, p. 701

11 Shagass and Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 800.

12 Goff et al., op. cit., p. 710.

Gold electrodes were placed on the skin, 3 cm. apart (anode distal). A ground electrode was placed proximal to the cathode, 5.1 cm. from it. Recording EEG leads were placed in the parasaggital plane, 7 cm. left of the midline; the posterior lead was 2 cm. behind a line from the vertex to the external auditory meatus and the other was 6 cm. anterior to it. All electrodes were attached with collodion.

There is considerable controversy surrounding the use of either monopolar or bipolar recording leads. Bipolar electrodes were utilized to permit duplication of the procedures as developed by Shagass and Schwartz. Further, these authors compared results obtained in recovery work, by the use of bipolar and monopolar leads. They conclude that bipolar leads provide greater localization power and "reduce the extent to which undesired biological signals such as muscle potentials are picked up."[13] The work of Goff *et al*. has also shown that the distribution of somatosensory evoked potentials in man is such that the lead placement as used by Shagass and Schwartz in effect gives monopolar derivation of early components since the anterior lead would be inactive for these early components; "for

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13 Marvin Schwartz and Charles Shagass, "Recovery Functions of Human Somatosensory and Visual Evoked Potentials," Annals of the New York Academy of Sciences, Vol. 112, 1964, p. 514-515.

later components, the anterior lead would then be active and the derivation bipolar."[14,15] Because records derived from monopolar and bipolar leads differ in their components[16] and because the purpose of this research is to extend the work of Shagass and Schwartz, bipolar recording leads were utilized.

The subjects were introduced to the subject room, separated from the apparatus for the measurement of somatosensory responses. The subject room, measuring 7-1/2 by 8 feet, was kept at an average of 73.2°F and was connected to the apparatus room by an intercom system for communication during the determination of sensory threshold, and throughout the experiment when necessary. The subject was seated in a well-padded chair with adjustable padded arm-rests, instructed to relax but remain alert, and to refrain from moving or speaking during the course of the experiment. The subject was told that no painful stimuli would be presented.

Sensory threshold was then determined. Pulses were presented in gradually ascending magnitude until the subject

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14 Goff et al., op. cit., p. 709.

15 W. R. Goff, Y. Matsumiya, Truett Allison and G. D. Goff, "Cross-modality Comparisons of Averaged Evoked Potentials," in Averaged Evoked Potentials: Methods, Results and Evaluations, a conference held at San Francisco, California, September 10-12, 1968, Washington, D.C., National Aeronautics and Space Administration, 1969, p. 98.

16 Shagass, Evoked Brain Potentials in Psychiatry, p. 53.

reported sensation. The pulses were then presented in gradually descending magnitude, beginning from a level slightly higher than the previously reported level, until the subject reported no sensation. This procedure was repeated five times; the sensory threshold used in the experiment was the mean of the five ascending and five descending determinations.

The EEG was amplified by a Mousseau Scientific Instruments differential amplifier, Model SA4, with a frequency response of .1 to 5K Hz. The gain on the amplifier was set at 36,700 times to give a full-scale deflection of 28 microvolts on display scale 2 of the Enhancetron. The evoked responses were averaged by a Nuclear Data Inc. Model ND-800 Enhancetron 1024; on display scale 2, analysis time to store 512 data points was 250 msec. During the first part of the stimulus sequence, responses for the unpaired stimuli (R_1) were stored in one channel of the computer on the first sweep. On the following sweep, in the same computer channel, the responses to the paired stimuli (R_1+R_2) were subtracted from the preceding sweep [$R_1-(R_1+R_2)$]. An alternate add and subtract mode is a feature of the Enhancetron. This automatic subtraction procedure permits independent visualization of R_2. This method is felt by Shagass to "represent the best available approximation of the response to the second stimulus which would otherwise not be visible with brief interstimulus intervals."[17] In the second part of the stimulus sequence, in the other computer channel and in opposite polarity, responses to a series of unpaired stimuli (R_1), given after the first series of paired and unpaired stimuli, were stored. The responses were written out with a H.P. Mosley 7035A X-Y Recorder. The relative positivity at the posterior recording lead gave upward deflections on the plotted traces.

Somatosensory responses were evoked by stimulating the right median nerve. The stimulus was a pulse of 0.1 msec. duration at an intensity of 10 ma. above the subject's sensory threshold. "This intensity is nearly always on the asymptotic portion of the intensity-response curve."[18] The source of the pulse was a constant-current stimulator, designed and manufactured by the technical staff in the laboratory of the Department of General Experimental Psychology, Faculty of Psychology, University of Ottawa. The onset of the stimuli was controlled by a Lafayette Model 5431A, eight bank timer programmed to give pseudorandom time intervals between stimuli averaging one second and ranging from

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17 Charles Shagass and A. Canter, "Cerebral Evoked Responses and Personality," in V. D. Nebylitsyn and J. A. Gray (eds.), Biological Basis of Individual Behavior, New York, Academic Press, 1972, p. 112. (Underlining writer's.)

18 Shagass and Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 800.

800 to 1200 msec. Time delay between paired stimuli was built into the stimulator, and presentation of a single or double pulse was controlled by the Enhancetron. The nineteen interstimulus intervals between paired stimuli were presented in a random order, independently determined for each subject; these time intervals were set at 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0, 25.0, 30.0, 40.0, 50.0, 60.0, 70.0, 80.0, 90.0, 100.0, 110.0, 120.0 msec., ± 2%, respectively.

Each stimulus sequence involved two parts. The first part involved alternate presentation of an unpaired (R_1) and a paired stimulus (R_2) until fifty each, i.e., fifty paired and fifty unpaired stimuli, had been administered. The second part of the stimulus sequence involved presentation of fifty unpaired stimuli (R_1) at the same average repetition rate of approximately one per second. This procedure became necessary since, during a pilot study, it was found that the baseline of the Enhancetron was unstable on dual overlap and that a loss of data could occur with very minor variations in baseline. Simultaneous storage of R_1 values in two channels of the Enhancetron thus became risky. Therefore, although the R_1 utilized for the subtraction procedure is identical with the R_1 utilized by Shagass for this same procedure, the R_1 utilized to carry out the statistical adjustments to the R_2 values were not identical to those utilized by Shagass. The R_1 values used in the subtraction procedure, as in Shagass' work, are those R_1 presented in the first part of the stimulus sequence and thus those immediately adjacent in time but preceding the R_2 (paired) stimuli. The R_1 values used for the adjustment of the R_2 values were obtained in the second part of the stimulus sequence, a procedure differing from Shagass' as a result of the technical limitations of the Enhancetron.

Shagass found that habituation did occur for R_1 values over the course of the testing session but that "although statistically significant, they were relatively slight." Shagass suggests that because the interval between the paired stimuli was systematically lengthened in their experiments as the recording session progressed, "it is possible that the greater proximity of the second stimulus to the succeeding unpaired stimuli was responsible for this observed decrement."[19] In this study, the R_1 values plotted out are not identical to the R_1 values plotted out by Shagass, since the presentation of fifty unpaired stimuli became necessary in a second part of each stimulus sequence to obtain a trace for R_1 values. Thus, habituation in this study, if any, cannot be ascribed to the increasing proximity to the second of the paired stimuli. Further, habituation

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19 Shagass, Evoked Brain Potentials in Psychiatry, p. 131.

was minimized by the following procedures: rather than sequential presentation of interstimulus intervals, as did Shagass and Schwartz with 2.5, 5.0, 7.5, and so on, being presented in a set order, the presentation of the nineteen interstimulus intervals was randomized independently for each subject; paired and unpaired stimulus repetition rate averaged one per second, thus was aperiodic; relatively naïve subjects were used (having participated in only one previous experiment, from which experiment the writer obtained the subject scores on the EPI, Form B, and on the Otis Higher Examination, Form A); frequent rest periods were given. Rest periods occurred between stimulus sequences while the response traces were plotted out, and lasted approximately two to three minutes. These measures are suggested by Perry and Childers[20] and Shagass[21] to minimize habituation.

The EEG and stimulus pulses were constantly monitored on a Telequipment Oscilloscope Model D52. The averaged evoked responses were monitored on a Fairchild Oscilloscope Model 708A. System diagram is shown in Figure 1.

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20 N. W. Perry and D. G. Childers, The Human Visual Evoked Response; Method and Theory, Springfield, Ill., Charles C. Thomas, 1969, as quoted in Shagass, Evoked Brain Potentials in Psychiatry, p. 131.

21 Shagass, Evoked Brain Potentials in Psychiatry, p. 131.

SYSTEM DIAGRAM

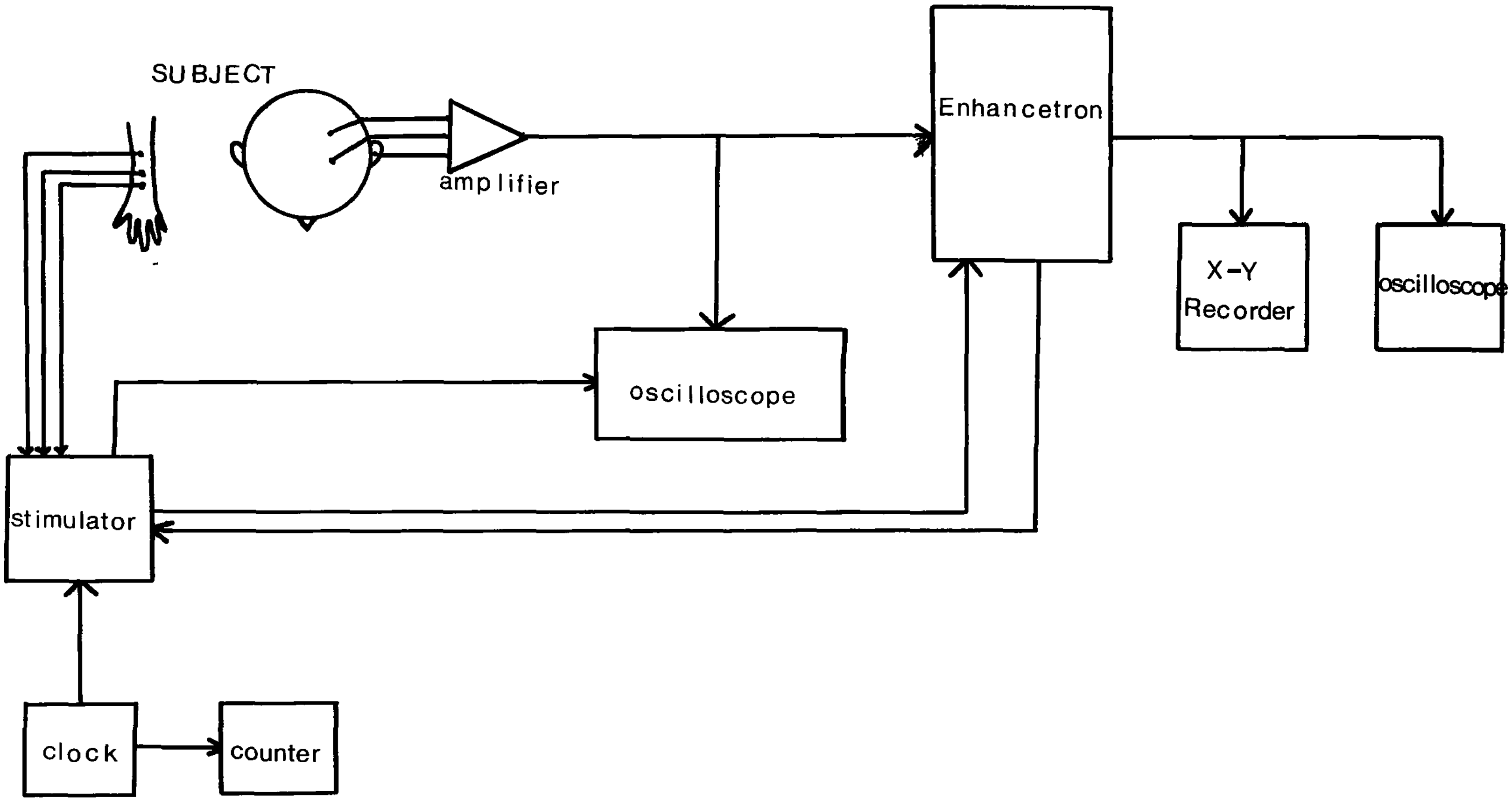

Figure I

3. Summary of the Experimental Procedure.

The subjects were introduced to a laboratory where their height was measured and electrodes were applied. They were then taken to the subject room and instructed to relax, remain alert, and refrain from moving or speaking during the course of the experiment. They were told that no painful stimuli would be presented. The sensory threshold for each subject was then determined.

Before beginning the stimulus sequences, each subject was given three sample stimuli to minimize the startle response found in naïve subjects.[22] The stimulus sequences were then begun with alternate presentation of an unpaired and a paired stimulus until fifty each had been presented. Then a series of fifty unpaired stimuli was presented and the stimulus sequence was then complete. Graphs of R_1 and R_2 data were then plotted out. This procedure was repeated for the nineteen interstimulus intervals, presented in a random order independently determined for each subject.

4. Treatment of the Data and Statistical Analysis.

Beginning with the initial negative peak, ten sequential evoked response peaks, consistent both within and

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22 Goff, Matsumiya, Allison, Goff, op. cit., p. 112.

between subjects were identified for R_1 and R_2 records. Among the records scored were duplicates of fifty randomly selected R_1 records and fifty randomly selected R_2 records. These duplicate records were used for computation of Pearson correlation coefficients to provide estimates of scorer reliability in the peak numbering task. Independent reliability estimates were computed for each peak involved in the null hypotheses, more specifically for peaks 1, 4, 6 and 7. The scorer was not aware of the identity of any one subject, although all records from one subject were kept together.

The main criteria used in peak identification were those of Shagass: "their latency and consistency from one record to another in a given subject,"[23] and a table of latencies (mean, standard deviation) for somatosensory response measurements in non-patients.[24]

For peaks 4, 6 and 7, amplitude in terms of deviation from a system isoelectric line was measured. A registration bar was utilized to hold the records and the translar film overlay (on which the isoelectric lines for R_1 and R_2 were inscribed) in place so that accurate amplitude determination

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23 Shagass and Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 801.

24 Shagass, Evoked Brain Potentials in Psychiatry, p. 52.

could be made. Where the system isoelectric line disagreed blatantly with the data, an estimated isoelectric line was utilized for amplitude measurement for that record.[25] Amplitudes were converted into microvolts. The peak-to-peak amplitude from peak 1 - peak 4 was also measured and converted to microvolt values.

Latency, in terms of time of occurrence after the stimulus onset, was measured for peaks 6 and 7, respectively. A template was made for each interstimulus interval. These templates were obtained by averaging the interval pulses in the Enhancetron. This procedure decreased the error to $\pm$ .5%. The interstimulus intervals, as measured by this procedure were: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 16.3, 20.0, 25.0, 30.0, 40.0, 50.0, 58.8, 68.0, 77.5, 87.5, 97.5, 105.0 and 118.0 msec., respectively. These real values for latency were utilized for the measurement of latencies of peaks 6 and 7, and for the determination of stimulus onset for the second of the paired stimuli (R_2) in the $[R_1-(R_1+R_2)]$ averaged stimulus sequences. These templates were inscribed on translar film overlay and were held fast to the record being scored at any one time by a registration bar.

25 Recommendation from Dr. Charles Shagass, personal communication.

Thus, interstimulus intervals 2.5 to 30.0, inclusive, yielded two amplitude measures (peaks 4, and 1 - 4) for each of R_1 and R_2; interstimulus intervals 40.0 to 120.0, inclusive, yielded four amplitude measures (peaks 4, 1 - 4, 6 and 7), and two latency measures (peaks 6 and 7) for each of R_1 and R_2. There were 158 measures per subject, or a total of 4,740 measures obtained from 1,040 R_1 and R_2 records. These were utilized to test the null hypotheses outlined in Section 4 of chapter one.

Since R_1 and R_2 are significantly correlated,[26] the R_2 data required special processing before being submitted to analysis to test the null hypotheses.

For amplitude, the within-group regression equation was obtained for R_1 and R_2 for each interstimulus interval. For peaks 4, and 1 - 4, regression equations were calculated for each interstimulus interval; for peaks 6 and 7, within-groups regression equations were calculated for interstimulus intervals 40.0 to 120.0 msec., inclusive. The equations were then used to calculate the predicted value of the individual R_2 peak amplitudes; the values then obtained and utilized for analyses were the deviations of the actually obtained individual R_2 values from the predicted individual R_2 values.

26 Shagass and Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 801.

Shagass suggested this manner of correction for covariance with R_1 values, as a more conservative procedure.[27]

For latency, the correction of R_2 values was achieved differently. Shagass feels that a covariance correction of R_2 values for their correlation with R_1 values likely leads to spurious results and recommends as the best procedure to "simply subtract the R_1 latency from the R_2 latency."[28] Latency for peaks 6 and 7, respectively, were so corrected for R_2 values of interstimulus intervals 40.0 to 120.0 msec., inclusive.

The adjusted amplitude and latency R_2 values so obtained "depict variations in responsiveness to the second stimulus that were independent of the varying responsiveness to the first."[29]

The adjusted R_2 values were subjected to Type I analysis of variance for "mixed" designs,[30] to determine main effects: personality along the Extraversion dimension, and interactions between interstimulus intervals and the

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27 Dr. Charles Shagass, personal communication.

28 Ibid.

29 Shagass and Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 801.

30 Everet Franklin Lindquist, Design and Analysis of Experiments in Psychology and Education, Boston, Houghton Mifflin, 1956 (2nd ed.), p. 267-273.

personality variable. For each peak a separate analysis was computed for the amplitude measurements. For peaks 4, and 1 - 4, respectively, the analyses were oomputed across all interstimulus intervals; degrees of freedom were corrected for the regression coefficients estimated. One degree of freedom was removed from the error for between-subjects variance and the error variance within-subjects was reduced by eighteen degrees of freedom.[31] For peaks 6 and 7, respectively, the analyses for R_2 amplitude values were computed across interstimulus intervals 40.0 to 120.0 msec., inclusive; degrees of freedom were also adjusted for each regression coefficient estimated, with one degree of freedom removed from the error for between-subjects variance and eight degrees of freedom removed from the error variance for within-subjects.

The adjusted R_2 latency measures for peaks 6 and 7 were respectively subjected to a Type I analysis of variance for mixed designs, across interstimulus intervals 40.0 to 120.0 msec., inclusive.

Should these procedures yield over-all significant differences at the .05 level or above, the post hoc procedure

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31 Shagass and Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 801.

employed would be the Tukey test,[32] again set at the .05 level of significance.

In the following chapter, the results of this study are presented and discussed.

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32 A. L. Edwards, <u>Statistical Methods for the Behavioral Sciences</u>, New York, Rinehart, 1954, p. 330-331.

CHAPTER III

PRESENTATION AND DISCUSSION OF RESULTS

This chapter presents the results of the statistical analyses of the data and their interpretation in the light of the theoretical background and hypotheses outlined in chapter one.

1. Presentation of Results.

A. Selection Data for Groups of Introverted, Middle and Extraverted Subjects

An initial sample of 117 subjects was classified on the basis of scores on the Eysenck Personality Inventory (EPI), Form A; twenty subjects were classified as Introverted, 77 as Middle and 20 as Extraverted. Groups of ten Introverted, 10 Middle and 10 Extraverted subjects were selected in a random fashion within each subgroup of the initial sample of 117 subjects, such that the average scores on the Neuroticism dimension were as low as possible for each group. The means of the Extraversion and Neuroticism dimensions for the total population of 117 subjects were 12.43 and 10.28, respectively, whereas the means of the Extraversion and Neuroticism dimensions for the total sample of thirty subjects were 12.10 and 9.067, respectively. The means of the Extraversion dimension for the ten Introverted, 10 Middle and 10 Extraverted subjects were 5.8, 12.7 and 17.8, respectively (Table I). The Tukey test applied to the sample data indicated that for the Extraversion dimension, each of the three groups differed significantly from each other ($p < .001$). The analysis of variance results are presented in Table II. Tukey q values are presented in Table III.

While the three sample groups differed significantly from each other on the Extraversion dimension, they did not differ significantly for Neuroticism, age, height nor IQ scores as measured by the Otis (Higher Examination, Form A). A one-way analysis of variance model used to analyze the data for each of the above-mentioned factors yielded no significant differences between groups. Means and standard deviation values for the Neuroticism factor are presented in Table I; means and standard deviation values for age, height and IQ values are presented in Table IV. Analysis of variance results for the Neuroticism, age, height and IQ scores are presented in Tables V, VI, VII and VIII.

A Pearson "r" coefficient computed between EPI (Form A) and EPI (Form B) for the thirty subjects of the sample yielded a reliability estimate of .784.

The three sample groups did not differ in the time of day of the experimental session since four from each

Table I.-

EPI (Form A) Score Distribution on Extraversion(E) and Neuroticism(N) for the Total Population Group, Total Sample Group and Introverted, Middle and Extraverted Groups.

Group	N	(E)		(N)	
		Mean	SD	Mean	SD
Total population group	117	12.43	3.98	10.28	4.88
Total sample group	30	12.10	5.142	9.067	3.52
Introverted group	10	5.80	.98	9.00	4.38
Middle group	10	12.70	1.55	9.50	3.17
Extraverted group	10	17.80	.87	8.70	2.53

Note: The EPI scores for the Introverted, Middle and Extraverted subjects are given in Appendix 2.

Table II.-

Analysis of Variance of the Extraversion (EPI, Form A) Scores for Groups of Introverted, Middle and Extraverted Subjects.

Source of Variation	SS	df	MS	F Ratio
Between subjects	725.4	2	362.7	237.12
Within subjects	41.3	27	1.53	
Total	766.7	29		

$F_{.95}(2,27) = 3.35$

Table III.-

Q Values Obtained on the Tukey *Post Hoc* Test for Extraversion(E) Dimension for Introverted(I), Middle(M) and Extraverted(E) Groups on the *EPI* (Form A).

Dimension	Group	I	M	E
	I			
E	M	-30.682*		
	E	-17.642*	13.040*	

$q_{99\%}(3,27) = 4.5005$

$q_{99.5\%}(3,27) = 4.898$

*p < .005

Table IV.-

Mean and Standard Deviation Values for Groups of Introverted, Middle and Extraverted Subjects on Age, Height and IQ Measurements.

Group	N	Age (years)		Height (in.)		IQ	
		Mean	SD	Mean	SD	Mean	SD
Introverted	10	21.5	3.41	69.62	2.35	119.4	5.39
Middle	10	21.0	2.49	68.83	1.72	115.1	5.49
Extraverted	10	20.0	1.73	70.12	2.52	120.3	5.71

Note: Raw data for age, height and *Otis* IQ scores for groups of Introverted, Middle and Extraverted subjects are given in Appendix 2.

Table V.-

Analysis of Variance of the Neuroticism (EPI, Form A) Scores for Groups of Introverted, Middle and Extraverted Subjects.

Source of Variation	SS	df	MS	F Ratio
Between subjects	3.267	2	1.634	.124
Within subjects	356.6	27	13.207	
Total	359.9	29		

$F_{.95}(2,27) = 3.35$

Table VI.-

Analysis of Variance of Age (to the nearest six months) for Groups of Introverted, Middle and Extraverted Subjects.

Source of Variation	SS	df	MS	F Ratio
Between subjects	11.67	2	5.84	.755
Within subjects	208.50	27	7.72	
Total	220.17	29		

$F_{.95}(2,27) = 3.35$

Table VII.-

Analysis of Variance of Height Measurement for Groups of Introverted, Middle and Extraverted Subjects.

Source of Variation	SS	df	MS	F Ratio
Between subjects	8.46	2	4.23	.771
Within subjects	148.11	27	5.49	
Total	156.57	29		

$F_{.95}(2,27) = 3.35$

Table VIII.-

Analysis of Variance of *Otis* (*Higher Examination*, *Form A*) IQ Scores for Groups of Introverted, Middle and Extraverted Subjects.

Source of Variation	SS	df	MS	F Ratio
Between subjects	154.47	2	77.23	2.27
Within subjects	917.40	27	33.98	
Total	1071.87	29		

$F_{.95}(2,27) = 3.35$

group were tested in the morning, three from each group in the noon hours, and three from each group in the afternoon. There is some indication that time of day could affect aspects of the evoked potential data.[1]

B. Reliability of Recovery, and Somatosensory Threshold Data

Reliability of peak numbering was arrived at by duplicating randomly selected R_1 and R_2 records and numbering peaks in effect twice over for these records, once for the original and once for the duplicate. The latencies of the peaks from stimulus onset were then measured. These measurements served for the calculation of scorer reliability in numbering peaks. The reliability of peak 1 was .94, of peak 4 was .91, of peak 6 was .68, and of peak 7 was .75 as per the Pearson "r" coefficient. As described in chapter two, the instrumentation was set at a ± 2% accuracy. The system noise was less than 0.3μv. The measuring procedures brought the errors to ± 0.5%. Reliability within one individual across all interstimulus intervals to produce the peaks utilized in the analyses was not numerically estimated. However, Shagass has shown that recovery curves had a very

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1 G. R. Henninger, R. K. McDonald, W. R. Goff and A. Sollberger, "Diurnal Variations in the Cerebral Evoked Responses and EEG: Relations to 14 Hydroxycorticosteroid Levels," Archives of General Psychiatry, Vol. 15, 1969, p. 418-426.

high degree of stability over a few hours or a few months apart.[2] In this study, it appeared that high intraindividual stability also existed.

The mean thresholds in milliamps for the somatosensory modality for the Introverted, Middle and Extraverted groups were .967, 1.38 and 1.20, respectively. The over-all mean was 1.18 ma. The analysis of variance yielded an F ratio which was not statistically significant for the Extraversion factor. These results are shown in Table IX.

C. Recovery Data for Peak 4 and Peak 1 - 4 Measurements

The mean corrected R_2 amplitudes in μv for the Introverted, Middle and Extraverted groups across all interstimulus intervals for peak 4 were -.236, .073 and .217, respectively. The over-all mean corrected R_2 amplitude in μv for peak 4 was .018. The results are shown in Table X, along with R_1 and uncorrected R_2 data for peak 4.

The analysis of variance yielded F ratios which were not statistically significant for the Extraversion factor nor

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2 Marvin Schwartz and Charles Shagass, "Effect of Different States of Alertness on Somatosensory and Auditory Recovery Cycles," Electroencephalography and Clinical Neurophysiology, Vol. 14, 1962, p. 16; and Charles Shagass and Marvin Schwartz, "Excitability of the Cerebral Cortex in Psychiatric Disorders," in Robert Roessler and Norman S. Greenfield (eds.), Physiological Correlates of Psychological Disorder, Madison, University of Wisconsin Press, 1962, p. 56.

Table IX.-

Analysis of Variance of Thresholds in Milliamps to Somatosensory Stimulation for Groups of Introverted, Middle and Extraverted Subjects.

Source of Variation	SS	df	MS	F Ratio
Between subjects	.869	2	.434	2.716
Within subjects	4.317	27	.1599	
Total	5.186	29		

$F_{.95}(2,27) = 3.35$

R_2 INTERSTIMULUS INTERVAL 40 MSEC.

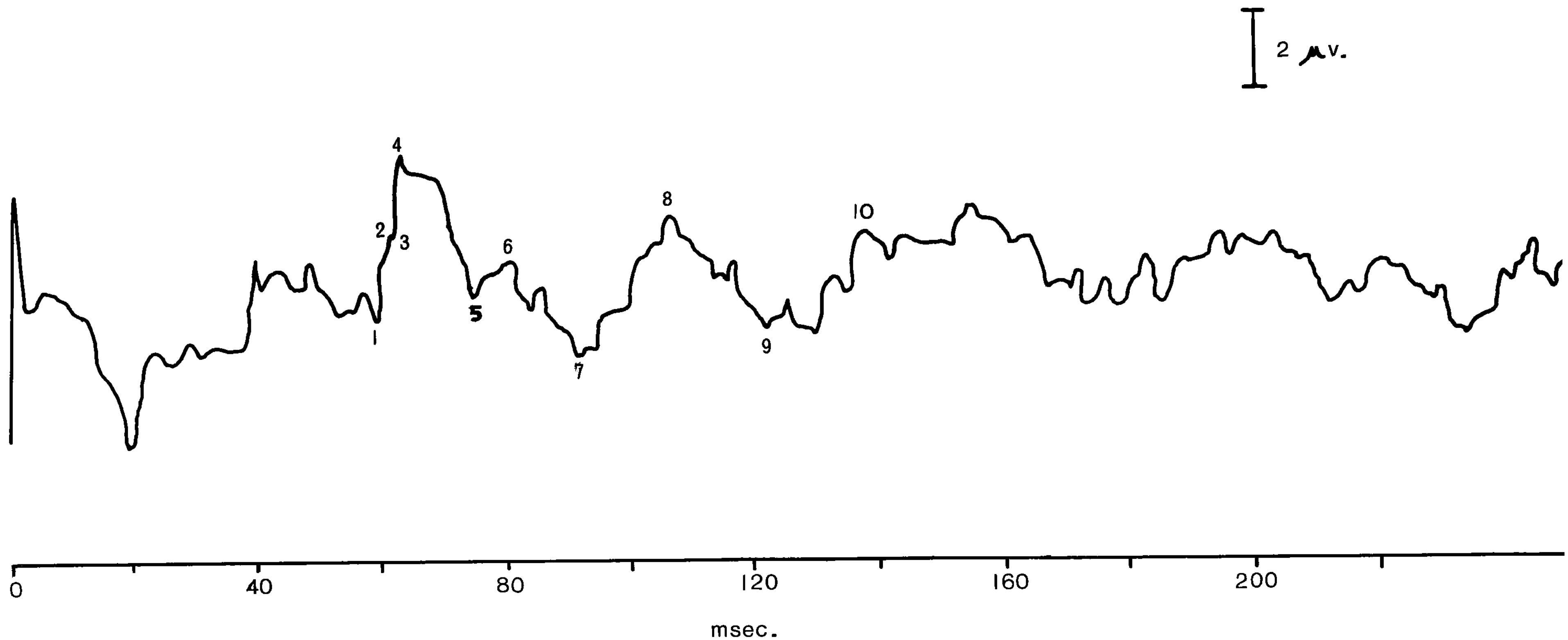

FIGURE 2

Table X.-

Mean μv Amplitudes for Peak 4 for Groups of Introverted(I), Middle(M) and Extraverted(E) Subjects.

Data	Group I	Group M	Group E	Mean over all groups
R_1	3.19	4.11	5.32	4.21
Uncorrected R_2	2.05	1.96	2.779	2.26
Corrected R_2*	- .236	.073	.217	.018

Note: The R_1, uncorrected R_2 and corrected R_2 amplitudes for peak 4 for the Introverted, Middle and Extraverted groups are given in Appendix 3.

*Corrected R_2 is the deviation of the obtained individual R_2 amplitude from the predicted R_2 amplitude as per the within groups regression equation for each interstimulus interval. See chapter two.

for the interaction of Extraversion and interstimulus interval. The results of the analysis for peak 4 are shown in Table XI.

The mean corrected R_2 amplitudes in μv for the Introverted, Middle and Extraverted groups across all interstimulus intervals for peak 1 - 4 measurements were -.087, -.063 and .149, respectively. The over-all mean corrected R_2 amplitude in μv was -.0003. These results are shown in Table XII along with R_1 and uncorrected R_2 data for peak 1 - 4 measurements.

The analysis of variance yielded F ratios which were not statistically significant for the Extraversion factor nor for the interaction of Extraversion and interstimulus interval. The results of the analysis of variance are shown in Table XIII.

Therefore, the first two null hypotheses outlined in chapter one are not rejected. These hypotheses are:

I. There is no significant difference between groups of Introverted, Middle and Extraverted subjects across all interstimulus intervals on measures of amplitude of peak 4 of the recovery function as operationally defined by Shagass.

II. There is no significant difference between groups of Introverted, Middle and Extraverted subjects across all interstimulus intervals on measures of amplitude of peaks 1 - 4 of the recovery function as operationally defined by Shagass.

Table XI.-

Analysis of Variance of Corrected R2 μv Amplitudes, for Peak 4, across Interstimulus Intervals 2.5 to 120 msec. Inclusive for Introverted, Middle and Extraverted Groups.

Source of Variation	SS	df	MS	F Ratio
Between subjects				
A (Extraversion)	22.903	2	11.451	1.497
Subjects within groups	198.844	26	7.648	
Within subjects				
B (Interstimulus intervals)	.317	18	.018	.013
AB	44.483	36	1.236	.088
B X Subjects within groups	655.960	468	1.402	

Table XII.-

Mean μv Amplitudes for Peak 1 - 4 Measurements for Introverted(I), Middle(M) and Extraverted(E) Groups.

Data	Group I	Group M	Group E	Mean over all groups
R_1	7.26	7.19	7.45	7.30
Uncorrected R_2	4.23	3.48	4.15	3.96
Corrected R_2	-.087	-.063	.149	-.0003

Note: The R_1, uncorrected R_2 and corrected R_2 amplitudes for peak 1 - 4 measurements for the Introverted, Middle and Extraverted groups are given in Appendix 3.

Table XIII.-

Analysis of Variance of Corrected R_2 μv Amplitudes for Peak 1 - 4, across Interstimulus Intervals 2.5 to 120 msec. Inclusive for Introverted, Middle and Extraverted Groups.

Source of Variation	SS	df	MS	F Ratio
Between subjects				
A (Extraversion)	8.218	2	4.109	.259
Subjects within groups	413.054	26	15.887	
Within subjects				
B (Interstimulus intervals)	2.370	18	.132	.061
AB	46.642	36	1.296	.573
B X Subjects within groups	1057.667	468	2.260	

D. Recovery Data for Peaks 6 and 7 Amplitude

The mean corrected R_2 amplitudes in μv for the Introverted, Middle and Extraverted groups across interstimulus intervals 40.0 to 120 msec., inclusive, for peak 6 were -.401, .671 and -.015, respectively. The over-all corrected R_2 amplitude in μv was .085. These results are shown in Table XIV along with the R_1 and uncorrected R_2 data for peak 6.

The analysis of variance yielded F ratios which were not statistically significant for either the Extraversion factor or for the interaction of Extraversion and interstimulus intervals. The results of the analysis of variance are shown in Table XV.

The mean corrected R_2 amplitudes in μv for Introverted, Middle and Extraverted groups across interstimulus intervals 40.0 to 120 msec., inclusive, for peak 7 were .032, .189 and -.061, respectively. The over-all corrected R_2 amplitude in μv was .053. These results are shown in Table XVI along with R_1 and uncorrected R_2 data for peak 7.

The analysis of variance yielded F ratios which were not found to be statistically significant for the Extraversion factor nor for the interaction of Extraversion and interstimulus intervals. The results of the analysis of variance are shown in Table XVII.

Table XIV.-

Mean μv Amplitudes for Peak 6 for Groups of Introverted(I), Middle(M) and Extraverted(E) Subjects.

Data	Group I	Group M	Group E	Mean over all groups
R_1	2.080	3.483	4.321	3.295
Uncorrected R_2	.690	2.146	2.039	1.625
Corrected R_2	-.401	.671	-.015	.085

Note: The R_1, uncorrected R_2 and corrected R_2 amplitudes for peak 6 for Introverted, Middle and Extraverted groups are given in Appendix 3.

Table XV.-

Analysis of Variance of Corrected R_2 μv Amplitudes, for Peak 6, across Interstimulus Intervals 40.0 to 120.0 msec. Inclusive for Introverted, Middle and Extraverted Groups.

Source of Variation	SS	df	MS	F Ratio
Between subjects				
A (Extraversion)	51.173	2	25.587	2.201
Subjects within groups	302.249	26	11.625	
Within subjects				
B (Interstimulus intervals)	.685	8	.086	.043
AB	12.453	16	.778	.376
B X Subjects within groups	428.389	207	2.069	

Table XVI.-

Mean μv Amplitudes for Peak 7 for Groups of Introverted(I), Middle(M) and Extraverted(E) Subjects.

Data	Group I	Group M	Group E	Mean over all groups
R_1	-.578	-.282	1.643	.449
Uncorrected R_2	-.967	-.647	-.932	-.849
Corrected R_2	.032	.189	-.061	.053

Note: The R_1, uncorrected R_2 and corrected R_2 amplitudes for peak 7 for Introverted, Middle and Extraverted groups are given in Appendix 3.

Table XVII.-

Analysis of Variance of Corrected R_2 μv Amplitudes, for Peak 7, across Interstimulus Intervals 40.0 to 120.0 msec. Inclusive for Introverted, Middle and Extraverted Groups.

Source of Variation	SS	df	MS	F Ratio
Between subjects				
A (Extraversion)	22.689	2	11.344	1.359
Subjects within groups	217.010	26	8.347	
Within subjects				
B (Interstimulus intervals)	1.156	8	.144	.067
AB	43.397	16	2.712	.065
B X Subjects within groups	462.955	207	2.237	

Consequently, the second two null hypotheses outlined in chapter one are not rejected. These hypotheses are:

III. There is no significant difference between groups of Introverted, Middle and Extraverted subjects for interstimulus intervals of 40.0 to 120.0 msec. inclusive on measures of amplitude of peak 6 of the recovery function as operationally defined by Shagass.

IV. There is no significant difference between groups of Introverted, Middle and Extraverted subjects for interstimulus intervals of 40.0 to 120.0 msec. inclusive on measures of amplitude for peak 7 of the recovery function as operationally defined by Shagass.

E. Recovery Data for Peaks 6 and 7
Latency

The mean corrected R_2 latencies in msec. for the Introverted, Middle and Extraverted groups across interstimulus intervals 40.0 to 120 msec. inclusive for peak 6 were .276, -.896 and .598, respectively. The over-all corrected R_2 msec. latency was -.007. These results are shown in Table XVIII along with R_1 and uncorrected R_2 data for peak 6 on latency.

The analysis of variance yielded F ratios which were not statistically significant for either the Extraversion factor or for the interaction of Extraversion and interstimulus intervals. However, the interstimulus factor was found to be significant. The results for the analysis of variance are shown in Table XIX.

Table XVIII.-

Mean msec. Latency for Peak 6 for Groups of Introverted(I), Middle(M) and Extraverted(E) Subjects.

Data	Group			Mean over all groups
	I	M	E	
R_1	39.082	40.670	38.603	39.452
Uncorrected R_2	39.553	39.937	39.234	39.575
Corrected R_2	.276	-.896	.598	-.007

Note: The R_1, uncorrected R_2 and corrected R_2 latencies for peak 6 for Introverted, Middle and Extraverted groups are given in Appendix 3.

Table XIX.-

Analysis of Variance of Corrected R_2 msec. Latencies, for Peak 6, across Interstimulus Intervals 40.0 to 120 msec. Inclusive for Introverted, Middle and Extraverted Groups.

Source of Variation	SS	df	MS	F Ratio
Between subjects				
A (Extraversion)	59.639	2	29.820	.762
Subjects within groups	1056.063	27	39.113	
Within subjects				
B (Interstimulus intervals)	317.123	8	39.640	3.3499*
AB	144.537	16	9.034	.763
B X Subjects within groups	2555.974	216	11.833	

$F_{.99}(8,216) = 2.596$

*p $\leq$ .001

The mean corrected R_2 msec. latencies for peak 7 for Introverted, Middle and Extraverted groups across interstimulus intervals 40.0 to 120.0 msec. inclusive were -.822, -3.36 and -1.174, respectively. The over-all corrected R_2 msec. latency was -1.785. These results are shown in Table XX along with R_1 and uncorrected R_2 latency data for peak 7.

The analysis of variance yielded F ratios which were not statistically significant for the Extraversion factor and for the interaction of Extraversion and interstimulus intervals. The results of the analysis of variance are shown in Table XXI.

Therefore, the last null hypotheses outlined in chapter one are not rejected. These hypotheses are:

V. There is no significant difference between groups of Introverted, Middle and Extraverted subjects for interstimulus intervals 40.0 to 120 msec. inclusive of measures of latency of peak 6 of the recovery function as operationally defined by Shagass.

VI. There is no significant difference between groups of Introverted, Middle and Extraverted subjects for interstimulus intervals of 40.0 to 120.0 msec. inclusive on measures of latency for peak 7 of the recovery function as operationally defined by Shagass.

Consequently, from the analyses performed, no significant differences were found for peaks 4, 1 - 4, 6 and 7, and none of the null hypotheses is rejected.

Table XX.-

Mean msec. Latency for Peak 7 for Groups of Introverted(I), Middle(M) and Extraverted(E) Subjects.

Data	Group			Mean over all groups
	I	M	E	
R_1	46.520	50.659	47.736	48.305
Uncorrected R_2	46.004	47.731	46.754	46.830
Corrected R_2	-.822	-3.360	-1.174	-1.785

Note: The R_1, uncorrected R_2 and corrected R_2 latencies for peak 7 for Introverted, Middle and Extraverted groups are given in Appendix 3.

Table XXI.-

Analysis of Variance of Corrected R_2 msec. Latencies, for Peak 7, across Interstimulus Intervals 40.0 to 120.0 msec. Inclusive for Introverted, Middle and Extraverted Groups.

Source of Variation	SS	df	MS	F Ratio
Between subjects				
A (Extraversion)	230.817	2	115.409	1.504
Subjects within groups	2072.106	27	76.745	
Within subjects				
B (Interstimulus intervals)	273.081	8	34.135	1.865
AB	156.280	16	9.768	.534
B X Subjects within groups	3953.114	216	18.302	

2. Discussion of Results.

The basic question asked in this study is answered in the negative. Somatosensory recovery rates do not appear to be related to the Extraversion dimension. Although the recovery measures have proven valuable in the abnormal range, a generalization to the normal range seems difficult. The corollary questions are also answered in the negative in that differences in arousal are not demonstrated, by means of the recovery curve, between groups of differentially extraverted subjects.

It has been stated that the cycle of cortical excitability or the recovery function shows the current state of personality functioning. Perhaps the recovery function is not a sensitive enough instrument to detect subtle differences between the personality types within the normal range. The normal and dysthymic groups were not differentiated by this measure.[3] Further, the additional controls added to this study may help to account for the negative findings.

Normal populations studied for Extraversion relationships with other data have yielded many instances of

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3 Charles Shagass and Marvin Schwartz, "Cortical Reactivity in Psychotic Depressions," Archives of General Psychiatry, Vol. 6, 1962, p. 235-242.

contradictory results including evoked potential research.[4] Findings with abnormal populations seem more straightforward and in agreement.[5] This situation seems to be repeated with recovery curve findings. With abnormal populations, reliable and highly significant differences in recovery function data have been repeatedly found. With normal populations, this study does not confirm Shagass' recent finding that:

> Although there are uncertainties in interpretation, the results with the MPI in non-patients do indicate that some portion of the interindividual variations in somatosensory response characteristics is related to personality factors measured by the MPI.[6]

Thus, with two studies, contradictory findings are already plaguing the normal range. Shagass himself concluded in his discussion that:

> These findings present some inconsistencies in relation to what would be expected from patient-control comparisons. It is possible that it may not be valid to extrapolate from sick to healthy populations.[7]

If one reviews the studies of evoked responses in normal and abnormal populations along the Extraversion dimension, it

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4 H. J. Eysenck, Biological Basis of Personality, Springfield, Ill., Charles C. Thomas, 1967, p. 177.

5 *Ibid*., p. 67-68.

6 Charles Shagass, Evoked Brain Potentials in Psychiatry, New York, Plenum Press, 1972, p. 122.

7 Charles Shagass and A. Canter, "Cerebral Evoked Responses and Personality," in V. D. Nebylitsyn and J. A. Gray (eds.), Biological Bases of Individual Behavior, New York, Academic Press, 1972, p. 122.

does indeed seem that extrapolation could be risky. The panorama appears to support Eysenck's findings of orthogonality between the dimensions of Extraversion and Psychoticism and not to support the continuum theory of abnormal behavior.

In a study utilizing the data of unpaired responses, Shagass found characteristics which he hypothesized to be related to CNS maturation and neuronal degeneration.[8] These characteristics, combined amplitude-latency measures, were "affected" by an Extraversion-age interaction; for the age groups twenty to thirty-nine years, the data seemed to suggest equal levels of hypothesized CNS maturation for extraverted and introverted subjects. It is perhaps possible to interpret the results obtained with the recovery function in this study in support of Shagass' theory of differential CNS maturation curves in introverts and extraverts, at least for the age range mentioned earlier. Although such interpretation would involve a generalization from evoked response data to recovery curve data, the greater apparent sensitivity of the recovery curve data to current levels of the individual's functioning would seem to offer some possibility. Perhaps the negative findings of this study are an indication that the groups of

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8 Charles Shagass and Marvin Schwartz, "Age, Personality and Somatosensory Cerebral Evoked Responses," Science, Vol. 148, 1965, p. 1360-1361.

individuals in that age range have reached equal levels of CNS maturation as hypothesized by Shagass. It may also be noted that for his recently reported study with the recovery function and the dimension of Extraversion, Shagass was utilizing a population ranging from fifteen to eighty years.[9] The wider age range utilized by Shagass could have tapped differences which were out of reach of this research by virtue of the restricted age range utilized.

This lack of support for a hypothesis of differential functioning of the reticular formation with respect to arousal, adds to a list of contradictory findings with regards to differences in arousal in normals classified along the dimension of Extraversion. A possibility which may be considered is that there is indeed no difference in cortical arousal between individuals at extremes of the dimension of Extraversion and the differences which were periodically found with studies of simple evoked responses were confounding arousal with attentional differences. Attentional differences have been found not to affect the recovery curve.[10]

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9 Shagass and Canter, op. cit., p. 115.

10 Charles Shagass, D. A. Overton, G. Bartolucci and J. J. Stroumanis, "Effect of Attention Modification by Television Viewing on Somatosensory Evoked Responses and Recovery Function," Journal of Nervous and Mental Disease, 1970, in press as referred to in Shagass, Evoked Brain Potentials in Psychiatry, p. 138.

It is also possible that the peaks used to test the hypotheses relating to arousal theory in this study were too unreliable for such a sensitive test. One may also re-affirm the perils of generalizing from animal to human data. The differences in the recovery curve with respect to differences in arousal were animal findings, done with cats. The negative results of this study seem to indicate that caution in generalizations across species is an admissible stance to adopt.

Although the design developed by Shagass and Schwartz[11] was the one basically adopted for this study, there were a few variations. The randomization of the interstimulus intervals, independently for each subject, was suggested and adopted to diminish adaptation and habituation over the testing session[12] and to eliminate order effects. Aperiodic presentation of the stimulus and stimulus pause in the sequences of stimuli ensured that "locking stimuli to particular phases of biological cycles" was avoided.[13] Further, the time of day was eliminated as a source of variance since all groups were equated for the time of testing. In addition, to control for age and sex variables this study introduced

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11 Charles Shagass and Marvin Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," British Journal of Psychiatry, Vol. 112, 1966, p. 800-801.

12 Roger Broughton, M.D., Ph.D., personal communication.

13 Shagass, Evoked Brain Potentials in Psychiatry, p. 104.

controls for intelligence and Neuroticism score on the EPI. Although no known studies relate intelligence to the recovery curve variables, several studies, as outlined by Shagass,[14] have shown relationships between measured intelligence and evoked potentials, although these results were not confirmed by Shagass' own findings.[15] If, indeed, intelligence is correlated with certain aspects of recovery curve data, this study removed that source of variance since there were no significant differences in IQ for the three groups of subjects comprising the total sample in this study. The Neuroticism factor was also controlled as a source of variance since the groups were not significantly different in that respect. One aspect of the recovery curve has been shown to be related to Neuroticism.[16]

These additional controls and variations in the design could account for the obtention of different results than those of Shagass. It would seem that before any serious interpretation of these present results could be entertained, a cross-validation would be required. This cross-validation should control for the same factors which were added to the Shagass design in this study, as well as eliminate some of

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14 Ibid., p. 159.

15 Ibid., p. 160-161.

16 Ibid., p. 165.

the weaknesses of this work--the Enhancetron, gold electrodes, low amplitude age group, restricted range filter. After so many replications yielding positive results with abnormal persons and recently with normals divided at the median on the dimension of Extraversion, the results of this study must be considered with due scientific caution.

Other aspects of the study may also have affected findings. The sample chosen for this research was in an age range where the amplitudes for the evoked potential are at their lowest ebb.[17] This fact might have curtailed the attainment of significant differences between the subgroups of the sample. However, there are also technical aspects of this study which may have imposed limitations on the interpretation of the results. The filter range for the differential amplifier differed from that used in the studies conducted by Shagass; a filter range of .1 to 5K Hz. was utilized as compared to a filter range of .3 to 10K Hertz.[18] Gold electrodes were used and, although considered interchangeable, are not as excellent as the silver/silver-chloridated electrodes.[19] The averager used, the Enhancetron,

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17 Dr. Charles Shagass, personal communication.

18 Shagass and Schwartz, "Somatosensory Cerebral Evoked Responses in Psychotic Depression," p. 800.

19 R. Cooper, "Electrodes," American Journal of EEG Technology, Vol. 3, No. 4, 1963, p. 91-101.

seems to have posed several problems. As noted in chapter two, the averager's limitations on dual overlap necessitated a change in the procedure for collecting R_1 data. Further, there are doubts concerning the Enhancetron's power of resolution[20] and the limitations of this averager may have curtailed the kind of detail and crispness in the data collecting required to isolate differences between the groups of subjects utilized in this study, should there have been differences to be found.

The R_1 data collected and utilized for analysis was, of necessity, different from that utilized by Shagass. This limited the recording of the carry-over effect created as a result of the very closely spaced stimuli in the stimulus sequences; these stimuli are presented at the rate of approximately one per second. The method utilized to analyze the data incorporated a more conservative procedure to correct R_2.[21] This variation may have led towards a reduction of the possibility of finding significant results.

These differences may not individually be materially responsible for the non-significance of results. However, they may act in a cumulative fashion to affect the obtained results.

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20 Dr. Charles Shagass, personal communication.

21 _Ibid_.

Although this study does not confirm the extension of recovery curve results into the normal range, these results can be interpreted to support Shagass' theory of differential maturation in extraverts and introverts.

CONCLUSION

The results of this study suggest that the recovery function is not related to the personality dimension of Extraversion. Nevertheless, they also appear to suggest that the recovery function may contribute to further specification of the Extraversion dimension.

The findings of this research appear to be indicating that there is no significant difference between introverts and extraverts in the response of the sensory brain to electrocutaneous stimulation. In the theory of Shagass, these results can be interpreted as indicating no significant difference in the capacity for information transmission and information processing in groups of male introverts and extraverts of equal measured intelligence in the age range of eighteen to twenty-eight years. Differences in arousal were not found for this population.

These findings suggest that the basic psychophysiological capacity for information transmission and processing of males in this age range may not be a contributory factor to personality differences. Attentional differences in reference to information transmitted may be more crucial and provide fruitful areas for further psychophysiological research.

However, it is suggested that this study be cross-validated with research controlling the same factors as were controlled in this design, in addition to improving such aspects as the averager, the electrodes and the differential amplifier's filter range. Age could be included as a variable to further investigate the CNS maturation theory in relation to Extraversion as expounded by Shagass.

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This article confirms the effects of the reticular formation on the recovery cycle and extended materially the basis upon which hypotheses regarding arousal and the recovery cycle could be made.

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This article provides evidence of the sensitivity of recovery cycle data to current personality functioning.

Shagass, Charles, "Age, Personality and Somatosensory Cerebral Evoked Responses," <u>Science</u>, Vol. 148, June 4, 1965, p. 1359-1361.

This article presents the basis of Shagass' theory relating differential maturation and the continuum of Extraversion.

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This article was the basis for the experimental design utilized in this study; several improvements had been introduced adding to the significance of earlier findings.

Shagass, Charles, and Katsumi Ando, "Septal and Reticular Influences on Cortical Evoked Response Recovery Functions," <u>Biological Psychiatry</u>, Vol. 2, 1970, p. 3-18.

This article provided precise information with regards to the relationship between arousal and the recovery cycle.

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This text provided excellent methodological and theoretical guidance for this research.

APPENDIX 1

EYSENCK PERSONALITY INVENTORY, FORM A

EYSENCK PERSONALITY INVENTORY

FORM A

By H. J. Eysenck
and Sybil B. G. Eysenck

Name____________________ Age__________ Sex__________

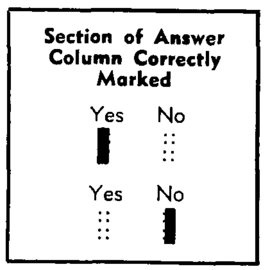
Grade or Occupation____________________ Date__________

School or Firm____________________ Marital Status__________

INSTRUCTIONS

Here are some questions regarding the way you behave, feel and act. After each question is a space for answering "Yes," or "No."

Try and decide whether "Yes," or "No" represents your usual way of acting or feeling. Then blacken in the space under the column headed "Yes" or "No."



Work quickly, and don't spend too much time over any question; we want your first reaction, not a long drawn-out thought process. The whole questionnaire shouldn't take more than a few minutes. Be sure not to omit any questions. Now turn the page over and go ahead. Work quickly, and remember to answer every question. There are no right or wrong answers, and this isn't a test of intelligence or ability, but simply a measure of the way you behave.

PUBLISHED BY EDUCATIONAL AND INDUSTRIAL TESTING SERVICE
BOX 7234, SAN DIEGO, CALIFORNIA 92107

E N L

1. Do you often long for excitement? .... Yes No

2. Do you often need understanding friends to cheer you up? .... Yes No

3. Are you usually carefree? .... Yes No

4. Do you find it very hard to take no for an answer? ... Yes No

5. Do you stop and think things over before doing anything? .... Yes No

6. If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so? .... Yes No

7. Does your mood often go up and down? .... Yes No

8. Do you generally do and say things quickly without stopping to think? .... Yes No

9. Do you ever feel "just miserable" for no good reason? Yes No

10. Would you do almost anything for a dare? .... Yes No

11. Do you suddenly feel shy when you want to talk to an attractive stranger? .... Yes No

12. Once in a while do you lose your temper and get angry? .... Yes No

13. Do you often do things on the spur of the moment? .. Yes No

14. Do you often worry about things you should not have done or said? .... Yes No

15. Generally do you prefer reading to meeting people? .. Yes No

16. Are your feelings rather easily hurt? .... Yes No

17. Do you like going out a lot? .... Yes No

18. Do you occasionally have thoughts and ideas that you would not like other people to know about? ...... Yes No

19. Are you sometimes bubbling over with energy and sometimes very sluggish? .... Yes No

20. Do you prefer to have few but special friends? ..... Yes No

21. Do you daydream a lot? .... Yes No

22. When people shout at you, do you shout back? ...... Yes No

23. Are you often troubled about feelings of guilt? ...... Yes No

24. Are all your habits good and desirable ones? ...... Yes No

25. Can you usually let yourself go and enjoy yourself a lot at a gay party? .... Yes No

26. Would you call yourself tense or "highly-strung"? ... Yes No

27. Do other people think of you as being very lively? ... Yes No

28. After you have done something important, do you often come away feeling you could have done better? ..... Yes No

29. Are you mostly quiet when you are with other people? Yes No

30. Do you sometimes gossip? .... Yes No

31. Do ideas run through your head so that you cannot sleep? .... Yes No

32. If there is something you want to know about, would you rather look it up in a book than talk to someone about it? .... Yes No

33. Do you get palpitations or thumping in your heart? ... Yes No

34. Do you like the kind of work that you need to pay close attention to? .... Yes No

35. Do you get attacks of shaking or trembling? .... Yes No

36. Would you always declare everything at the customs, even if you knew that you could never be found out? .. Yes No

37. Do you hate being with a crowd who play jokes on one another? .... Yes No

38. Are you an irritable person? .... Yes No

39. Do you like doing things in which you have to act quickly? .... Yes No

40. Do you worry about awful things that might happen? .. Yes No

41. Are you slow and unhurried in the way you move? ... Yes No

42. Have you ever been late for an appointment or work? . Yes No

43. Do you have many nightmares? .... Yes No

44. Do you like talking to people so much that you would never miss a chance of talking to a stranger? ...... Yes No

45. Are you troubled by aches and pains? .... Yes No

46. Would you be very unhappy if you could not see lots of people most of the time? .... Yes No

47. Would you call yourself a nervous person? .... Yes No

48. Of all the people you know are there some whom you definitely do not like? .... Yes No

49. Would you say you were fairly self-confident? ...... Yes No

50. Are you easily hurt when people find fault with you or your work? .... Yes No

51. Do you find it hard to really enjoy yourself at a lively party? .... Yes No

52. Are you troubled with feelings of inferiority? ...... Yes No

53. Can you easily get some life into a rather dull party? . Yes No

54. Do you sometimes talk about things you know nothing about? .... Yes No

55. Do you worry about your health? .... Yes No

56. Do you like playing pranks on others? .... Yes No

57. Do you suffer from sleeplessness? .... Yes No

PLEASE CHECK TO SEE THAT YOU HAVE ANSWERED ALL THE QUESTIONS.

APPENDIX 2

RAW DATA FOR *EPI*, AGE, HEIGHT AND *OTIS*

APPENDIX 2

Eysenck Personality Inventory (*EPI*) Scores on Form A and Form B for Extraversion(E) and Neuroticism(N) Dimensions by Groups of Introverted, Middle and Extraverted Subjects.

Subject	EPI (Form A)		EPI (Form B)	
	E	N	E	N
Introverted				
1	7	3	16	8
2	6	9	11	11
6	6	16	9	16
10	6	10	8	13
13	5	15	10	15
17	7	8	12	15
22	5	5	6	6
24	4	3	9	10
26	5	8	16	11
27	7	13	11	14
Middle				
3	11	12	13	13
4	14	11	19	12
5	11	12	15	12
8	14	7	19	9
16	10	6	14	14
20	12	6	16	9
21	14	16	19	18
23	13	10	13	7
28	13	9	12	5
29	15	6	14	4
Extraverted				
7	17	8	20	5
9	17	5	20	6
11	19	8	21	6
12	17	8	21	9
14	19	9	19	5
15	18	13	16	10
18	19	8	19	18
19	17	11	20	9
25	17	5	21	6
30	17	12	14	8

Ages (to the nearest six months) for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Age
Introverted	
1	20
2	19
6	20
10	18
13	20
17	28
22	28
24	19
26	21
27	22
Middle	
3	18
4	19
5	20
8	20
16	22
20	19
21	22
23	23
28	20
29	27
Extraverted	
7	20
9	19
11	19
12	19
14	20
15	20
18	19
19	19
25	20
30	25

Height Measurements (in inches) for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Height
Introverted	
1	73.7
2	71.2
6	69.2
10	71.5
13	67.5
17	67.2
22	72.7
24	66.7
26	68.0
27	68.5
Middle	
3	66.7
4	69.0
5	71.0
8	69.0
16	68.0
20	67.7
21	66.0
23	70.2
28	69.0
29	71.7
Extraverted	
7	71.2
9	71.7
11	68.2
12	69.0
14	65.2
15	75.0
18	70.0
19	68.5
25	70.2
30	72.2

APPENDIX 2

Otis Higher Examination (Form A) IQ Scores for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Otis IQ
Introverted	
1	115
2	122
6	116
10	114
13	113
17	124
22	128
24	118
26	116
27	128
Middle	
3	116
4	122
5	112
8	123
16	118
20	104
21	119
23	111
28	111
29	115
Extraverted	
7	124
9	122
11	130
12	115
14	115
15	122
18	111
19	118
25	118
30	128

APPENDIX 3

RAW DATA FOR R_1, UNCORRECTED R_2 AND CORRECTED R_2 MEASURES ON PEAK 1 - 4, PEAK 4, PEAK 6 AND PEAK 7

APPENDIX 3

R$_1$ μv Amplitudes for Peak 1 - 4 Measurements for Groups of Introverted, Middle and Extraverted Subjects

Subject	Interstimulus Interval msec. 2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	25.0	30.0
Introverted										
1	4.37	5.30	8.64	3.80	6.00	5.20	4.80	4.60	5.40	4.50
2	7.90	7.60	8.60	10.20	9.20	9.90	8.20	10.60	10.60	8.90
6	6.40	6.70	8.70	6.40	6.20	6.00	5.40	5.82	5.60	6.70
10	15.20	15.90	12.60	13.20	15.12	13.60	12.00	13.92	15.92	13.30
13	2.77	3.14	1.32	3.70	1.88	4.28	1.22	3.27	4.24	2.12
17	.48	3.30	3.30	2.60	2.40	3.00	.74	1.04	3.52	2.14
22	9.44	10.40	7.54	9.54	4.30	8.10	8.20	3.10	8.92	9.20
24	9.00	5.10	4.10	4.60	2.60	5.20	11.60	3.70	4.40	5.30
26	7.20	7.62	9.54	8.00	8.40	8.90	8.12	8.80	9.40	6.40
27	11.00	9.80	7.80	9.00	9.06	9.96	10.70	11.80	11.60	6.36
Middle										
3	8.20	9.26	9.50	9.90	10.10	9.84	10.20	9.92	9.12	8.80
4	10.78	9.50	10.00	8.40	7.70	9.70	9.60	8.70	8.70	10.60
5	7.60	8.60	9.32	7.40	8.80	8.04	9.30	9.10	11.60	5.94
8	7.40	6.90	5.40	4.20	6.70	4.70	6.30	5.20	8.00	5.00
16	4.00	2.42	3.86	4.10	1.88	1.76	2.60	2.80	3.40	5.68
20	6.80	7.34	4.78	6.20	6.80	5.30	6.44	7.00	5.54	4.50
21	5.50	4.04	4.00	2.88	4.70	4.30	4.40	1.10	3.60	2.40
23	8.40	8.00	4.80	10.90	7.26	7.32	9.10	6.50	7.30	7.80
28	6.80	7.32	8.44	7.94	10.90	6.22	6.78	7.08	7.90	8.24
29	11.68	10.70	10.60	10.08	19.90	10.60	11.80	12.50	12.60	11.60
Extraverted										
7	1.90	2.40	2.08	2.22	3.90	2.82	1.70	2.75	1.80	2.20
9	8.52	7.20	4.20	4.42	6.80	6.30	6.30	4.80	6.40	7.70
11	6.30	5.30	5.90	4.88	8.62	8.00	6.10	6.90	6.12	6.72
12	13.80	11.48	7.38	11.12	10.00	12.00	9.04	6.30	9.28	12.22
14	10.60	10.40	10.30	10.00	9.80	10.60	11.20	9.70	10.40	9.60
15	11.20	8.48	10.60	8.20	14.30	11.40	12.32	11.40	7.80	8.20
18	8.46	2.20	2.20	4.80	6.80	5.10	1.20	9.60	8.10	8.28
19	8.76	7.32	7.42	6.98	6.72	8.42	8.32	6.60	6.84	7.10
25	9.92	9.60	7.80	6.85	8.18	6.90	10.90	10.46	9.60	7.02
30	8.32	7.80	8.50	5.10	7.10	5.80	9.30	5.00	7.70	8.70

R_1 μv Amplitudes for Peak 1 - 4 Measurements (Cont'd.)

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	4.40	5.20	4.20	3.20	6.00	4.40	3.90	4.80	3.62
2	8.00	10.70	8.00	8.40	10.90	7.16	9.10	9.80	8.42
6	6.00	6.60	6.36	7.50	6.10	4.60	7.20	6.80	6.00
10	13.68	12.76	14.40	14.10	14.92	9.90	14.10	15.32	12.70
13	4.60	2.78	3.00	4.50	2.52	3.10	4.00	2.80	1.84
17	4.40	.76	1.00	3.10	3.84	4.44	1.80	3.96	4.00
22	7.80	10.20	10.50	8.50	8.90	6.72	10.38	8.12	9.20
24	5.20	6.60	6.20	5.30	8.20	7.10	7.20	9.00	6.50
26	7.80	8.50	8.20	9.50	7.60	9.68	7.60	8.70	8.40
27	11.60	8.40	9.52	10.20	10.80	11.60	8.70	10.40	10.00
Middle									
3	11.40	8.52	7.90	10.60	8.30	7.40	8.24	8.60	8.90
4	8.30	10.20	8.70	9.40	9.54	9.40	10.30	11.74	9.20
5	8.52	9.32	8.16	8.44	7.12	7.10	8.44	8.84	6.66
8	7.50	4.30	6.90	4.80	7.40	6.60	6.12	3.70	6.00
16	2.72	1.90	1.70	3.30	2.60	4.72	1.12	4.20	3.20
20	7.04	6.00	7.90	6.20	7.00	8.78	10.20	3.90	5.60
21	1.90	3.56	3.40	2.40	3.72	2.40	4.52	4.44	5.24
23	8.40	7.60	9.20	5.00	6.10	7.30	7.92	7.90	6.52
28	8.00	6.10	7.10	6.00	6.80	7.92	7.04	7.20	7.20
29	10.30	10.10	9.48	11.16	11.60	9.92	10.20	2.20	8.60
Extraverted									
7	3.10	4.10	3.84	2.90	2.50	3.68	1.50	3.30	3.40
9	8.70	7.80	6.60	5.40	8.00	6.70	1.04	8.12	8.40
11	7.50	4.60	7.10	5.40	6.20	4.72	6.62	4.40	5.20
12	8.60	14.00	12.90	6.92	9.90	11.80	7.70	8.60	9.60
14	10.10	9.20	8.90	10.30	9.45	10.80	10.80	8.80	9.90
15	8.32	10.14	8.60	9.50	9.44	8.50	11.74	7.80	8.60
18	4.90	9.60	8.32	6.00	6.10	5.60	8.80	5.00	5.30
19	6.50	7.80	7.30	5.70	6.70	6.50	9.50	7.90	5.60
25	8.40	9.20	7.70	8.02	8.10	7.84	10.00	6.44	9.72
30	8.70	7.80	4.30	5.40	7.50	6.70	6.82	8.12	8.40

Uncorrected $R_2 \mu v$ Amplitudes for Peak 1 - 4 Measurements for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.									
	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	25.0	30.0
Introverted										
1	3.06	1.80	4.10	4.30	3.80	6.02	5.90	4.00	3.52	6.10
2	4.20	1.30	3.98	3.60	1.20	2.30	4.40	2.50	1.60	1.20
6	2.24	4.00	2.14	3.32	2.964	2.90	4.90	5.16	6.70	5.10
10	4.20	.70	3.00	.80	3.40	3.30	7.46	8.00	5.60	5.68
13	2.50	1.80	3.12	2.40	.88	3.32	3.80	4.90	3.44	3.24
17	2.70	2.10	1.60	1.40	1.80	4.10	.52	1.30	4.80	1.60
22	3.20	3.24	2.40	1.00	4.14	3.24	1.68	3.56	4.40	3.00
24	2.10	2.00	2.20	3.10	2.60	3.80	6.20	4.10	4.80	3.00
26	3.60	3.60	2.52	6.30	5.30	4.80	6.32	5.50	5.60	5.20
27	4.35	5.40	4.20	4.80	5.30	11.00	8.40	10.60	8.24	5.50
Middle										
3	2.40	3.30	6.70	2.30	4.96	5.00	6.80	5.70	3.25	5.00
4	4.18	1.50	3.10	2.10	7.00	3.60	2.10	2.02	2.30	2.80
5	4.50	2.64	3.10	5.10	2.60	4.08	2.00	5.20	3.84	3.00
8	4.60	2.40	2.80	2.90	2.90	1.50	3.10	2.10	2.50	2.60
16	3.40	.70	3.20	3.32	2.40	.00	.15	1.60	1.80	3.20
20	2.10	4.50	5.30	3.90	4.08	2.90	4.00	5.36	2.40	2.80
21	3.00	1.76	1.20	1.20	1.80	1.30	1.50	2.20	4.10	3.70
23	2.96	.90	1.32	2.32	1.90	3.10	5.48	3.70	2.80	2.10
28	3.10	3.86	4.00	4.10	2.72	2.20	3.70	5.20	2.00	3.60
29	4.00	3.10	2.50	1.00	2.60	3.84	1.60	1.50	1.60	2.50
Extraverted										
7	3.12	2.30	1.40	2.80	2.70	2.50	2.50	5.00	3.40	4.84
9	3.50	2.50	2.80	2.00	2.80	4.70	3.20	4.20	3.60	4.80
11	5.30	3.40	2.80	3.34	4.00	2.20	7.00	1.30	2.84	2.20
12	4.10	6.56	3.80	6.40	4.70	6.80	8.30	6.34	6.80	9.00
14	6.30	2.85	3.70	4.90	5.80	4.88	5.20	7.00	6.70	3.40
15	2.30	1.30	.00	2.40	1.40	2.40	2.90	4.60	2.90	2.50
18	.60	1.30	2.30	1.00	.40	1.50	1.10	3.90	4.60	12.20
19	2.80	2.40	3.80	2.56	2.10	1.70	3.60	5.10	3.70	4.00
25	4.20	5.70	4.82	4.30	4.52	3.72	3.20	4.20	7.20	5.40
30	2.50	3.50	4.40	2.90	3.60	2.90	4.40	3.50	3.10	4.50

Uncorrected R_2 µv Amplitudes for Peak 1 - 4 Measurements (Cont'd.)

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	4.60	4.40	4.10	3.52	5.00	2.70	1.60	3.30	1.50
2	3.83	3.80	3.04	5.40	4.00	6.22	5.84	6.30	1.80
6	4.90	3.60	4.30	3.30	2.10	3.20	4.60	3.30	1.00
10	4.60	5.20	6.00	6.34	11.90	11.60	8.50	12.10	2.60
13	5.68	3.00	3.68	3.32	2.30	5.00	2.40	2.30	3.92
17	2.68	1.92	2.80	1.50	.60	5.60	2.52	4.32	3.00
22	2.32	2.60	1.84	3.30	4.36	4.90	6.30	5.04	2.40
24	4.30	3.60	4.20	3.92	3.90	8.92	4.60	9.00	3.10
26	4.70	5.90	6.12	4.52	6.04	9.00	7.00	8.40	3.20
27	2.92	6.90	5.30	5.00	8.20	7.90	10.90	9.02	5.40
Middle									
3	4.88	8.22	8.70	6.60	9.62	6.64	9.90	5.98	5.10
4	3.44	4.20	2.80	6.00	3.42	5.72	3.50	8.60	2.00
5	3.68	3.20	3.00	1.21	1.40	3.72	1.60	1.70	3.00
8	3.40	3.60	2.20	3.80	4.22	6.22	4.80	3.28	5.00
16	1.00	1.60	.40	1.10	.80	1.60	.80	1.50	1.02
20	3.24	5.96	7.60	6.10	8.10	6.92	4.34	3.52	4.20
21	.60	3.70	2.92	2.00	3.30	5.32	3.50	4.48	4.00
23	3.90	3.92	5.22	4.10	7.60	5.20	7.76	6.88	2.80
28	1.90	3.68	3.00	3.12	5.60	4.28	5.36	6.20	2.10
29	4.90	1.00	2.20	1.80	2.80	2.70	1.40	2.12	2.70
Extraverted									
7	2.40	1.90	1.90	4.40	2.84	3.00	1.60	3.20	3.40
9	3.60	3.10	3.10	4.90	6.00	3.80	5.00	6.10	3.60
11	2.22	2.20	2.10	2.70	1.20	3.64	3.50	3.40	3.10
12	3.90	8.52	6.40	4.00	9.52	9.10	4.80	6.90	.80
14	4.30	6.12	5.00	5.60	6.10	5.90	6.20	5.40	2.80
15	4.20	3.80	3.50	6.30	9.40	6.10	9.80	7.50	4.50
18	5.20	3.80	4.60	4.70	4.20	5.00	2.80	5.50	3.00
19	2.20	2.80	4.72	5.60	5.70	6.40	5.50	6.00	4.60
25	3.80	5.60	4.60	5.60	6.20	6.00	5.56	5.00	5.20
30	3.40	3.10	2.60	4.90	6.00	3.00	4.60	6.10	3.60

APPENDIX 3

Corrected R_2 μv Amplitudes for Peak 1 - 4 Measurements for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.									
	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	25.0	30.0
Introverted										
1	.066	-.636	.831	1.449	.706	3.09	2.64	.317	-.169	2.46
2	-.996	.333	-.964	1.57	.760	1.94	.62	-.946	.579	.640
6	.252	-1.11	.057	-.249	.251	.162	1.79	.202	1.618	-.417
10	-1.45	.716	.316	-2.11	-1.95	.134	-2.75	-2.79	-3.24	.168
13	-1.49	-.326	-1.06	3.79	-.597	-2.58	-2.70	-1.84	-1.95	-.268
17	-1.91	.040	-.890	-.350	1.47	-.500	.460	-.230	.580	-.180
22	1.38	-1.14	.290	-.140	-.249	1.47	1.16	2.98	1.06	1.59
24	-.240	-.25	2.01	-.690	.350	-2.59	.340	-.695	-.900	-.066
26	.960	-.153	.416	.730	-1.52	3.36	-2.98	-.950	-1.84	-1.35
27	-3.16	-.73	-2.69	-.32	-2.00	2.07	1.88	.480	.440	-.030
Middle										
3	-.250	-.095	-.020	-.24	-1.28	-.60	-1.74	-1.54	-1.13	-.17
4	2.296	.68	3.05	1.33	1.95	3.79	2.21	2.58	3.96	.14
5	-.35	.696	-.44	-1.93	.66	1.61	1.54	-.09	.03	2.61
8	-1.35	.48	.45	-.41	-1.95	-2.46	-1.61	-1.62	-.65	-1.75
16	-.27	.24	1.63	2.45	.43	.045	1.98	2.33	-1.17	.28
20	-.07	-1.05	-1.37	-1.05	1.799	-1.53	-1.45	1.37	-1.60	-.36
21	1.79	2.48	.89	.93	-.05	.26	1.04	-1.31	-.84	-.25
23	-1.56	-3.495	-.75	-2.26	-2.28	-2.59	-.86	-1.12	-1.81	.49
28	.12	-.74	-2.24	1.16	-.50	-2.59	.27	.23	-1.49	-1.30
29	-.51	-1.53	-1.59	-1.20	-1.37	-1.64	-.57	.66	.44	-2.01
Extraverted										
7	-.72	-.23	-1.92	-2.75	-1.395	-1.09	-1.09	.54	7.87	2.05
9	-.41	-.55	.195	-.26	.88	.93	.65	1.25	-.79	1.12
11	-1.897	-1.51	-1.01	-1.28	-.42	.95	-.48	-1.15	-2.14	.18
12	-.31	.67	-.51	-1.04	-2.13	-.70	.89	-.185	-.11	-1.199
14	.85	-.85	3.17	2.04	.83	2.08	.72	1.37	1.22	1.08
15	1.15	.75	.97	-.71	-1.01	-.15	.87	-2.03	-.72	-1.76
18	2.69	1.65	1.20	1.28	.32	-1.87	-1.01	2.94	1.30	-.75
19	2.36	1.03	1.597	1.997	6.73	3.39	5.04	3.71	1.19	-1.35
25	-.06	-.995	-2.28	-1.44	-.61	-3.73	-4.25	-3.07	-2.43	.85
30	.73	1.15	-.39	.43	-.19	-.19	-.29	-.90	.098	-.38

Corrected R_2 μv Amplitudes for Peak 1 - 4 Measurements (Cont'd.)

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	1.56	1.02	1.05	.348	.84	-1.41	-1.76	-.546	-1.51
2	3.89	4.58	1.46	4.01	.976	4.657	-.539	1.877	.378
6	-1.16	-1.05	1.307	.885	-.735	-.720	.409	.402	.835
10	-1.15	-1.10	.848	-3.25	.68	.225	-1.06	-1.40	.516
13	-.608	-1.55	1.18	2.96	-.98	-2.63	-.13	-1.24	.071
17	-1.02	-.650	1.14	.580	-1.50	2.88	-.080	.397	-.869
22	-.180	.620	-1.01	-2.12	-1.01	-.190	-1.95	-2.10	1.17
24	-2.36	-1.195	-3.35	-3.47	-1.79	-3.73	-4.99	-.132	2.1
26	-1.01	-1.79	-1.06	-3.09	-.630	-1.04	-.170	-.030	.078
27	-.340	.001	.276	2.12	4.64	.717	.856	-.778	1.29
Middle									
3	.48	-1.60	.20	-.82	.97	.477	.21	1.895	.12
4	2.63	.84	-.16	2.90	1.15	-.21	.38	-2.45	-.33
5	.31	.98	-.197	.34	1.57	-1.00	-.14	.99	.44
8	-.84	-1.93	-2.098	-1.22	-1.67	-1.35	-1.92	-1.97	2.66
16	1.597	.59	.54	-.23	-1.53	-.15	-1.26	-.46	.11
20	-.195	.67	-1.65	-2.199	1.47	.07	1.06	.023	-1.15
21	2.35	3.48	2.13	1.31	.54	-1.75	.31	1.11	-1.41
23	-.99	-.82	1.46	3.07	-.14	3.04	1.54	1.29	-.33
28	-2.21	-3.03	-1.28	-1.63	-.41	.15	-1.14	-.84	-.12
29	.79	.10	-.96	.58	2.25	-.13	.89	.93	-2.82
Extraverted									
7	-.84	.36	.79	-.02	.27	-2.69	1.51	-.08	-1.38
9	-.18	.57	.19	-1.65	3.41	-.19	2.20	-.03	-.46
11	-.15	.724	.45	3.38	-.41	2.66	.85	-.33	-.65
12	-1.32	.77	1.76	1.098	1.20	-.29	-.03	1.51	.31
14	1.58	1.91	-.32	.87	2.15	2.04	1.80	-.002	-.15
15	-.04	-.89	-.795	.94	-1.65	.64	.67	-1.05	.63
18	1.08	.54	1.15	.72	.11	.45	.0002	1.94	.66
19	2.61	.71	-.03	1.02	.57	5.46	1.24	2.13	.24
25	-3.78	-2.38	-3.48	-4.89	-4.27	-4.69	.10	-.51	-.91
30	-1.02	-.48	1.14	.895	-2.30	-.03	-.08	.397	.066

APPENDIX 3

Means of Corrected R2 Values for Groups of Introverted(I), Middle(M), and Extraverted(E) Subjects for Peak 1-4.

Interstimulus Interval (msec.)	Mean Amplitude μv Values I	M	E
2.5	-.66	-.02	.44
5.0	-.33	-.23	.11
7.5	-.17	-.04	.10
10.0	.37	-.12	-.17
12.5	-.28	-.26	.0005
15.0	.66	-.57	-.04
17.5	.05	.08	.11
20.0	-.35	.15	.25
25.0	-.38	-.43	.55
30.0	.23	-.23	-.02
40.0	-.24	.39	-.21
50.0	-.11	-.07	.18
60.0	.19	-.20	.09
70.0	-.10	.21	.24
80.0	.05	.42	-.09
90.0	.43	-.09	.34
100.0	-1.01	-.01	.74
110.0	-.38	.05	.39
120.0	.39	-.28	-.16

R_1 μv Amplitudes for Peak 4 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.									
	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	25.0	30.0
Introverted										
1	1.06	2.50	6.00	1.50	1.20	1.50	2.00	1.80	1.10	.40
2	1.30	1.60	1.00	.80	2.40	3.50	2.50	2.40	2.60	3.30
6	2.80	2.00	3.20	3.10	3.70	2.30	3.56	3.70	4.40	3.10
10	7.50	7.70	7.40	5.00	7.80	5.60	5.60	8.20	8.22	6.70
13	.93	1.04	1.20	1.30	.60	2.60	1.10	1.86	1.84	1.12
17	.24	1.40	1.50	1.00	1.20	1.80	.30	.80	2.60	1.64
22	7.60	7.60	6.30	7.44	7.60	5.50	6.12	2.10	7.12	6.48
24	5.00	2.00	2.30	1.30	1.40	2.60	5.20	2.20	3.20	2.20
26	1.60	2.32	1.44	.80	1.20	2.40	2.40	1.80	1.80	3.20
27	3.40	3.10	2.40	3.40	1.10	3.16	2.90	3.80	3.20	2.36
Middle										
3	6.80	6.76	5.70	8.50	8.00	7.60	6.40	7.92	7.12	6.90
4	7.10	7.00	6.80	6.00	6.40	5.50	5.60	6.50	5.30	7.60
5	3.20	4.80	4.72	2.60	5.00	2.72	4.40	4.70	5.60	4.70
8	4.00	4.50	2.30	2.20	4.70	2.30	3.10	3.20	4.00	3.60
16	1.20	1.10	2.30	2.10	.88	.20	1.00	.80	1.00	3.60
20	4.80	6.30	3.50	6.00	4.80	2.30	4.80	3.80	3.84	3.10
21	2.00	2.00	1.80	.80	2.30	1.90	1.20	.50	1.00	1.40
23	6.80	6.40	3.60	9.90	7.06	7.32	6.70	6.40	6.40	7.00
28	2.00	4.00	3.92	1.90	4.10	1.32	.70	.40	.30	.92
29	4.72	4.50	3.80	6.24	8.70	3.60	4.92	6.70	3.80	5.60
Extraverted										
7	1.20	.80	1.20	1.30	2.10	.70	1.10	.75	.80	1.30
9	5.72	4.80	2.80	3.50	4.30	4.00	4.20	4.00	4.10	5.20
11	5.80	2.50	2.30	2.60	5.32	4.00	4.00	3.10	2.32	4.00
12	6.80	5.80	6.48	5.92	5.40	6.80	7.72	4.30	6.48	6.72
14	10.00	8.80	8.70	9.10	9.20	8.70	9.10	8.90	9.20	8.40
15	8.40	7.28	9.30	6.60	10.70	10.80	12.12	11.00	6.60	6.20
18	6.16	1.20	1.60	4.40	4.30	4.20	1.00	7.20	5.70	7.28
19	4.96	4.00	4.50	2.90	3.20	4.90	4.12	3.70	3.84	3.10
25	6.72	6.80	5.60	4.00	7.28	5.60	6.00	6.36	6.80	6.12
30	5.72	6.20	8.40	3.80	4.60	3.40	7.00	4.00	5.80	7.10

$R_1 \mu v$ Amplitudes for Peak 4 (Cont'd.)

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1.	3.60	4.60	1.00	.00	5.00	.20	2.70	1.00	.52
2	1.40	3.10	1.60	1.20	1.20	3.16	2.10	2.20	1.50
6	3.20	3.20	3.76	3.20	2.50	2.60	3.80	3.60	2.40
10	7.68	5.56	7.60	7.80	8.40	3.10	7.30	8.00	7.60
13	2.80	.88	1.60	1.90	2.12	1.60	.80	.40	1.20
17	3.20	.40	.80	2.30	3.20	3.12	1.30	2.56	2.80
22	4.80	8.50	8.70	5.40	6.80	5.52	8.10	6.28	8.30
24	3.20	3.20	3.60	2.10	3.20	3.10	3.80	2.00	2.40
26	3.80	2.40	3.40	2.10	1.20	4.08	.80	1.90	3.10
27	4.80	2.40	3.60	3.00	2.80	6.00	.70	1.40	2.00
Middle									
3	7.80	5.20	7.20	6.40	5.20	5.00	6.40	4.40	6.40
4	3.50	7.00	4.90	6.80	7.10	6.00	7.00	7.50	6.80
5	4.32	5.92	4.80	4.00	1.40	3.90	3.20	4.40	3.26
8	3.50	3.10	4.50	3.20	5.00	5.00	3.20	2.30	2.60
16	1.32	.70	1.10	1.40	1.20	3.12	1.32	3.60	1.20
20	4.92	2.20	5.50	3.60	5.00	7.90	7.20	2.30	2.60
21	1.90	1.04	1.30	.80	1.32	.80	1.60	1.04	1.20
23	8.00	5.60	9.20	5.00	5.20	5.50	6.32	6.70	4.92
28	.60	1.70	.30	2.60	3.00	2.72	3.20	3.60	3.60
29	6.30	6.00	4.68	5.32	6.00	3.52	2.80	.80	2.20
Extraverted									
7	1.20	1.80	2.64	1.30	1.10	1.48	.40	1.30	1.40
9	7.00	5.40	4.10	3.20	6.60	4.90	6.64	7.12	7.40
11	4.70	3.30	2.30	4.20	2.90	2.12	3.10	2.40	2.40
12	7.60	8.70	8.20	6.12	4.10	7.40	5.90	6.60	4.80
14	8.80	8.00	7.40	8.90	9.00	8.70	9.20	8.00	8.90
15	6.32	8.24	5.80	6.30	8.40	6.70	9.30	6.50	8.50
18	3.60	7.10	6.60	4.00	5.60	5.40	6.00	4.10	4.80
19	4.00	4.50	3.50	2.00	2.20	3.30	3.90	2.80	2.40
25	5.80	6.00	6.40	6.32	6.80	6.04	7.92	5.00	6.00
30	7.00	5.40	4.10	3.20	6.60	4.90	6.64	7.12	7.40

Uncorrected R_2 µv Amplitudes for Peak 4 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.									
	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	25.0	30.0
Introverted										
1	3.06	1.40	4.20	2.00	1.30	4.52	2.60	2.00	1.72	3.70
2	1.80	.90	2.38	1.40	.40	.30	.40	-.90	1.04	.40
6	.70	2.00	1.70	1.72	2.10	2.10	3.80	3.20	6.50	3.10
10	1.80	.40	.80	.20	1.80	1.20	2.50	3.60	2.10	2.88
13	.30	1.00	1.20	2.00	.76	.80	2.20	3.40	1.80	1.64
17	1.00	.30	.60	1.00	.90	2.50	.20	1.10	3.20	1.40
22	1.96	2.80	1.20	.60	3.70	1.64	1.28	2.50	2.72	2.20
24	.80	1.10	1.20	1.50	1.20	2.20	1.40	2.60	3.10	2.10
26	1.80	2.40	1.52	3.60	2.80	2.40	2.40	1.90	4.40	3.60
27	2.60	3.80	2.60	2.80	3.30	3.30	3.40	6.20	6.40	3.40
Middle										
3	.40	2.20	3.60	.80	3.20	1.00	3.20	3.70	2.25	3.20
4	2.70	.80	2.40	1.40	1.30	2.40	1.30	.90	1.80	1.60
5	1.50	1.44	.60	.80	2.00	2.04	1.00	1.20	1.32	1.40
8	1.80	1.60	2.10	1.40	2.00	.90	2.10	1.10	1.00	1.40
16	2.20	.40	4.80	1.28	1.20	.00	.05	1.20	.80	1.80
20	2.00	3.20	5.00	2.10	3.36	2.20	3.40	4.24	1.60	.80
21	2.90	.80	.80	.80	1.00	.40	-.70	1.30	2.90	1.80
23	1.60	.50	.80	1.04	1.50	2.90	3.20	3.40	2.40	2.10
28	1.50	2.42	1.00	.50	1.40	.60	1.00	1.30	.80	1.80
29	2.20	1.30	1.00	.20	.60	1.84	.60	.80	.80	1.30
Extraverted										
7	1.72	1.20	.60	1.28	1.10	.80	.90	2.60	2.20	3.20
9	2.80	2.10	2.40	1.50	2.10	4.00	2.40	3.30	2.10	4.10
11	4.80	3.00	2.40	1.44	3.10	1.60	5.20	.70	1.40	1.50
12	1.70	2.92	2.90	3.80	3.20	5.20	7.00	5.04	4.20	6.20
14	3.10	2.85	3.10	3.50	4.70	3.72	5.20	6.90	4.40	2.20
15	1.60	.90	.00	.60	.20	2.40	2.40	4.00	1.80	2.40
18	.30	1.20	.80	.50	.20	.80	.20	3.40	3.00	9.80
19	2.00	1.00	1.20	1.00	1.60	1.30	2.40	3.10	1.80	1.20
25	3.30	4.10	2.50	3.60	1.72	2.40	2.40	3.60	5.60	4.80
30	2.20	2.50	4.40	.80	.80	2.50	3.80	3.30	2.00	3.60

Uncorrected R_2 μv Amplitudes for Peak 4 (Cont'd.)

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	4.40	3.10	.70	1.80	2.70	.70	1.60	1.90	.80
2	2.03	2.30	1.04	.60	2.40	1.70	2.20	2.80	1.10
6	1.60	1.20	1.60	1.80	.60	1.50	1.80	.90	.60
10	.80	.40	3.00	1.10	2.40	4.40	1.70	3.50	2.60
13	1.60	1.20	.96	2.12	1.20	2.00	1.20	.80	.60
17	2.04	1.32	.80	1.30	.20	4.80	1.00	3.52	2.40
22	1.52	.20	1.64	.20	3.40	1.70	3.90	3.84	2.40
24	1.60	1.20	1.50	2.12	1.50	4.40	1.80	2.20	2.40
26	3.10	2.70	4.00	2.12	3.60	2.60	3.20	2.00	.80
27	1.00	2.60	2.90	2.20	4.60	3.40	2.90	2.12	3.60
Middle									
3	2.08	4.32	3.20	1.00	4.92	4.40	5.90	1.50	3.46
4	2.00	1.20	.60	3.60	2.32	3.72	2.20	4.80	1.20
5	2.00	.60	.60	.76	.80	.40	.60	1.00	1.20
8	2.00	2.40	1.20	2.40	2.32	4.40	2.80	1.68	3.20
16	.80	.80	.20	.90	.00	.80	.40	.80	.82
20	2.00	3.52	3.20	2.60	7.50	4.52	2.30	1.68	3.20
21	.60	1.90	1.60	.60	1.40	3.50	1.50	2.92	2.00
23	3.10	3.52	3.72	4.00	7.20	4.20	6.80	5.68	1.80
28	.30	2.40	2.40	2.52	2.40	3.48	4.32	4.70	1.40
29	.60	.40	1.00	1.20	1.40	.40	.80	1.52	1.20
Extraverted									
7	.80	.70	.90	1.60	1.44	.80	.20	.80	.60
9	3.20	2.20	.70	2.00	3.80	2.60	4.20	3.20	3.40
11	1.32	1.60	2.00	2.00	1.20	2.60	.70	1.60	1.10
12	3.50	2.00	2.80	2.80	3.92	4.30	2.80	6.30	.80
14	3.70	4.92	2.60	4.80	4.80	4.70	5.60	5.00	2.80
15	1.80	1.00	1.90	6.00	9.00	5.20	8.80	5.60	3.60
18	4.40	1.80	3.60	4.30	3.40	1.80	1.20	4.90	2.80
19	1.40	.80	1.00	2.80	3.50	3.60	2.40	3.80	3.00
25	3.30	4.40	1.80	4.20	4.00	2.80	4.40	3.60	3.60
30	3.20	2.20	.20	2.00	3.80	2.60	4.20	3.20	3.40

Corrected R_2 μv Amplitudes for Peak 4 Measurements for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.									
	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	25.0	30.0
Introverted										
1	1.37	-.08	2.00	.48	-.21	2.95	1.11	-.04	-.34	2.03
2	-1.699	.097	1.44	-.67	1.06	-1.63	.22	.04	-.81	-.14
6	.015	-.036	-1.10	-.24	-.49	-.64	-.28	.85	.19	1.295
10	.08	-.95	.697	-.128	-1.22	-1.62	-1.25	-3.11	-1.27	-2.02
13	.58	-1.34	.12	-.089	-.69	.14	-1.41	-2.45	-.95	-1.92
17	.78	.28	.53	-.008	.305	1.995	.17	.65	-.46	1.19
22	-1.12	.59	-.21	.21	.36	.39	1.79	.63	3.896	.73
24	-.35	-.38	-1.46	-.72	.14	.26	-1.299	-1.65	-1.48	-1.38
26	2.77	1.52	.58	-.08	1.21	-.406	3.04	-1.98	-.86	-1.099
27	-.35	-1.84	-1.54	1.297	-.32	-1.08	-.21	-.22	-1.14	-.41
Middle										
3	-.102	-.17	.28	-.12	.17	-.81	.24	-1.33	-1.54	-1.096
4	-.399	.96	.66	2.31	1.30	2.71	3.57	2.30	1.25	2.90
5	-1.39	-.27	-.50	.48	-.69	-.96	1.02	1.34	-.38	-.22
8	.495	-.88	2.98	-.24	-.28	-1.35	-1.09	-.57	-1.24	-.696
16	.78	.45	.63	2.03	2.45	.90	1.30	2.89	1.00	-1.53
20	-.64	-1.02	-1.13	-.53	-.61	.88	-.70	-.67	.89	-.59
21	.04	1.16	3.06	.61	1.52	.49	.965	1.64	-.91	-1.57
23	-.61	-1.28	-2.53	-.89	-2.19	-.78	-2.53	-.596	-1.17	-.76
28	-.195	.58	-1.03	-.88	1.598	-.63	-1.61	.37	-.34	-1.04
29	1.14	1.61	-.97	-.73	-.61	1.24	-1.91	-.38	.86	-1.31
Extraverted										
7	-1.75	-.09	-.84	-1.00	-1.595	-1.24	-.94	-.14	.18	6.36
9	-1.17	-.31	-.62	-.02	-.33	.44	-1.17	.45	.695	-.04
11	-.499	-1.55	-1.15	-.42	-.55	.32	.12	.08	-.54	-1.27
12	.03	-.70	-.84	-.51	-.09	-.86	.196	.53	-.71	-1.17
14	.07	.94	-.208	2.07	1.29	.67	.78	-.14	2.23	1.21
15	-.26	.72	-.98	-1.02	-.38	-.94	-.04	-.36	-1.13	-.007
18	1.21	1.99	.35	2.096	-.35	.12	-.40	.29	2.598	1.66
19	.74	2.23	.77	1.29	1.80	1.44	1.61	3.60	3.995	1.22
25	.25	-.47	-.97	-1.29	-1.60	-1.096	-1.88	-2.60	-1.71	-1.71
30	.18	.48	1.96	-.71	-1.02	.598	.62	.65	-.84	.21

Corrected R_2 μv Amplitudes for Peak 4 Measurements (Cont'd.)

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	2.54	1.13	-.32	.59	-.67	-.82	-.34	.26	-.47
2	-.67	2.33	.77	-1.96	1.46	1.195	2.16	-1.65	.86
6	-.55	-1.17	-.49	.03	-.11	-1.167	-.62	-.97	-.87
10	.63	.38	-.11	-.91	.80	-.86	.55	.63	.39
13	.16	-.86	-1.31	.53	-2.02	.16	-1.83	.27	-1.49
17	.62	.20	-1.02	-.09	-.31	-.57	.37	-1.17	.57
22	-.17	-.72	-.05	-.29	-1.60	-.86	-.68	-1.896	-1.095
24	-.0096	-1.42	-1.28	-1.55	-.89	-2.42	-1.59	-2.15	-.69
26	-.77	-.33	.69	-.36	-1.19	.41	-1.44	-.66	-.595
27	-1.92	-1.61	.48	-2.24	-2.55	1.86	-.25	-1.26	-.28
Middle									
3	.16	.48	-.62	.31	-1.05	1.195	.61	-.536	1.46
4	.795	-.115	.14	-.09	.97	.25	-.70	2.17	-1.44
5	-.09	-.64	-.19	.39	-.83	-.0096	.18	-.57	-.82
8	-.57	-1.04	-.84	-.695	-1.60	-1.74	-.87	-1.996	-.60
16	.74	2.83	.12	1.16	-.42	.19	-.49	.24	-.37
20	.27	-.50	-.17	-.54	-2.33	2.26	-.26	1.19	.61
21	-.14	1.63	1.16	.40	4.14	.296	-1.83	-.536	1.46
23	-.36	-1.099	-.21	3.07	4.06	1.397	3.65	1.51	.52
28	-.59	-1.91	-1.13	-2.49	-.80	-1.69	-.67	-.15	-.63
29	-.897	.054	.51	-.83	-.26	1.77	-.09	1.27	.58
Extraverted									
7	2.54	-.26	1.31	1.99	-.24	-1.55	-2.35	1.88	.56
9	-.17	-.72	-.11	.33	-1.03	1.86	-.68	.12	.71
11	.31	1.51	.83	1.42	3.74	.82	3.096	1.50	-.47
12	-.54	-1.17	-.59	1.04	1.44	.99	-.13	1.36	1.31
14	1.20	.81	2.44	.33	2.00	-.28	2.18	-.04	-1.05
15	-.92	.53	1.55	.597	-.035	1.08	2.13	1.90	-.57
18	.98	2.38	.45	1.26	-.20	-.77	-.083	.18	1.09
19	-1.11	.71	1.29	.17	2.26	-.16	1.90	.31	1.996
25	-1.83	-1.62	-.86	-1.47	-2.43	-2.29	-1.19	-.03	-.45
30	.62	.20	-1.52	-.09	-.31	-.57	.34	-1.17	.57

APPENDIX 3

Means of Corrected R_2 Values for Groups of Introverted(I), Middle(M), and Extraverted(E) Subjects for Peak 4.

Interstimulus Interval (msec.)	Mean Amplitude μv Values I	M	E
2.5	.21	-.09	-.12
5.0	-.21	.11	.32
7.5	.11	.15	-.25
10.0	.001	.20	-.05
12.5	.02	.27	-.28
15.0	.04	.17	-.05
17.5	.19	-.07	-.11
20.0	-.73	.49	.24
25.0	-.32	-.16	.48
30.0	-.17	-.59	.65
40.0	-.02	-.07	.11
50.0	-.21	-.03	.24
60.0	-.20	-.12	.48
70.0	-.57	.07	.56
80.0	-.71	.19	.52
90.0	-.31	.25	-.09
100.0	-.37	-.005	.52
110.0	-.86	.26	.60
120.0	-.37	.08	.37

R_1 μv Amplitudes for Peak 6 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	3.80	5.50	1.60	1.30	6.00	-.90	1.60	-1.40	2.10
2	.80	.30	-.80	-.40	-2.00	2.60	.20	.30	1.50
6	.70	.30	2.00	.40	.40	1.10	.30	.40	-.80
10	6.00	4.76	5.60	5.30	7.60	5.04	6.00	6.36	6.20
13	1.96	.68	1.44	.20	1.12	-.20	2.20	.80	.48
17	3.60	.50	.00	2.10	2.16	2.20	1.20	2.49	3.00
22	4.76	7.00	6.36	3.60	5.12	5.80	6.32	5.40	7.50
24	2.70	1.20	2.00	1.30	1.00	1.10	.40	1.50	3.00
26	3.30	1.20	.60	1.70	-1.00	2.60	.00	.40	1.60
27	.06	1.30	.70	.52	.70	1.00	.40	1.50	-1.60
Middle									
3	4.80	2.80	5.20	2.00	2.80	2.80	3.40	.60	4.50
4	2.80	4.30	5.20	6.40	6.24	5.90	5.70	5.16	4.60
5	4.72	1.50	2.70	.80	.20	2.00	-.50	3.00	5.20
8	2.40	2.40	3.20	2.50	2.80	2.40	3.40	3.00	4.20
16	2.44	2.40	1.10	2.52	3.16	4.68	1.44	4.52	2.40
20	5.10	3.56	4.00	3.10	3.20	6.10	5.80	2.80	1.90
21	.00	2.56	2.40	2.50	2.80	1.84	2.70	2.30	1.84
23	6.56	6.30	9.12	6.40	7.12	5.10	6.60	6.40	4.00
28	-2.40	.50	-1.50	.50	.80	1.20	.20	1.50	.20
29	10.00	5.50	6.00	6.00	6.70	2.40	3.40	9.80	4.80
Extraverted									
7	.30	-.30	.10	.10	.80	2.00	.00	.02	.30
9	3.20	4.40	6.40	6.40	6.70	5.20	6.80	7.12	7.40
11	.40	2.20	.80	1.20	2.10	.80	1.84	2.20	2.10
12	6.30	4.40	5.50	3.80	1.40	2.80	5.20	3.00	.00
14	4.40	4.30	3.90	5.60	5.44	6.80	6.44	6.00	4.44
15	8.20	10.80	7.80	7.50	11.30	10.30	10.70	9.00	11.44
18	2.30	3.40	3.10	3.52	4.30	5.00	2.90	3.52	3.60
19	2.30	3.70	2.40	.40	1.80	2.90	3.20	1.80	1.20
25	10.32	10.10	7.32	9.36	10.24	9.80	9.50	7.20	10.60
30	7.10	6.00	6.40	6.40	6.65	5.20	6.80	7.12	7.40

Uncorrected R_2 μv Amplitudes for Peak 6 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	.60	-.40	-.60	-1.80	2.90	-.90	-2.24	.76	.12
2	.92	.20	.10	1.60	.20	2.00	2.50	-1.40	1.72
6	.40	-.50	.30	1.10	1.60	.92	.30	-.90	-2.00
10	.60	1.96	.80	.40	1.60	1.60	-.52	.60	1.86
13	1.40	.60	.48	1.20	-.24	1.40	-.40	1.20	.80
17	3.12	2.30	-1.40	2.40	.00	3.56	6.00	1.72	2.30
22	.64	-2.30	.80	.20	2.00	1.00	1.00	2.80	1.40
24	.80	1.10	.30	.40	1.20	.92	1.00	.20	2.30
26	1.50	.80	1.30	-2.00	1.20	.60	.40	-.70	1.60
27	-3.20	1.40	-1.20	-2.80	.90	1.00	1.00	.20	.60
Middle									
3	2.00	4.50	3.60	3.90	4.80	4.48	1.72	2.80	1.80
4	.80	.80	-1.60	.40	-.30	2.20	2.00	1.60	.60
5	.60	.70	2.50	.84	.20	2.00	1.90	1.40	2.40
8	1.20	1.80	1.70	2.60	3.20	2.40	1.50	1.40	1.60
16	2.20	1.80	1.40	.20	.40	.20	.40	-1.64	2.80
20	6.32	9.32	6.00	7.24	9.60	5.80	1.40	6.00	4.52
21	.90	1.90	1.72	2.90	3.20	2.40	1.60	1.70	1.60
23	.80	2.80	3.40	3.28	4.40	3.56	3.30	5.68	1.40
28	.60	.40	-1.80	.60	.40	1.20	.01	.10	.80
29	1.20	4.40	-.80	2.40	.00	2.40	.00	1.10	3.60
Extraverted									
7	2.12	-1.50	-.20	.10	.40	1.00	1.04	1.00	1.00
9	2.12	-.80	.80	2.40	4.20	1.20	4.40	2.80	.80
11	.80	-.40	.80	2.40	.00	.40	-2.30	.60	1.92
12	2.80	.80	.80	2.90	2.52	2.80	.60	2.80	-.40
14	1.50	4.10	2.70	3.60	3.40	2.40	3.28	2.40	2.80
15	2.50	1.80	2.40	4.90	6.32	4.40	7.80	4.20	2.80
18	2.60	-.50	.90	6.40	1.10	-.40	1.60	4.80	1.50
19	.40	-.30	1.20	.80	1.80	1.20	1.10	.90	.80
25	2.00	2.80	1.80	2.80	6.40	3.60	5.20	4.00	1.40
30	3.00	2.90	.80	2.40	3.30	1.20	4.40	2.80	.80

Corrected R_2 μv Amplitudes for Peak 6 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	-.87	-2.14	-1.17	-2.98	-.21	-1.55	-3.13	.56	-1.21
2	.36	3.19	2.15	2.48	2.87	2.79	.08	1.98	.16
6	1.25	-2.32	-.41	-.67	-.81	-.48	-.82	.36	-.095
10	-.32	-.71	.11	1.004	.0196	.36	2.199	-2.12	.47
13	-.496	-.75	-3.05	-2.52	-3.49	-.32	-.597	-.62	-1.05
17	.75	-2.37	-.94	-.52	.84	-1.14	1.34	-.026	-1.21
22	-.54	-1.41	-.37	.23	.54	-.32	-.04	-1.65	-2.95
24	-1.03	-.41	1.66	-.166	-.79	.52	1.89	-.156	.67
26	-.08	-1.61	.42	1.26	-1.68	-.76	-3.29	-.709	.59
27	-1.25	.34	-.75	-2.14	-2.09	-.69	-3.24	-1.99	.008
Middle									
3	-.03	.55	.74	1.01	1.27	.82	-.14	-.16	.002
4	.90	-.77	-.72	.87	1.097	1.11	-1.79	1.25	-2.46
5	.25	-.37	-.05	.399	-1.56	.51	-1.50	.32	-.32
8	.97	.55	.95	-1.39	-1.67	-1.996	-.418	-3.66	1.43
16	-.07	2.55	1.57	.96	.4998	-.37	.37	-.085	1.70
20	1.69	1.35	-.58	.95	-1.70	2.03	5.28	.32	.86
21	4.63	7.89	4.84	5.45	7.52	3.22	-1.39	4.51	3.22
23	.28	-.79	.32	1.61	1.28	.695	3.12	.795	.27
28	-.99	4.28	-.93	-1.76	-.78	-1.496	-1.86	.51	-.63
29	.09	.63	.95	1.31	1.27	.97	.26	.36	.31
Extraverted									
7	1.39	-1.91	-.04	4.47	-1.38	-2.68	.17	3.08	-.02
9	-.48	.04	-.37	-.78	-.08	-.32	.62	-.89	.86
11	-1.14	.93	.99	4.47	.89	1.25	.33	3.08	-.17
12	-.81	-1.18	.43	-.07	.23	.52	-.45	-.29	-.41
14	.12	-.26	.97	-3.31	.65	-1.04	.18	-1.45	.34
15	.197	-.55	-1.62	-.30	-.80	-.06	-.29	-.99	-.28
18	-.59	.33	-.17	-1.13	1.75	-.0295	1.02	1.15	-1.024
19	-4.12	.33	-1.55	-3.71	-.27	-.21	.62	-.89	-.25
25	-1.33	2.66	-2.45	-.38	-3.36	.82	-1.60	-2.55	1.93
30	.97	1.08	-.94	-.52	-.04	-1.14	1.34	-.03	-1.21

Means of Corrected R_2 Values for Groups of Introverted(I), Middle(M), and Extraverted(E) Subjects for Peak 6.

Interstimulus Interval (msec.)	Mean Amplitude μv Values I	M	E
40.0	-.22	.77	-.58
50.0	-.82	1.59	.15
60.0	-.24	.71	-.48
70.0	-.40	.94	-.13
80.0	-.48	.47	-.24
90.0	-.16	.55	-.29
100.0	-.56	.19	.19
110.0	-.29	.38	.02
120.0	-.46	.44	-.02

APPENDIX 3

R_1 μv Amplitudes for Peak 7 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	3.80	4.80	1.10	.70	5.30	-1.26	1.20	-1.20	1.80
2	-3.90	.00	-1.56	-1.60	-2.40	4.20	-.20	-.04	.12
6	-4.00	-3.70	-2.40	-.390	-3.00	-2.50	-1.70	-3.30	-4.40
10	-1.40	-3.10	-3.04	-4.40	-3.60	-5.00	-.44	-4.00	-2.08
13	-.20	.00	-.92	.44	-1.10	-.20	1.20	.20	-1.60
17	-.80	-1.20	-.60	1.80	-1.40	-1.44	-.44	-.12	.72
22	1.16	3.20	3.96	.30	2.90	2.20	3.30	1.64	3.70
24	1.10	-3.10	1.10	-1.60	-2.40	-.20	-.20	-2.20	1.80
26	1.20	-.40	-.80	-.60	-2.00	.60	-2.40	-2.40	-.40
27	-1.80	.50	-3.40	-2.20	.00	-4.20	-.20	-2.20	-2.08
Middle									
3	.40	-.70	.70	-1.72	-.70	-.10	-1.00	-3.20	.60
4	-.90	3.60	-2.00	4.00	3.80	3.40	4.00	-4.00	3.04
5	-3.20	-.60	-.70	-2.04	-2.00	-2.12	-2.20	-1.00	.72
8	1.50	1.20	-1.40	-1.50	2.40	-.20	-1.72	-1.50	-.10
16	-.20	.70	-1.20	-.50	1.52	.30	-1.20	-.60	-.40
20	3.20	1.44	2.00	2.80	-1.64	4.32	-1.36	1.72	.00
21	-1.30	-.90	-1.20	-.70	-.92	-1.00	-.70	-.80	-.90
23	2.60	2.20	5.04	3.52	2.40	2.80	3.20	4.20	-1.32
28	-4.40	-1.50	-3.20	-1.60	-1.40	-1.50	-.50	-1.90	-.20
29	5.10	.90	2.80	2.00	1.20	1.20	-1.72	6.80	1.40
Extraverted									
7	.30	-2.20	-2.20	-1.20	-.80	1.40	-.50	-.50	-.60
9	.20	1.50	2.30	2.40	3.00	1.60	2.40	.60	3.20
11	-1.70	.60	-1.72	-1.60	.92	-.40	-.30	-.40	-.45
12	-1.60	.20	.50	.40	-2.50	-.50	.00	1.20	-.75
14	1.20	1.80	1.40	1.90	3.00	.00	2.80	2.50	1.72
15	3.00	7.90	5.20	4.40	7.80	5.60	6.00	5.80	8.80
18	-.40	.70	-.40	1.92	.60	-.60	-.20	2.00	-.70
19	.35	1.50	-.20	-.80	-.50	.70	.00	-.90	-1.10
25	6.80	5.00	4.44	6.60	7.96	6.40	6.40	4.60	5.44
30	2.80	1.00	2.30	2.40	2.30	1.60	2.40	.60	3.20

Uncorrected R_2 μv Amplitudes for Peak 7 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec. 40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	.00	-.60	-1.20	-2.00	1.80	2.00	-3.60	-.10	-.30
2	-.40	-.80	2.20	1.60	-.20	1.60	1.10	-1.60	1.44
6	-1.30	-2.70	.00	-1.60	-.40	-.20	-1.20	-1.84	-3.60
10	-1.40	.20	-.70	-1.96	-1.20	-2.10	-4.92	-1.00	.00
13	-3.96	-1.84	.48	-.30	-.24	-.60	-.40	.70	.80
17	-.76	1.32	-2.80	2.20	.00	-1.20	5.60	-1.36	.00
22	-2.16	-.40	-1.70	-1.30	-1.90	-2.40	-.80	-.60	.00
24	-1.00	.20	-1.20	1.00	-.20	-.60	-4.80	-.40	-.30
26	-2.40	-1.40	-3.50	-3.20	-.60	-.10	-1.60	-2.40	-.80
27	-5.60	-1.80	-2.00	-4.00	-.90	-.40	-4.80	-.40	-1.64
Middle									
3	-2.60	.00	-.60	-3.60	-1.70	-.48	-5.20	-3.40	-.60
4	-2.20	-3.20	-4.20	-.30	-4.10	1.80	-2.40	-2.24	-.80
5	-4.40	-.30	.60	-.52	-.60	.60	-1.88	-.40	-1.20
8	1.20	.70	-.50	-1.20	1.90	-.60	-.90	-.80	.70
16	-1.20	-.30	1.20	-.90	.20	-.60	-2.80	-.30	1.04
20	1.30	4.40	1.60	4.08	5.20	3.90	-1.40	3.12	4.80
21	-2.80	-.90	-.40	-.20	-.52	-1.16	-1.84	-5.00	-.90
23	-1.60	-.40	-1.00	2.12	1.90	1.60	1.00	.70	-.35
28	-5.12	-2.80	-2.80	-2.40	-1.40	-2.40	-2.40	-1.20	-1.20
29	-2.50	3.60	-2.00	1.04	-1.60	-.10	-.90	-.40	3.60
Extraverted									
7	1.12	-3.20	-1.80	-.80	-1.20	-.35	-.20	-.40	-.20
9	1.10	-1.00	-1.60	-.40	.20	-1.20	-.10	-4.80	-1.80
11	-2.00	-.40	-1.90	.70	-.70	-.20	-3.40	-.80	-.20
12	-1.40	-4.40	-2.80	-1.40	-2.20	2.40	-1.92	.00	-1.60
14	-.80	-1.70	-.20	-.20	.00	-.60	.80	.20	1.60
15	-1.90	-4.20	-1.80	-1.80	.20	.20	5.10	-1.30	.80
18	1.40	-2.80	-.40	.80	.50	-1.60	-2.00	1.50	-2.00
19	-2.40	-1.00	-1.60	-3.44	-1.00	-.50	-2.00	-1.00	-1.60
25	-1.20	-.40	-1.80	-.40	-.60	-2.00	2.48	-.10	.00
30	-1.90	-.20	-1.16	-.40	.00	-1.20	.00	-4.80	-1.80

APPENDIX 3

Corrected R_2 μv Amplitudes for Peak 7 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec. 40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	.82	.895	-.07	-1.31	1.93	2.699	-2.78	1.165	-.26
2	2.06	.11	3.298	2.78	.23	1.299	2.67	-.57	1.717
6	1.17	-2.24	1.09	-.07	-.05	.73	1.18	-.15	-2.68
10	.52	.73	.38	-.18	-.73	-.72	-3.22	.83	.59
13	-2.29	-.93	1.60	.44	.14	-.095	.42	1.69	1.32
17	1.04	2.09	-1.69	2.65	.39	-.47	7.30	-.31	.19
22	-.78	-2.6999	-.54	-.53	-1.68	-2.33	-1.11	.095	-.23
24	.39	.73	-.07	2.18	.23	-.095	-3.23	1.07	-.26
26	-1.03	-.54	-2.39	-2.23	-.19	.26	1.16	-.89	-.45
27	-.59	-.83	-.92	-2.69	-.56	.84	-3.23	1.07	-.35
Middle									
3	-1.06	.83	.53	-2.39	-1.34	.007	-3.197	-1.73	-.59
4	-.38	-1.85	-3.11	-.32	-3.91	1.65	-3.09	-.41	-.21
5	-2.09	.54	1.71	.75	-.19	1.46	.77	.83	.14
8	2.51	1.76	.60	-.04	2.14	-.095	1.49	.53	-.19
16	.47	.696	2.30	-.04	.48	-.19	-.69	-.85	-.31
20	2.40	5.49	2.74	4.32	5.599	3.58	.796	3.799	-.35
21	-.897	-.099	.70	.79	-.15	-.51	.001	-3.82	-.29
23	-.53	.78	.18	-2.04	2.14	1.56	.74	.88	-.42
28	-2.56	-2.07	-1.72	-1.22	-1.01	-1.66	-.67	.21	-.88
29	-1.96	4.62	-.85	1.45	-1.31	.15	1.49	-.74	3.696
Extraverted									
7	2.68	-2.56	-.71	.29	-.83	-.14	1.53	.73	.18
9	2.68	-.09	-.46	-.08	.42	-1.03	.07	-3.895	-1.96
11	-.012	.58	-.80	1.88	-.399	.34	-1.77	.31	.16
12	.57	-3.47	-1.68	-.65	1.77	-1.84	-.46	.78	-1.199
14	.57	-.57	.93	.23	.22	-.13	.76	.72	1.65
15	-.91	-2.33	-.62	-1.92	.24	-.36	3.34	-1.44	-.15
18	3.11	-1.80	-.70	1.22	.81	-1.00	-.43	2.12	-1.60
19	-.85	-.09	-.49	-2.43	-.65	-.1597	-.54	.21	-1.15
25	-1.02	1.12	-.63	-.98	-.57	-2.70	.50	.004	-.48
30	-.87	-.83	-.02	-.08	.25	-1.03	.17	3.896	1.96

APPENDIX 3

Means of Corrected R_2 Values for Groups of Introverted(I), Middle(M), and Extraverted(E) Subjects for Peak 7.

Interstimulus Interval (msec.)	Mean Amplitude μv Values I	M	E
40.0	.13	-.41	.59
50.0	-.27	1.07	-1.00
60.0	.07	.38	-.52
70.0	-.10	.13	- .25
80.0	-.03	.25	.13
90.0	.21	.59	-.81
100.0	-.08	-.24	.32
110.0	.40	-.13	.34
120.0	-.04	.06	-.26

R_1 Latencies in msec. for Peak 6 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	45.0	47.5	42.5	38.7	47.5	35.0	38.0	38.7	41.2
2	43.7	40.0	37.5	37.5	40.0	38.7	37.5	41.2	38.5
6	39.5	42.0	41.2	42.0	40.0	42.5	45.5	41.2	45.0
10	37.5	35.0	37.5	37.5	36.2	36.2	36.2	37.5	37.5
13	38.7	41.2	37.5	36.2	35.0	41.2	38.7	40.0	39.0
17	41.8	45.0	37.5	42.5	40.0	42.0	35.0	41.2	41.2
22	37.5	36.2	38.7	36.0	38.7	36.2	38.0	36.2	35.0
24	37.5	36.2	37.5	36.0	38.7	37.5	38.0	37.5	35.0
26	33.0	35.0	35.0	37.5	39.0	36.2	36.2	38.7	36.2
27	42.5	42.5	42.5	42.5	38.7	41.2	42.5	42.5	38.7
Middle									
3	40.0	40.5	38.7	38.7	38.7	40.0	40.0	38.0	40.0
4	36.2	43.7	35.0	35.0	37.5	38.7	42.5	46.2	42.5
5	36.2	43.7	42.5	40.0	42.0	42.5	42.5	38.7	37.5
8	37.5	42.5	38.7	36.2	41.2	42.5	43.0	41.2	41.2
16	45.0	44.5	45.0	46.2	45.0	45.0	45.0	42.5	45.0
20	37.5	37.5	40.0	38.7	30.0	40.0	36.2	40.0	38.7
21	43.2	40.0	42.5	42.5	41.2	42.5	37.0	41.2	40.0
23	45.0	45.0	45.0	42.5	45.0	45.0	45.0	41.2	41.2
28	40.0	46.0	42.5	37.5	37.5	42.5	43.0	42.5	42.5
29	37.5	38.9	35.0	36.2	37.5	41.2	37.5	36.2	38.0
Extraverted									
7	42.5	42.5	36.2	37.5	37.5	42.5	41.2	46.2	43.2
9	39.5	40.0	38.7	35.0	37.5	38.7	35.0	36.2	37.5
11	42.5	42.5	42.5	41.2	42.5	41.2	42.5	38.7	37.5
12	35.0	36.2	36.2	37.0	38.0	40.0	40.0	46.2	39.5
14	41.2	37.0	40.0	36.5	42.0	35.5	36.2	40.0	37.5
15	37.5	40.0	37.5	37.5	37.5	37.5	37.5	37.5	37.5
18	40.0	38.7	38.7	40.0	40.0	40.0	38.0	41.2	40.0
19	38.7	38.7	37.5	37.5	36.2	37.5	35.0	35.0	36.2
25	38.7	38.7	38.7	37.5	38.7	38.7	37.5	43.7	37.5
30	36.2	35.0	36.2	35.0	34.7	38.7	35.0	36.2	36.2

Uncorrected R_2 Latencies in msec. for Peak 6 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	39.5	37.5	37.5	37.5	46.2	35.0	37.5	33.7	41.2
2	40.0	37.5	35.0	41.2	38.7	40.0	47.5	36.2	35.0
6	36.2	38.7	40.0	47.5	40.0	36.2	50.5	36.2	36.5
10	36.2	36.2	40.0	36.2	37.5	36.2	36.2	37.5	38.7
13	37.5	40.0	40.0	43.7	41.2	42.5	42.5	42.5	42.5
17	41.2	32.5	40.0	42.5	45.0	43.7	47.5	43.7	43.7
22	37.5	35.0	38.7	40.0	37.5	37.5	41.2	38.7	37.5
24	37.5	35.0	40.0	40.0	37.5	40.0	41.2	37.5	37.5
26	38.7	36.2	32.5	37.5	37.5	40.0	38.7	38.7	40.0
27	43.7	42.5	43.7	43.7	46.2	45.0	45.0	40.0	35.0
Middle									
3	37.0	40.5	40.0	41.2	40.0	40.0	40.0	40.0	40.0
4	37.5	33.0	37.5	41.2	35.0	35.0	37.5	36.2	46.2
5	38.7	38.7	45.0	40.0	37.5	38.7	41.2	47.0	43.0
8	38.7	40.0	40.0	38.7	42.5	43.7	41.0	46.2	37.5
16	37.5	38.7	38.0	40.0	42.5	37.5	32.5	43.7	47.5
20	40.0	42.5	41.2	41.2	42.5	42.5	41.2	41.2	38.7
21	37.5	41.2	38.0	40.0	42.5	43.7	45.0	47.5	42.5
23	41.2	40.0	38.7	33.7	42.5	32.5	33.7	46.2	37.5
28	36.2	40.0	43.7	41.2	40.0	40.0	41.0	42.5	36.2
29	38.7	40.0	35.0	38.7	40.0	36.2	38.7	37.5	40.0
Extraverted									
7	41.0	40.5	42.5	32.5	38.7	41.2	45.0	37.5	43.0
9	40.0	38.2	40.0	39.0	42.5	40.0	37.5	38.7	38.5
11	40.0	38.7	41.0	38.7	41.2	42.5	36.0	41.2	40.0
12	37.5	34.5	41.0	35.0	34.5	35.0	38.0	41.0	40.0
14	41.2	36.2	42.5	42.5	44.0	42.5	41.2	40.0	38.0
15	35.0	38.2	40.0	37.5	41.2	40.0	38.7	37.5	38.5
18	40.0	39.0	40.0	35.0	41.2	40.0	40.0	40.0	41.2
19	35.0	41.0	37.5	38.7	40.0	38.7	35.0	38.7	34.7
25	38.7	38.7	40.0	40.0	41.2	40.0	42.5	42.5	43.7
30	35.0	36.2	38.7	39.0	38.7	40.0	37.5	38.7	37.5

APPENDIX 3

Corrected R_2 Latencies in msec. for Peak 6 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	-5.50	-10.00	-5.00	-1.20	-1.30	.00	-.50	-5.00	.00
2	-3.70	-2.50	-2.50	3.70	-1.30	1.30	10.00	-5.00	-3.50
6	-3.30	-3.30	-1.20	5.50	.00	-6.30	5.00	-5.00	-8.50
10	-1.30	1.20	2.50	-1.30	1.30	.00	.00	.00	1.20
13	-1.20	-1.20	2.50	7.50	6.20	1.30	3.80	2.50	3.50
17	-.60	-12.50	2.50	.00	5.00	1.70	12.50	2.50	2.50
22	.00	-1.20	.00	-4.00	-1.20	1.30	3.20	2.50	2.50
24	.00	-1.20	2.50	-4.00	-1.20	2.50	3.20	.00	2.50
26	5.70	1.20	-2.50	.00	-1.50	3.80	2.50	.00	3.80
27	1.20	.00	1.20	1.20	7.50	3.80	2.50	-2.50	-3.70
Middle									
3	-3.00	.00	1.30	2.50	1.30	.00	.00	-2.00	.00
4	1.30	-10.70	2.50	6.00	-2.50	-3.70	-5.00	-10.00	3.70
5	2.50	-5.00	2.50	.00	-4.50	-3.80	-1.30	8.30	5.50
8	1.20	-2.50	1.30	2.50	1.30	1.20	-2.00	-5.00	-3.70
16	-7.50	-5.80	-7.00	-6.20	-2.50	-7.50	-12.50	1.20	2.50
20	2.50	5.00	1.20	2.50	12.50	2.50	5.00	1.20	.00
21	-5.70	1.20	-4.50	-2.50	1.30	1.20	8.00	6.30	2.50
23	-3.80	-5.00	-6.30	-8.80	-2.50	-12.50	-11.70	5.00	-3.70
28	-3.80	-6.00	1.20	3.70	2.50	-2.50	-2.00	.00	-6.30
29	1.20	1.10	.00	2.50	2.50	-5.00	1.20	1.30	2.00
Extraverted									
7	-1.50	-2.00	6.30	-5.00	1.20	-1.30	3.80	-8.70	-.20
9	.50	-1.80	1.30	4.00	5.00	1.30	2.50	2.50	1.00
11	-2.50	-3.80	-1.50	-2.50	-1.30	.80	-6.50	2.50	2.50
12	2.50	-1.70	4.80	-2.00	-3.50	-5.00	-2.00	-5.20	.50
14	.00	-.80	2.50	6.00	2.00	7.00	5.00	.00	.50
15	-2.00	-1.80	2.50	.00	3.70	2.50	1.20	.00	1.00
18	.00	-.30	1.30	-5.00	1.20	.00	2.00	-1.20	1.20
19	-3.70	2.30	.00	1.20	3.80	1.20	.00	3.70	-1.50
25	.00	.00	1.30	2.50	2.50	1.30	5.00	-1.20	6.20
30	-1.60	1.20	2.50	4.00	4.00	1.30	2.50	2.50	1.30

Means of Corrected R_2 Values for Groups of Introverted(I), Middle(M), and Extraverted(E) Subjects for Peak 6.

Interstimulus Interval (msec.)	Mean Latency Values (msec.) I	M	E
40.0	- .85	-1.51	- .83
50.0	-2.95	-2.77	- .87
60.0	.00	- .78	2.10
70.0	.74	.22	.32
80.0	1.35	.94	1.66
90.0	.94	-3.01	.91
100.0	4.22	-2.03	1.35
110.0	-1.00	.63	- .51
120.0	.03	.25	1.25

R_1 Latencies in msec. for Peak 7 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	47.0	52.5	50.0	44.2	56.2	40.0	42.5	43.7	43.0
2	46.2	42.5	42.5	42.0	42.0	43.7	42.5	42.5	42.5
6	52.5	52.0	50.0	52.5	50.0	52.5	50.0	50.0	55.0
10	46.2	44.0	51.2	45.0	45.5	50.0	46.7	50.0	45.0
13	51.2	51.2	47.5	43.7	47.5	43.5	51.2	47.5	53.7
17	53.0	53.7	45.0	47.5	53.7	53.7	52.5	46.2	46.2
22	45.0	43.7	43.7	42.5	45.0	43.7	43.7	43.7	42.5
24	46.2	43.7	43.7	43.7	47.5	43.5	43.7	43.7	42.5
26	42.5	42.5	43.7	45.0	44.0	43.7	46.2	42.5	42.5
27	48.7	47.5	50.0	50.0	41.2	53.7	44.5	50.0	40.0
Middle									
3	52.0	50.0	52.5	50.0	48.7	51.2	50.0	51.2	52.5
4	47.5	48.7	50.0	53.7	50.0	47.5	50.0	51.2	50.0
5	52.5	52.5	55.0	50.0	55.0	52.5	53.7	51.2	53.7
8	47.5	51.2	51.2	47.5	51.2	51.2	50.0	52.5	50.0
16	53.7	54.5	55.0	55.0	53.7	56.2	52.5	52.5	56.2
20	47.5	48.7	46.2	43.7	45.0	45.0	42.5	46.2	46.2
21	52.5	52.5	56.2	55.0	53.0	53.7	48.0	54.0	53.0
23	55.0	55.0	53.7	52.5	57.5	51.2	52.5	52.5	57.5
28	48.7	52.5	48.0	53.7	49.5	51.2	48.7	52.5	45.0
29	43.7	50.0	46.2	47.5	38.7	46.2	48.0	42.5	49.0
Extraverted									
7	46.2	49.5	43.7	42.5	45.0	47.5	46.2	50.0	52.5
9	51.2	50.0	48.7	42.5	50.0	42.5	42.5	48.7	43.0
11	47.5	47.5	50.0	50.0	50.0	47.5	49.5	50.0	47.5
12	40.0	45.0	45.0	42.5	46.0	46.2	47.5	52.5	43.7
14	51.2	50.0	50.0	52.5	52.5	52.5	47.5	49.0	50.0
15	47.5	46.2	45.0	47.5	47.5	47.5	47.5	47.0	45.0
18	57.2	50.0	48.7	55.0	52.5	52.5	51.2	46.2	53.7
19	43.7	42.5	45.0	43.7	43.7	45.0	43.7	43.7	43.7
25	51.2	55.0	50.0	50.0	52.5	52.5	53.7	55.0	52.5
30	45.0	43.7	44.5	42.5	43.7	42.5	42.5	48.7	43.0

Uncorrected R_2 Latencies in msec. for Peak 7 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	42.0	41.2	42.5	43.7	51.2	40.0	41.2	38.7	46.2
2	45.0	42.5	40.0	45.0	42.0	43.0	52.5	37.5	39.2
6	41.2	43.7	44.5	56.7	43.7	42.5	55.0	42.5	42.5
10	42.5	43.7	44.0	40.0	45.0	47.5	43.7	42.5	45.0
13	51.2	51.2	44.5	46.2	43.0	50.0	47.5	47.5	47.0
17	53.0	36.2	52.5	48.7	52.0	53.7	52.5	53.7	54.8
22	48.0	42.5	48.7	49.5	47.5	47.5	46.7	47.5	42.5
24	42.5	42.5	44.5	46.2	45.0	50.0	46.7	38.7	42.5
26	47.5	42.5	43.7	45.0	46.2	45.0	46.2	50.0	52.5
27	48.7	48.7	50.0	51.2	53.7	50.0	54.5	42.5	38.7
Middle									
3	51.2	51.2	51.2	53.0	53.7	50.0	50.0	50.5	55.0
4	42.5	40.0	45.0	48.7	42.5	44.0	46.2	47.5	49.5
5	48.0	52.5	53.7	45.0	41.2	47.5	48.7	56.2	51.2
8	46.2	50.0	50.0	45.0	50.0	50.0	46.2	46.7	49.5
16	47.5	47.5	42.5	47.5	46.2	42.5	42.5	50.0	56.2
20	52.5	53.7	50.0	52.5	50.0	47.5	42.5	50.0	42.5
21	46.2	47.5	48.0	45.0	51.2	53.7	53.7	56.0	46.2
23	51.2	50.0	46.0	42.5	50.0	33.7	36.2	53.7	45.0
28	50.0	50.0	47.5	48.7	52.0	48.7	43.7	46.2	45.0
29	45.0	46.2	46.2	45.0	45.0	40.0	43.7	42.5	41.2
Extraverted									
7	46.0	48.0	45.0	40.0	42.5	46.2	51.2	42.5	47.5
9	47.5	50.0	50.0	47.5	45.0	47.5	47.5	43.0	43.7
11	45.0	42.5	46.2	51.2	45.0	47.5	43.7	46.0	42.0
12	46.2	42.5	45.0	45.0	45.0	42.5	41.2	53.0	45.0
14	50.0	50.0	50.0	57.5	50.0	51.2	45.0	36.2	50.0
15	44.5	47.5	52.5	50.0	50.0	48.7	51.2	46.2	43.7
18	45.0	45.0	43.2	42.5	49.5	50.0	45.0	60.0	43.7
19	46.0	45.0	43.2	43.7	45.0	42.5	45.0	46.2	42.5
25	47.5	46.2	51.2	51.2	50.5	50.0	51.2	52.5	55.0
30	43.7	47.5	43.7	47.5	46.2	47.5	47.5	43.0	43.7

APPENDIX 3

Corrected R_2 Latencies in msec. for Peak 7 for Groups of Introverted, Middle and Extraverted Subjects.

Subject	Interstimulus Interval msec.								
	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
Introverted									
1	-5.00	-11.30	-7.50	-.50	-5.00	.00	-1.30	-5.00	3.20
2	-1.20	.00	-2.50	-3.00	.00	-.70	10.00	-5.00	-3.30
6	-11.30	-8.30	-5.50	4.20	-6.30	-10.00	5.00	-7.50	-12.50
10	-3.70	-.30	-7.20	-5.00	-.50	-2.50	-3.00	-7.50	.00
13	.00	.00	-3.00	2.50	-4.50	6.50	-3.70	.00	-6.70
17	.00	-17.50	7.20	1.20	-1.70	.00	.00	7.50	8.70
22	-3.00	-1.20	5.00	7.00	2.50	-4.00	3.00	3.80	.00
24	-3.70	-1.20	.80	2.50	-2.50	6.50	3.00	-5.00	.00
26	5.00	.00	.00	.00	2.20	1.30	.00	7.50	10.00
27	.00	-1.20	.00	1.20	12.50	-3.70	10.00	-7.50	-1.30
Middle									
3	-.80	-1.20	-1.30	3.00	5.00	-1.20	.00	-.70	2.50
4	-5.00	-8.70	-5.00	-5.00	-7.50	-3.50	-3.80	-3.70	-.50
5	-4.50	.00	-1.30	-5.00	-13.80	-5.00	-5.00	-5.00	-2.50
8	-1.30	-1.20	-1.20	-2.50	-1.20	-1.20	-3.80	-5.80	-.50
16	-6.20	-7.00	-12.50	-7.50	-7.50	-13.70	-10.50	-2.50	.00
20	5.00	5.00	3.80	8.80	-5.00	2.50	.00	3.80	-3.70
21	-6.30	-5.00	-8.20	-10.00	-1.80	.00	5.70	2.00	-6.80
23	-3.80	-5.00	-7.70	-10.00	-7.50	-17.50	-16.30	1.20	-12.50
28	1.30	-2.50	-.50	-5.00	2.50	-2.50	-5.00	-6.30	.00
29	1.30	-3.80	.00	-2.50	6.30	-6.20	-4.30	.00	-7.80
Extraverted									
7	-.20	-1.50	1.30	-2.50	-2.50	-1.30	5.00	-7.50	-5.00
9	-3.70	.00	1.30	5.00	-5.00	5.00	5.00	-5.70	.70
11	-2.50	-5.00	-3.80	1.20	-5.00	.00	-5.80	-4.00	-5.50
12	-6.20	-2.50	.00	2.50	-1.00	-3.70	-6.30	.50	1.30
14	-1.20	.00	.00	5.00	-2.50	-1.30	-2.50	-12.80	.00
15	-3.00	1.30	7.50	-2.50	2.50	1.20	3.70	-.80	-1.30
18	-12.20	-5.00	-5.50	-12.50	-3.00	-2.50	-6.20	13.80	-10.00
19	2.30	2.50	-1.80	.00	1.30	-2.50	1.30	2.50	-1.20
25	-3.70	-8.80	1.20	1.20	-2.00	-2.50	-2.50	-2.50	2.50
30	-1.30	3.80	-.80	5.00	2.50	5.00	5.00	-5.70	.70

Means of Corrected R_2 Values for Groups of Introverted(I), Middle(M), and Extraverted(E) Subjects for Peak 7.

Interstimulus Interval (msec.)	Mean Latency Values (msec.)		
	I	M	E
40.0	-2.29	-2.03	-3.17
50.0	-4.10	-2.94	-1.52
60.0	-1.27	-3.39	- .06
70.0	1.01	-3.57	.24
80.0	- .33	-3.05	-1.47
90.0	- .66	-7.08	- .26
100.0	2.30	-4.30	- .33
110.0	-1.87	- .70	-2.22
120.0	- .19	-3.18	-1.78

APPENDIX 4

POST-ANALYSES

APPENDIX 4

POST-ANALYSES

Second statistical analyses were carried out upon the advice of Dr. Charles Shagass. These analyses, considered more liberal in nature, follow more closely the procedures utilized by Shagass in his data analysis. Utilizing the within-groups regression equation for each individual inter-stimulus interval, the uncorrected R_2 values were corrected for their regression upon R_1 values. These corrected R_2 values were then submitted to the appropriate analysis of variance procedure, the Type I analysis of variance for "mixed" designs. Separate analyses of amplitude data were done for each of peaks 1 - 4, 4, 6 and 7.

Although the levels of significance reached were higher than those obtained with the more conservative procedure reported in the text of this thesis, the levels of significance reached were not considered statistically significant.

Further statistical analyses were carried out on the R_1 data. The Type I analysis of variance for "mixed" design was done separately for R_1 data for peaks 1 - 4, 4, 6 and 7 (amplitude) and 6 and 7 (latency). The levels of significance reached were not considered statistically significant for any of the analyses.

APPENDIX 5

ABSTRACT OF

Extraversion: Recovery from the Effects of Somatosensory Stimulation

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Extraversion: Recovery from the Effects of Somatosensory Stimulation[1]

This thesis attempted to investigate the relationship between the Eysenckian dimension of Extraversion and certain aspects of the recovery function. The recovery function, as operationally defined by Shagass, was utilized as a measure of physiological reactivity for the study of arousal and information transmission, or in Eysenckian terms, of cortical excitation and cortical inhibition.

Three groups of ten male subjects, selected on the basis of the Eysenck Personality Inventory, Form A, and designated as Introverted, Middle and Extraverted subjects, were stimulated at the right median nerve with a constant current of 10 ma. above individually determined thresholds; pulses were .1 msec. in duration and given in series. Each series consisted of paired and unpaired stimuli; repetition rate averaged one per second and the paired stimuli were separated by nineteen intervals whose length ranged from 2.5 to 120 msec. The presentation of the interstimulus

1 L. S. Burgess, doctoral thesis presented to the School of Graduate Studies of the University of Ottawa, Ontario, 1973, xi-137 p.

intervals were random for each subject. Evoked responses from the left hemisphere were detected, averaged, plotted and utilized for developing recovery function data.

The results of the recovery function data analyses did not demonstrate that the dimension of Extraversion, in the age group tapped by this study, is related to aspects of the recovery function hypothesized to be indicative of efficiency in information transmission and cortical clearing, as well as levels of arousal. These findings could, nevertheless, be interpreted in support of Shagass' theory of differential maturation rates in introverted and extraverted subjects. However, some technical aspects of the study called for a cautious interpretation of these findings.

These results were interpreted in the light of related theoretical background and research studies.