BILINGUAL MEMORY AND THE ORIENTING REFLEX

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CURRICULUM STUDIORUM

Daniel Crocco was born July 10, 1943, in Timmins, Ontario. He received the Bachelor of Arts degree from the University of Western Ontario in 1965. The degree of Master of Applied Science was granted to him from the University of Waterloo, Waterloo, Ontario, in 1969. The title of his research was Canter's BIP Bender Test for the Detection of Organic Brain Disorder: Left vs. Right Hemispheric Performance.

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INTRODUCTION

The nature of processes underlying bilingual or inter-language memories is a question with far reaching scientific and practical importance. The following study is concerned with the investigation of bilingual memory storage and processes using a physiological index of cortical memory relationships called the Orienting Reflex. The research addresses itself to testing types of bilinguals, having operationally defined fused or different inter-language memories with stimuli similarly classed, using Sokolov's cortical memory model of the Orienting Reflex. More specifically, the thesis asks whether types of bilinguals and English-French dictionary equivalent words, the former defined from second language acquisitional history along a continuum of shared or separated inter-language memory stores and the latter along the concreteness-abstractness continuum, exhibit these differences in disinhibition of the Orienting Reflex. A sub-study also investigates whether dominant French bilinguals, having a greater familiarity with French words, manifest this difference on the Orienting Response.

There are two major hypotheses generated by Sokolov's theory of the Orienting Reflex. Orienting diminishes (habituates) as a cortical model is formed of the stimulus. Disinhibition occurs with presentation of a new stimulus and the magnitude of the new Orienting Response is related to the new stimulus' degree of similarity to the already present stimulus' memory model; the more mismatch existing between the new stimulus and model, the greater the Orienting Response.

Monolinguals have the signs that describe their experiences belonging to one linguistic system, whereas the bilingual or polyglot has two or more frameworks or sign systems to conceptualize his world. Bilingualism provides a unique avenue from which to study psychological indices of naturally acquired inter-language memory differences with expected physiological counterparts measured by the Orienting Response.

In this study three types of bilingual subjects differing in second language acquisitional history are used. In the major part of the study, only balanced (equally proficient) bilinguals are compared. A second minor investigation is concerned with a study of dominant French bilinguals.

Bilinguals are defined as "compound" if the memory store for both languages is fused; these bilinguals can be so typed if they have acquired both languages together so that the experiences encoded by both are similar. "Co-ordinate" bilinguals, conversely, are defined as having acquired both languages in separate contexts so that the memory of a word in one language will not be the same as the memory of a translated-equivalent word in the other language. Stimuli categorized as concrete or abstract are used with these subjects to test whether greater semantic distances are demonstrated for abstract vs. concrete inter-language dictionary equivalent words.

The principal study tests whether "Co-ordinate" balanced bilinguals show greater disinhibition to a stimulus than "Compound" balanced bilinguals after habituating to the same stimulus' other language dictionary equivalent; and whether abstract words exhibit greater disinhibition than concrete words because of fewer reported inter-language shared referents.

Based on Sokolov's model, it is predicted that dominant French bilinguals should show greater natural Orienting behavior to English words because of the fewer cortical models existing for these words.

The first chapter begins with a general perspective on the neurological and psychological evidence concerning bilingual language relationships. Following this general review, is a section on the compound-co-ordinate subject dimension. Sections on the Orienting Reflex and the dis-inhibition phenomenon and a statement of the hypotheses close this chapter. Chapter two is concerned with the experimental design, subject classifications, tools of the experiment, quantification, and the specific designs used in the statistical analyses. Chapter three includes a presentation of the physiological results and other experimental data, discusses the results, and raises questions concerning future research.

CHAPTER I

REVIEW OF THE LITERATURE

1. Neurological Observations of Bilingual Language Relationships.

The neurological studies of adult bilinguals' memory functioning and interlanguage relationships have been confined to a study of language behavior and loss following brain injury. Neurological observations of polyglots with aphasia, although providing seemingly excellent opportunities for examining interlanguage memory relationships, have produced no exact conclusions. Conflicting opinions and observations have long clouded the neurological question of the anatomical and functional relationships of a bilingual's languages.

According to Goldstein[1] and Vildomec[2] several rules have been generated to explain brain-damaged polyglots with differential loss between languages; however, all have failed to gain wide general acceptance. Ribot's law stated that in brain injury, the language having the oldest memory remains relatively intact whilst the more recent language is lost.

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1 Kurt Goldstein, Language and Language Disturbances, New York, Grune and Stratton, 1948, p. 138.

2 V. Vildomec, Multilingualism, Netherlands, Sythoff-Leyden, 1963, p. 61.

Pitre from his observations suggested alternatively that the language which was used most extensively used immediately prior to the lesion would be preserved over any others less widely used. Another more general view suggested that the return of a language depended on the personality and total psychological and affective needs of the recovering aphasic.[3]

R. E. Scoresby-Jackson, according to Vildomec,[4] proposed in 1867 that the second and subsequent languages of the polyglot were to be located within the anterior part of the third left frontal convolution. Although this point of view is generally unaccepted, an observation by Penfield[5] and others that the right hemisphere (usually the non-dominant language hemisphere in right-handed people) can assume language functions at an early age is well documented. Penfield stated his disbelief in separate storage areas for different languages, and for differential language loss after aphasia.[6] One author suggested that the phenomenon of right-hemispheric language transference at an early age may be one way of explaining widespread

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3 Goldstein, _op. cit_., p. 146.

4 Vildomec, _op. cit_., p. 60.

5 W. Penfield and L. Roberts, _Speech and Brain Mechanisms_, Princeton, N.J., Princeton University Press, 1959, p. 240.

6 _Ibid_., p. 221, 253.

observations of differential loss of languages after brain insult. Goldstein pointed out, although only referring to monolinguals recovering from aphasia:

> We are (...) not at all certain whether a returning performance is not due to the fact that that part in the hemisphere which is important for the performance has always functioned together with the corresponding part in the dominant hemisphere.[7]

The query has arisen then, whether adult polyglots who lose language functions due to a cerebral insult in the left hemisphere and only gain back their native (first) language may be doing so because that language was also coded within the right hemisphere.

O. Potzl, according to Vildomec, contained the bilingual's language switching functions within the "back limit of the sylvian fissure and neighboring part of the parietal lobe."[8] He suggested that an insult here might compel the aphasic to involuntarily use only one language. Penfield also spoke about a neurological switch, although he did not speculate about its location.[9]

Although only touched upon in the above review, there is no clear evidence coming from neurological

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7 Goldstein, op. cit., p. 51.

8 Vildomec, op. cit., p. 62.

9 Penfield, op. cit., p. 253.

pathologies to answer the question of one or two memory stores for a bilingual. One might conclude that the great variety of subjects involved in the studies and the diversity of brain insults combined in producing the assortment of speculations about differential memory and functional behavior. Goldstein ended his discussion on this topic with:

> There are a number of factors determining which language is preferred in a polyglot individual if he acquires an aphasia. No factor, however, can be considered isolatedly as a cause of the individual picture (...).[10]

This writer would like to turn now to selected psychological studies which have proven to be more successful in providing information on the decoding, memory and encoding processes of bilinguals.

2. Psychological Processes in Bilingualism.

It was I. Epstein's monograph "La pensée et la polyglossie" in 1915, according to Vildomec,[11] that first dealt with the psychological aspects of multilingualism. Epstein distinguished two types of language differences:

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10 Goldstein, <u>op. cit</u>., p. 146.

11 Vildomec, <u>op. cit</u>., p. 13-15.

(1) verbal-symbolic dissimilarities arising from different verbal signs;

(2) idiomatic differences due to variations in interlanguage meaning.

An excellent and relatively recent review of the psychological processes in bilingual functioning was presented by John MacNamara.[12] Selected psychological evidence, accumulated using a variety of techniques, on encoding, storage, and decoding of information across linguistic systems is presented below.

Potzl and Penfield and Roberts had explained the functional independence of language on the basis of a switch so that when one language was being used, the other was switched off. The latter authors also called the switch a "conditioned reflex." Bilinguals were shown to take more time reading a mixed paragraph of English and French phrases than reading a paragraph in one or the other language.[13] The longer reading time for a mixed passage was attributed to the operation of this neural switch.

Further analyses showed, however, that this switch was never completely closed as interference occurred between

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12 J. MacNamara, "A Bilingual's Linguistic Performance. A Psychological Overview," Journal of Social Issues, Vol. 23, 1967, p. 58-77.

13 P. A. Kolers, "Bilingualism and Information Processing," Scientific American, Vol. 218, March 1968, p. 78-86.

languages.[14,15] Preston showed that Penfield and Roberts' one-switch model was inadequate and proposed a model with two switches: the input switch automatically decoding the incoming language; the output switch, on the other hand, voluntarily closing towards the language chosen for encoding. Further evidence for this two-switch model was given by MacNamara and Kushnir.[16] They demonstrated that the switches operated sequentially and independently and experimentally arrived at a mean input switching time of 0.20 seconds and a mean output switching time of 0.20 seconds, for a total sequential time lag of 0.40 seconds--a figure similar to that found by another researcher.[17] It was suggested that the input switch is analogous to the pre-attentive processes described by Neisser:

> (...) those automatic perceptual analyzers which effect a preliminary characterization of a sensory input before it is subjected to fuller analytic processes.[18]

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14 M. S. Preston, Inter-lingual Interference in a Bilingual Version of the Stroop Colour Word Test, unpublished Ph.D. thesis, Montreal, McGill University, 1965, as reported in MacNamara, op. cit., p. 67.

15 Kolers, op. cit., p. 78-86.

16 J. MacNamara and S. Kushnir, "Linguistic Independence of Bilinguals: The Input Switch," Journal of Verbal Learning and Verbal Behaviour, Vol. 10, 1971, p. 480.

17 P. A. Kolers, "Reading and Talking Bilingually," American Journal of Psychology, Vol. 79, 1966, p. 357-376.

18 MacNamara and Kushnir, op. cit., p. 484.

The bilingual anticipating a switch while speaking can do so without much interruption.[19] The study showed that regularly anticipated output switches take a significantly shorter time than irregular ones. On the other hand, attempting to bring the input switch under control only disrupted its functioning.[20]

Using a continuous bilingual recognition memory test, Kintsch[21] demanded his subjects to respond using either language-specific cues or general semantic cues. For both conditions, interference effects showed that language-specific cues intruded when the subjects concentrated and operated upon word meanings and word meanings interfered with the recognition of language-specific forms.

Some evidence has suggested that the links within a language are stronger than between.[22] Other studies found that semantic categories were more powerful

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19 J. MacNamara and M. Krauthamer, "Language Switching in Bilinguals as a Function of Stimulus and Response Uncertainty," Journal of Experimental Psychology, Vol. 78, 1968, p. 208-215.

20 MacNamara and Kushnir, op. cit., p. 484.

21 W. Kintsch, "Recognition Memory in Bilingual Subjects," Journal of Verbal Learning and Verbal Behaviour, Vol. 9, 1970, p. 405-409.

22 Insup Taylor, "How Are Words from Two Languages Organized in Bilingual's Memory?" Canadian Journal of Psychology, Vol. 25, 1971, p. 228-240.

organizers.[23] Dalrymple-Alford and Aamiry concluded a compromise:

> (...) the main organizational principle in bilingual free recall is one in terms of conjoint category and language membership and not language or semantic category alone.[24]

Goggins and Wickens,[25] using a proactive interference paradigm, illustrated that release from interference occurred when either the language or the taxonomic category of the items changed in the last trial. An even greater release was demonstrated when both category and language were shifted.

A series of studies by Kolers gave further insight into the question of how a bilingual stores his language experiences. From a study using word association techniques, he suggested that memories were stored within the language used to define the experience.[26] In other words, if a

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23 W. Lambert, M. Ignatow and M. Krauthamer, "Bilingual Organization in Free Recall," Journal of Verbal Learning and Verbal Behaviour, Vol. 7, 1968, p. 207-214.

24 E. C. Dalrymple-Alford and A. AAmiry, "Language and Category Clustering in Bilingual Free Recall," Journal of Verbal Learning and Verbal Behaviour, Vol. 8, 1969, p. 767.

25 J. Goggins and D. Wickens, "Proactive Interference and Language Change in Short-term Memory," Journal of Verbal Learning and Verbal Behaviour, Vol. 10, 1971, p. 453-458.

26 P. A. Kolers, "Interlingual Word Associations," Journal of Verbal Learning and Verbal Behaviour, Vol. 2, 1963, p. 291-300.

bilingual has a monolingual learning experience, that experience will be tagged and conceptualized only within the language used in that particular context. Moreover, the same study showed that abstract words had fewer shared (dictionary-equivalent) associations between languages than more concrete stimuli; the author concluded that experiences and actions associated to concrete referents were more similar than those experiences linked to conceptually abstract or affective ones.

Bilingual subjects who received half the number of times ($\frac{1}{2}$N) a word in one language and $\frac{1}{2}$N its translated equivalent in the other language demonstrated the same recall of that word in either language as if having them presented N in one language.[27] The same author had stated earlier that memories were only stored within the language used in encoding.[28] His final conclusion, to this series of studies, was that if the same experience were presented and operated on within the same context by both languages, then a summation effect occurred which made the experience more or less semantically equivalent and readily available to both.[29]

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27 P. A. Kolers, "Interlingual Facilitation of Short Term Memory," Journal of Verbal Learning and Verbal Behaviour, Vol. 5, 1966, p. 314-319.

28 --------, *op. cit.*, 1963, p. 300.

29 --------, *op. cit.*, 1968, p. 84.

The idea of semantic memory storage being a function of the language or languages used in the context is not a new one. The next section introduces and expands the distinction of compound and co-ordinate bilingualism, proposing for bilinguals one or two memories depending on the acquisition and operational histories of their two languages.

3. Compound and Co-ordinate Bilingualism.

Weinreich[30] proposed essentially two methods by which the bilingual could handle two signs which are inter-language dictionary equivalents: treating or coding the two signs with an identical mediator (compound); treating the two signs with different mediators (co-ordinate).

According to Weinreich, Scerba extended this idea and distinguished two types of bilinguals according to the chronic fashion in which they gave meaning to their bilingual signs. It was Ervin and Osgood who first described a psychological model for the constructs of compound and co-ordinate bilingualism.[31]

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30 U. Weinreich, Languages in Contact, New York, Linguistic Circle of New York, 1953.

31 S. Ervin and C. Osgood, "Second Language Learning and Bilingualism," Journal of Abnormal and Social Psychology (Supplement), Vol. 49, 1954, p. 139-146.

Compound bilinguals are defined as having one set of mediational processes or meaning system for both languages since both languages coded the same experiences. Co-ordinates hold language-specific mediational processes, because each language was developed within different contexts and experiences.

Jacobovits[32] proposed a modified version of Ervin and Osgood's model for the compound-co-ordinate dimension. Jacobovits' model is illustrated on the next page.

L_a and L_b refer to the language input stimuli. The input switch is a proposed mechanism, discussed earlier, to channel input signs to the appropriate language to be decoded. In certain situations this mechanism is off, for example, in the case of no language set; this instance requires a separator or filter system to perceive language-specific cues and channel appropriately. At other times this input switch may be closed in whatever language context the bilingual is in.

Both compound and co-ordinate models to the L_a and L_b decoding mechanisms are identical. However, where the co-ordinate has one mediational system for each language and a direct line to encoding (output), the compound has one

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32 L. A. Jacobovits, "Dimensionality of Compound-Co-ordinate Bilingualism," Language Learning, Vol. 17-18, 1967-68, p. 29-55.

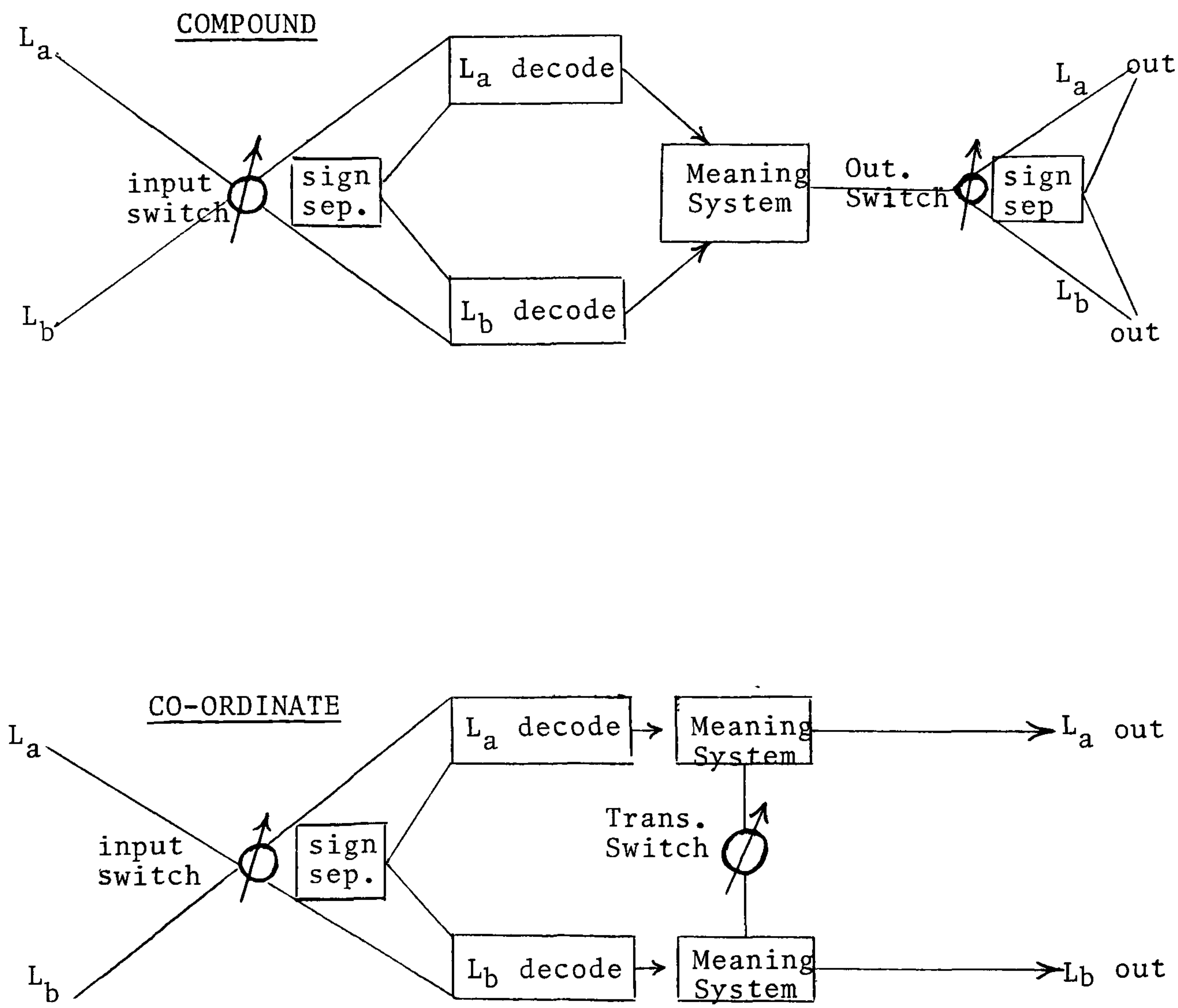

Figure 1.- Jacobovits' Model of Compound-Co-ordinate Bilingualism.[1]

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1 L. A. Jacobovits, "Dimensionality of Compound Co-ordinate Bilingualism," Language Learning, Vol. 17-18, 1967-68, p. 37.

mediational system and an output switch to encode in the proper language.

A separator or filter is also proposed at the output switch of the compound. The co-ordinate, however, has a switch between mediational systems to allow him translation capabilities from one language to the other.

It is important to note that, although early speculation on compound-co-ordinate bilinguals treated them either as one or the other, the more acceptable contemporary view is that this distinction is more continuous, with bilinguals being more or less compound or co-ordinate. Jacobovits presents a complete review of the methods which can be used to index a bilingual's place along this dimension.[33]

Most of the studies on the compound-co-ordinate construct were performed at McGill University; an excellent review of these studies has been presented by Wallace Lambert.[34]

The first reported study at McGill to test empirically the hypothetical construct of compound-co-ordinate bilingualism was that by Lambert, Havelka and Crosby.[35]

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33 *Ibid*., p. 41-47.

34 W. Lambert, "Psychological Studies of the Interdependencies of the Bilingual's Two Languages," in J. Puhvel (Ed.), *Substance and Structure of Language*, Berkeley, University of California Press, 1969, p. 99-126.

35 W. Lambert, J. Havelka, and C. Crosby, "The Influence of Language Acquisition Contexts on Bilingualism," *Journal of Abnormal and Social Psychology*, Vol. 56, 1958, p. 239-244.

To test Osgood's position that separated language learning contexts enhanced the functional separation of bilingual memory while experience in "fused" contexts reduced this separation, the authors performed a series of studies on bilinguals typed from language histories as compound or co-ordinate. Using Osgood's semantic differential and difference "D" scores, the investigators found that co-ordinates showed greater semantic distance between languages for dictionary equivalent stimuli than did subjects classified as compound. As well, the authors used a retroactive inhibition design and demonstrated again more inter-language independence for the co-ordinate bilinguals.

Lambert and Fillenbaum[36] surveyed the language acquisitional histories and functional language disturbances of a number of aphasic polyglots in Montreal and reported cases from Europe. The authors concluded that compound bilinguals seemed to have a more generalized loss than co-ordinate bilinguals who more often lost the use of one language over the other. These authors offered this study as further proof for the compound-co-ordinate distinction.

Semantic satiation is a phenomenon whereby words continuously repeated lose their meaning. This effect was

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36 W. Lambert and S. Fillenbaum, "A Pilot Study of Aphasia among Bilinguals," Canadian Journal of Psychology, Vol. 13, 1959, p. 28-34.

first illustrated in a study by Lambert and Jacobovits.[37] Using Osgood's semantic differential, they found that words which were indexed on these scales soon became more connotatively neutral following rapid repetition. The above authors extended this procedure to test whether cross-language satiation would occur differentially for compound-co-ordinate bilinguals.[38] Subjects were asked to index a word in one language on the semantic differential. They were then required to repeat the word over and over for a period of fifteen seconds. Upon completion of this phase, subjects were then required to index the word's translated equivalent on Osgood's scale. They found that co-ordinates showed less interlanguage satiation effects than compounds. As a matter of fact, they found that co-ordinates generated more meaning to their interlanguage word equivalents. The authors stated that repetition seemed to release the mediators within the other language. MacLeod[39] replicated the differential interlanguage satiation effect between compounds vs. co-ordinate bilinguals.

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37 W. Lambert and L. Jacobovits, "Verbal Satiation and Changes in the Intensity of Meaning," Journal of Experimental Psychology, Vol. 60, 1960, p. 376-383.

38 L. Jacobovits and W. Lambert, "Semantic Satiation among Bilinguals," Journal of Experimental Psychology, Vol. 62, 1961, p. 576-582.

39 Finlay MacLeod, A Study of Gaelic-English Bilinguals: The Effects of Semantic Satiation, unpublished Ph.D. thesis, Aberdeen University, 1966, reported in MacNamara, op. cit., p. 65.

The Stroop Color Word Test[40] used in the next study, combined in conflict, color of print with word printed. In other words, subjects were required to name quickly the color of print or ink used in the presented words. Conflict arose when the color of the print, for example blue ink, conflicted with the written word, for example, green. Lambert[41] used this procedure and showed that co-ordinate bilinguals were better able than compounds to gate out the conflicting "printed word" in one language when asked to name the "color of print" in the other language.

Another study reported by Lambert[42] showed that co-ordinates performed more poorly than compounds on a recall task facilitated by functional integration of the two languages, but the co-ordinates performed better than compounds on a similar task facilitated by functional independence.

One investigator had failed to find support for the compound-co-ordinate distinction.[43] Olton, using a recognition memory paradigm in one study and a shock-conditioned

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40 J. R. Stroop, "Studies of Interference in Serial Verbal Reactions," Journal of Experimental Psychology, Vol. 18, 1935, p. 643-661.

41 Lambert, op. cit., p. 108.

42 Ibid., p. 125.

43 R. M. Olton, Semantic Generalization between Languages, unpublished Master's thesis, Montreal, McGill University, 1960, 1-29 p.

stimulus reaction time paradigm in another study, attempted to demonstrate greater semantic generalization across languages for compounds over co-ordinates. Both measures failed to index significant differences. The author criticized his study on two main counts: (a) the particular semantic generalization tasks he used only very infrequently demonstrated semantic generalization for both groups; that is, they were only rough indices of generalization because of this low ceiling; (b) the particular tasks he used in the first part of each experiment required all subjects to switch quickly from one language to another. The author felt this switching might have caused the compound bilinguals to behave like co-ordinates, in order not to become linguistically confused. Similar and other criticisms were levied by others.[44,45]

Employing a more refined technique than Olton's, another semantic generalization paradigm was attempted to test whether the two types of bilinguals could be distinguished. In this study the authors[46] compared reaction latencies in a within- and between-language semantic

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44 N. Segalowitz and W. Lambert, "Semantic Generalization in Bilinguals," Journal of Verbal Learning and Verbal Behaviour, Vol. 8, 1969, p. 560.

45 MacNamara, op. cit., p. 65.

46 Segalowitz and Lambert, op. cit., p. 559-566.

generalization task. The experimenters found that both types of bilinguals generalized across languages through meaning. However, they also found that compound bilinguals were less effective in using semantic categories. The authors interpreted the results as reflecting the greater interdependence of the compounds' languages.

Further support for the proposal that two languages learned within one context support one another was given in a final study by Lambert and his group at McGill.[47] They established that compound subjects who were required to search out a core concept, when given mixed language cues, performed better than co-ordinates. The authors reasoned that the compounds' fused and integrated interlanguage memory was more shared and therefore more efficient in this task than the two independent semantic systems of the co-ordinate bilinguals.

More recently another author, using verbal association tasks, demonstrated that compound bilinguals tended to give more similar (dictionary translated) restricted associations than co-ordinates.[48]

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47 W. E. Lambert and C. Rawlings, "Bilingual Processing of Mixed Language Associative Networks," Journal of Verbal Learning and Verbal Behaviour, Vol. 8, 1969, p. 604-609.

48 W. Gekoski, "Effects of Language Acquisition Contexts on Semantic Processing in Bilinguals," reprinted from Proceedings, 78th Annual Convention, American Psychological Convention, 1970, p. 487-488.

Another major dimension in bilingualism is the degree of proficiency or balance exhibited by the bilinguals on their two languages, "balanced bilinguals" being defined as persons who are equally skilled in both languages. The compound-co-ordinate studies reviewed above have employed operationally defined balanced bilinguals. This dimension is deemed as another important consideration for studies using bilingual subjects, especially when an attempt is being made to investigate interlanguage memory processes. A survey of measurement techniques used to index degree of balance of languages is found in a number of reviews. Further consideration of this problem will be given in the second chapter.

4. Summary.

In summary, a few statements can be made about the anatomical and functional relationships between a bilingual's two languages. There is no firm or unanimous understanding of whether different languages are anatomically fused or separated and, if so, how. There is evidence, however, to suggest that a language "switching" does occur in order to allow bilinguals a substantial amount of freedom of interlanguage interference.

Kolers had demonstrated that interlanguage semantic similarity increased with increasing concretization of the stimuli or operations. He had used an association test to demonstrate that there were fewer interlanguage dictionary equivalent associations for abstract words over concrete. The author suggested that affective and abstract tasks or words provided more "distinct" operations and memories within each language which were reflected by the fewer similar interlingual associations at these levels.

Most important to this study is the fact that empirical psychological investigators have been able to demonstrate, using a great variety of measures, that bilinguals defined as "compound" were able to show functionally the greater intimacy and interdependence of their languages over bilinguals defined as "co-ordinates." In all the studies reviewed on bilingualism none has provided any controlled physiological evidence for the observed psychological differences in memory storage and bilingual functioning.

The major purpose of this research is to investigate and test further the compound-co-ordinate dimension, and the concrete-abstract stimulus distinction between languages using a physiological dependent measure, the Orienting Reflex, proposed by Sokolov as sensitive in reflecting degree of cortical memory relationships. There will also be a sub-study which will investigate the effect of language familiarity on the dependent measure.

The following sections will introduce and discuss the principal physiological phenomenon used in the investigation of the relevant subject and stimulus variables of this study. Salient features and issues of the Orienting Reflex are reviewed and a summary of their importance to the design of the present study is indicated at the end of the review. A general summary, integration of ideas, and a proposal of hypotheses to be tested end the chapter.

5. The Nature and Properties of the Orienting Reflex.

The Orienting Reflex (OR) was noted first in the early part of this century by Pavlov and his students.[49] Pavlov called the OR the "investigating" or "what is it" reaction, having noticed this behavior in dogs who would prick up their ears, turn towards, and attend to a change in their environment. This response would occur before and, to Pavlov, interfere with the conditioning process.

Pavlov described the OR as follows:

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49 I. P. Pavlov, Conditioned Reflexes, New York, Dover Publications, 1960, p. 12.

> It is this reflex which brings about the immediate responses in man and animals to the slightest changes in the world around them, so that they immediately orientate their appropriate receptor organ in accordance with the perceptible quality in the agent bringing about the change, making full investigation of it. The biological significance of this reflex is obvious. If the animal were not provided with such a reflex its life would hang at every moment by a thread. In man this reflex has been greatly developed with far-reaching results, being represented in its highest form by inquisitiveness--the parent of that scientific method through which we hope one day to come to a true orientation of the world around us.[50]

Although he felt this reflex could be used to index the degree to which the nervous system discriminates between stimuli, Pavlov did not pursue the study of the *OR* to any great length. Not only did he see it as a confounding preconditioning event, but he felt that the conditioned reflex (*CR*) afforded a much better entry into the study of the analyzer activity of the nervous system. He stated:

> One of its ("investigatory reflex's") chief defects is that in the case of certain weak stimuli, the reaction is only transient and cannot be repeated, and it is therefore useless for the purpose of exact experimentation. The detailed investigation of the conditioned reflex reaction, on the contrary, provides an eminently suitable method for an exact experimental research into the analyzing function.[51]

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50 *Ibid.*, p. 12.

51 *Ibid.*, p. 112.

Pavlov continued to use behavioral CR measures in an attempt to infer brain activity. He did not have the modern measurement technology of today to work adequately on the electrophysiological components of the OR so that its study was left to be developed later in the Soviet Union by Sokolov.[52]

Sokolov reiterated that the development of the OR is a sign that the nervous system has detected a change in a stimulus--that it has differentiated one stimulus from another.[53,54] Its purpose is to sensitize the organism to receive and further understand the implications of the new stimulus.

The OR has been characterized by a number of measurable events:[55] a general increase in the sensitivity of the sense organs (for example, pupil dilation, lowering of light and auditory threshold); overt musculature changes that direct the sense organs (for example, dog pricks his

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52 M. Cole and I. Maltzman (Eds.), "Introduction," in A Handbook of Soviet Psychology, New York, Basic Books, 1969, p. 12.

53 E. N. Sokolov, "Neuronal Models and the Orienting Reflex," in M. A. Brazier (Ed.), The Central Nervous System and Behavior: III, New York, Macy Foundation, 1960, p. 191.

54 --------, Perception and the Conditioned Reflex, New York, Pergamon Press, 1963, p. 283.

55 Ibid.

ears, and turns towards the source of stimulation); changes in general musculature (muscle tonus rises); electro-encephalographic changes (desynchronization) towards increased arousal; vegetative changes (vasoconstriction in limbs, vasodilation in head, galvanic skin response, heart-rate changes).

Lynn stated:

> The purpose of these changes, in general terms, is to make the animal more sensitive to incoming stimuli so that it is better equipped to discern what is happening, and to mobilize the body for whatever action may be necessary; for fight or flight as Cannon expressed it.[56]

Two further qualities have characterized the OR: (1) It is unspecific; that is, it is independent from the modality of stimulation. It is elicited by any increase, decrease, or qualitative change in the stimulus (for example, novelty, intensity, color, complexity, uncertainty or incongruity). Nonspecificity distinguishes it from defensive, adaptational (pupil constriction to light), and specific reflexes. (2) The OR is subject to extinction or habituation upon repeated presentation of the same stimuli. Selective habituation is demonstrated by the reoccurrence of the OR when one of the habituated stimuli's is changed.

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56 R. Lynn, Attention, Arousal and the Orientation Reaction, Oxford, England, Pergamon Press, 1966, p. 2.

Many theories have been developed for the habituation phenomenon generally.[57,58,59] However, the most widely used and tested, at least for the OR has continued to be Sokolov's two-stage neuronal model. This model suggests that stimulus analysis takes place in the cortex. After analysis the cortex, if it possesses a "model" characterizing the qualities of the stimulus, exerts an inhibitory influence on its reception and amplification by the reticular formation. On the other hand, if a "model" does not exist then the reticular formation is excited to help in model formation.

Sokolov's model for the OR has been diagrammed as Figure 2 on the next page. The system for the formation of the model (Part I) represents the cerebral cortex, and amplifying system (Part II) depicts the reticular formation of the brain.

Afferent stimuli pass up the classical sensory tracts to the cortex and collaterals to the reticular formation (lines 1 and 2). At the cortex, this stimulation

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57 *Ibid.*, p. 33-61.

58 R. F. Thompson and W. A. Spencer, "Habituation: A Model Phenomenon for the Study of Neuronal Substrates of Behavior," *Psychological Review*, Vol. 73, 1966, p. 16-43.

59 R. F. Thompson and P. M. Groves, "Habituation: A Dual-process Theory," *Psychological Review*, Vol. 77, 1970, p. 419-450.

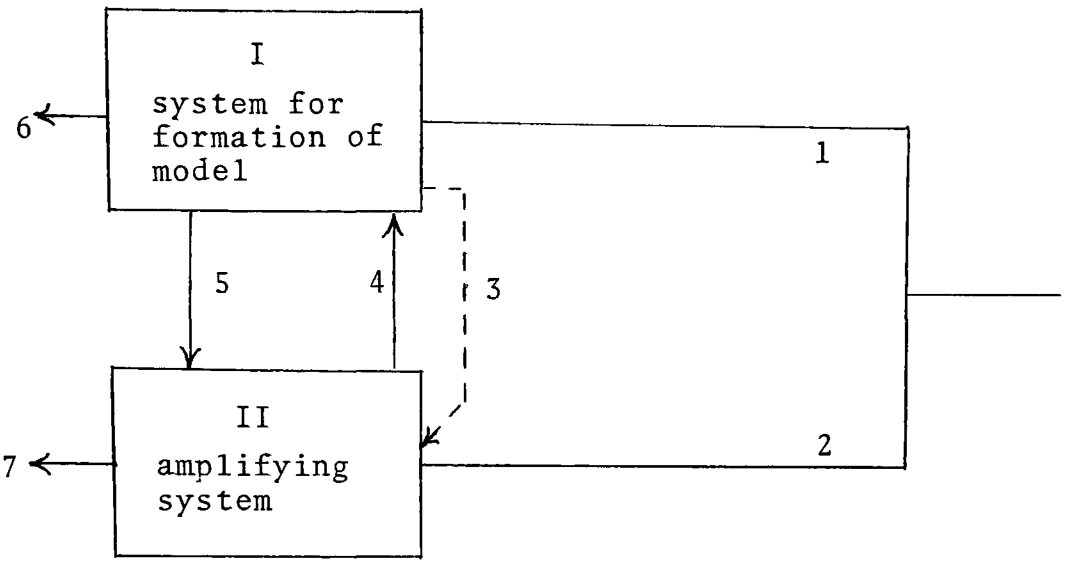

Figure 2.- Sokolov's Model for the Orienting Reaction.[1] I. modelling system. II. amplifying system. 1. specific pathway from sense organs to cortical level of modelling system. 2. collateral to reticular formation (represented here as amplifying device). 3. negative feedback from modelling system to synaptic connections between collaterals from specific pathway and reticular formation (RF) to block input in the case of habituated stimuli. 4. ascending activating influences from the RF to the modelling system (cortex). 5. pathway from modelling system to amplifying system (this is the pathway through which the impulses signifying nonconcordance between input and existing neuronal models are transmitted from cortex to RF). 6. to specific responses caused by coincidence between the external stimulus and the neuronal model elaborated in the cortex. 7. to the vegetative and somatic components arising from the stimulation of the RF.

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1 E. N. Sokolov, "Neuronal Models and the Orienting Reflex," in M. A. Brazier (Ed.), The Central Nervous System and Behavior: III, New York, Macy Foundation, 1960, p. 216.

is analyzed and, if novel, excitatory impulses from the cortex are sent to the brain stem reticular formation (RF) (line 5). If the stimulation, at the level of the cortex is found not to be novel, inhibitory impulses are generated and sent to the RF (line 3) via the descending cortico-reticular fibers. The impulses which control the OR can come from two sources: from the specific receptor collatoral neural pathways and from neural pathways emanating from the cerebral cortex. Habituation occurs when these paths are inhibited in their functioning.

With presentation, the stimulus can be considered to evoke an unconditioned response (UCR); with repeated stimulation, conditioned inhibitory processes develop in both specific afferent and cortical pathways with whatever stimulus was used in evoking the initial response. The pathways used for comparison (line 1) is always open. If any changes in the stimulus occurs there will be a signal of discrepancy which will break down the former conditioned inhibition and an OR will be produced. For the analyzing or comparison function, Sokolov introduces the concept of the "nervous model."

All incoming stimuli, according to this model, leave "information" or traces of all their characteristics within the nervous system, but especially in the cortex. The "model" preserves information about the stimuli, its intensity, quality, duration, and order of presentation. The RF continues to activate the cortex (line 4) as long as a discrepancy between the incoming stimuli and the "nervous model" exists.

The OR is produced, then, as Sokolov writes:

> (...) by signals of discrepancy which develop when afferent signals are compared with the trace formed in the nervous system by an earlier stimulus (...) insofar as the magnitude of the orienting reflex depends upon the degree to which the stimulus coincides with the trace process, we can determine the entire "configuration" left in the nervous system.[60]

He also stated that this signal of discrepancy does not occur throughout the period in which the new stimulus is being compared to the trace, but only initially, when the difference is noted.[61] Upon repeated presentation of the same stimulus, the OR decreases and finally habituates, but as long as the stimulus presented is novel, the orienting continues.

The OR, among other things, was proposed as a prerequisite for learning,[62] but its habituation being also

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60 E. N. Sokolov, "The Modeling Properties of the Nervous System," in M. Cole and I. Maltzman (Eds.), *A Handbook of Contemporary Soviet Psychology*, New York, Basic Books, 1969, p. 673-674.

61 *Ibid*., p. 682.

62 Lynn, *op. cit*., p. 85.

necessary in order to free the higher centers of the brain for more important functions.[63]

Support for containing the analyzing mechanism of the "nervous model" within the cortex has come from studies showing the fine discrimination possible and the loss of this power after cortical damage, or mental disease.[64,65,66] There also has been impressive evidence to implicate the frontal cortex in "patterning"; damage here affects both the ability to participate in higher order problem solving, and the mechanisms of the OR.[67,68]

Stimuli evoking an OR were classed by Sokolov within two categories: neutral stimuli or those stimuli with neither intrinsic meaning nor potential information value;

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63 Ibid., p. 61.

64 Ibid., p. 19.

65 S. V. Bruillova, "On Some Aspects of the OR in Persons Having Suffered a Covert Trauma of the Brain and in Neurotic Persons," in L. G. Voronin et al. (Eds.), Orienting Reflex and Exploratory Behavior, Washington, American Institute of Biological Sciences, 1965, p. 343-350.

66 A. L. Gamburg, "Orienting and Defensive Reactions in Simple and Paranoid Forms of Schizophrenia," in Voronin et al. (Eds.), op. cit., p. 351-359.

67 A. Luria, K. Pribram and E. Homskava, "An Experimental Analysis of the Behavior Disturbances Produced by the Left Frontal Arachnoidal Endothelioma," Neuropsychologia, Vol. 2, 1964, p. 257-280.

68 K. Pribram, "The Primate Frontal Cortex," Neuropsychologia, Vol. 7, 1969, p. 259-266.

and stimuli with signal value, that is, those:

> (...) which evoke a reaction in anticipation of external agents likely to appear in the future (...) we mean those acquired features of the stimuli which are the signals for certain reactions (...) in the case of man, the term (signal stimulus) should be applied to stimuli to which activity is directed by implication.[69]

A Soviet experiment illustrating that the OR can be conditioned to a particular stimulus has been reported by Razran.[70] In this experiment, fox cubs were brought into a laboratory situation and presented to the sound of squeaking mice. Although the sounds evoked ORs, they were quickly extinguished upon repetition. Yet, when the foxes were permitted to eat a mouse, the ORs became almost unextinguishable.

Other studies have indicated that the ORs of humans were much strengthened when the subjects were told that they had to do something such as push a button or count beats during presentation of the stimulus.

Although the term "signal value" has been reserved generally for stimuli overtly conditioned, it could be considered acquired through covert conditioning or normal interaction with other meaningful relationships. Words

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69 Sokolov, op. cit., 1963, p. 163.

70 G. Razran, "The Observable Unconscious and the Inferable Conscious in Current Soviet Psychophysiology: Interoceptive Conditioning, Semantic Conditioning, and the Orienting Reflex," Psychological Review, Vol. 68, 1961, p. 81-147.

occurring with more important consequences in our experience, for example our names, would take on a great deal of "potential informational value" and would be most resistant to habituation.[71]

The following section on disinhibition further expands and discusses the question of a stimulus' "informational value."

6. Disinhibition or Return of the OR.

Since Sokolov first published his model, many Western investigators have tested the different statements he made about the characteristics of the OR. The first comprehensive study was that by Zimny and Schwabe.[72] That work generally supported the Sokolovian postulates and, important to the present study, the authors found that a change in stimulus quality re-evoked an already habituated OR.

The electrodermal response (GSR) continues to be the most widely used measure of the OR. Since the present study uses the GSR, special emphasis is given to reviewed studies using this measure as an index of the OR. Therefore

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71 Lynn, op. cit., p. 30.

72 G. Zimny and L. Schwabe, "Stimulus Change and Habituation of the Orienting Response," Psychophysiology, Vol. 2, 1966, p. 103-115.

the disinhibition studies here reviewed all employ the GSR unless otherwise stated.

Many tactics have been used to study generalization OR gradients. In some studies, the OR to a stimulus has been conditioned. In the test trials, then, greater ORs were expected from stimuli closer in "cortical match" with the conditioned stimulus (CS). Other studies have used "non-conditioned" ORs (UCRs) of a particular stimulus to habituation. In these test trials, greater ORs were expected from stimuli more different in "cortical match" than the habituated stimulus.

Sokolov had shown that the non-conditioned OR as measured by electroencephalographic (EEG) activity could be extinguished to verbal stimuli. Re-emergence or disinhibition, then, was generated by a word having different meaning than the already habituated word.[73]

Western investigators using non-conditioned ORs illustrated the same generalization effect with tones.[74,75]

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73 L. G. Voronin and E. N. Sokolov, "Cortical Mechanisms of the Orienting Reflex and Its Relations to the Conditioned Reflex," Electroencephalography and Clinical Neurophysiology, Supplement 13, 1960, p. 335-346.

74 J. Williams, "Novelty, GSR and Stimulus Generalization," Canadian Journal of Psychology, Vol. 17, 1963, p. 52-61.

75 C. D. Corman, "Stimulus Generalization of Habituation of the Galvanic Skin Response," Journal of Experimental Psychology, Vol. 74, 1967, p. 236-240.

Those test tones which were more distant from the habituated tone elicited greater GSR-OR disinhibition or return.

Using color, others found that the magnitude of the OR was proportional to the distance between a standardized hue and disinhibition test hue.[76]

Two other studies using non-conditioned ORs have confirmed Sokolov's statement.[77,78] In the first study visually presented digits which were of greater disparity than the standardized habituated digits showed greater ORs. The other study showed that imaging a stimulus affected later OR habituation rate to the same stimulus when actually presented. The authors' conclusion was that "imagery" of the particular stimulus aided in the development of a cortical model.

Several other investigations using essentially the same type of stimuli as in all the reviewed studies

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76 P. F. Grim and S. H. White, "Effects of Stimulus Change upon the GSR and Reaction Time," Journal of Experimental Psychology, Vol. 69, 1965, p. 276-281.

77 R. M. Yaremko and K. Keleman, "The Orienting Reflex and Amount and Direction of Conceptual Novelty," Psychonomic Science, Vol. 27, 1972, p. 195-196.

78 R. M. Yaremko, B. B. Glanville and B. T. Leckart, "Imagery-mediated Habituation of the Orienting Reflex," Psychonomic Science, Vol. 27, 1972, p. 204-206.

above failed to support differential generalization effects.[79,80,81]

A more recent general review, among other criticisms, suggested that the evidence for Sokolov's contention that the OR is proportional to the degree of cortical mismatch is at best tenuous.[82] This author also suggested the need to emphasize additional aspects of the disinhibiting stimulus, for example "informational value," rather than considering the cortical model as static.

Others have also stated the possible importance of the stimuli's "noteworthiness."[83] One author[84] suggested that perhaps there should be an additional stage beyond the match-mismatch one, a stage which "involves an evaluation

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79 Zimny and Schwabe, op. cit., p. 108-109.

80 R. McCubbin and E. Katkin, "Magnitude of the Orienting Response as a Function of Extent and Quality of Stimulus Change," Journal of Experimental Psychology, Vol. 88, 1971, p. 182-188.

81 J. O'Gorman, G. Mangan and J. Gowen, "Selective Habituation of the GSR Component of the Orientation Reaction to an Auditory Stimulus," Psychophysiology, Vol. 6, 1970, p. 716-721.

82 J. O'Gorman, "Change in Stimulus Conditions and the Orienting Response," Psychophysiology, Vol. 10, 1973, p. 467.

83 I. Maltzman and M. Mandell, "The Orienting Reflex as a Predictor of Learning and Performance," Journal of Experimental Research in Personality, Vol. 3, 1968, p. 99-106.

84 A. Bernstein, "To What Does the Orienting Response Respond?" Psychophysiology, Vol. 10, 1973, p. 348.

of the significance of this information (...) of its potential value to the subject."

However, it seems that the Soviets, including Sokolov, have considered the "informational value" question.[85,86] They seemed to place the process of evaluation of significance as part of the cortical model, so that the degree of disinhibition occurred as a product of the amount of mismatch and informational value of the new stimulus.

In all the cases cited above on the disinhibition phenomenon, except Sokolov's and McCubbin _et al_.'s, tones, hue, or numbers were exclusively used as stimuli. The argument for "informational value" or "significance" as a necessary component for differential generalization of the _OR_ may not, perhaps, be conclusively found using digits, color, or tones. It may be that the degree of disparity of the test stimulus and the already habituated standard stimulus (tonal frequency, number differences) assumed by the experimenters to be directly proportional to the differences in cortical matching and informational value

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85 I. Feigenberg, "Probablistic Prognosis and Its Significance in Normal and Pathological Subjects," in Cole and Maltzman (Eds.), _op. cit_., p. 360.

86 Sokolov, "The Modelling Properties of the Nervous System," in Cole and Maltzman (Eds.), _op. cit_., p. 683.

may be unfounded. A similar argument was presented by Zimny, Pawlock and Saur[87] on habituation generally.

A more natural entry for studies on generalization may be gained in using "meaningful" verbal stimuli. There are studies other than Sokolov's which have obtained success on verbal-generalization gradients within the context of GSR measures.[88]

In GSR or OR studies on semantic generalization, the effect has traditionally and successfully been demonstrated using a conditioning paradigm, usually a noxious UCS paired with the conditioned word. The Soviet's, however, showed how engaging in a motor activity, for example, button pressing, could also be used as a conditioning agent.[89] Generally, the standard word was conditioned. This phase was followed by an examination of the degree of GSR transfer to target words graded along a continuum of semantic relatedness to the standard word.

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87 G. Zimny, G. Pawlock and D. Saur, "Effects of Stimulus Order and Novelty on Orienting Responses," Psychophysiology, Vol. 6, 1969, p. 171.

88 I. Maltzman, "The Orienting Reflex and Thinking as Determiners of Conditioning and Generalization in Words," in W. Spence and H. Kendler (Eds.), Essays in Neobehaviorism, New York, Appleton-Century-Crofts, 1971, p. 89-111.

89 A. Luria and O. Vinogradova, "An Objective Investigation of the Dynamics of Semantic Systems," British Journal of Psychology, Vol. 50, 1959, p. 89-105.

Maltzman and his associates demonstrated variations in "conditioning" techniques by using two groups: one "actively" conditioned, the other "passively."[90] Both groups were instructed to pedal push to the word light. The experimental group heard this word and pedal pushed (reinforced) to it; the control group were not presented the word, but "just" listened for it. Both groups showed semantic generalizations on the test words; that is, greater ORs to words similar in meaning to the word light. Maltzman interpreted that the process of listening and attending to a particular set was itself the reinforcing agent.

Although in certain cases it may be advisable to use a "conditioned" OR for studies of the generalization effect, according to Sokolov and others it is not a necessary nor perhaps preferred design.[91,92]

Cole and Maltzman pointed out that studies of generalization gradients using conditioned GSR-OR techniques unnecessarily introduced opposing and confounding

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90 I. Maltzman, B. Langdon and D. Feeney, "Semantic Generalization without Prior Conditioning," Journal of Experimental Psychology, Vol. 83, 1972, p. 73-75.

91 Voronin and Sokolov, op. cit., p. 335-337.

92 Cole and Maltzman (Eds.), "Introduction," A Handbook of Soviet Psychology, p. 706.

interactions. For example, if a stimulus is conditioned, then upon presentation of generalization test stimuli two processes resulted. A GSR-OR was produced because of stimulus change per se, and its magnitude was directly related to the difference between conditioned stimulus (CS) and test stimulus (TS), while a superimposed GSR was produced and its magnitude was directly related to the CS and TS similarities. In light of this confusing process, the authors suggested, among other solutions, a study of OR generalization in the absence of prior conditioning.

From the present writer's point of view, a "non-conditioned" OR paradigm also afford a more natural way of studying the generalization phenomenon. Although non-conditioned ORs have been used a great deal with non-verbal classes of stimuli as reviewed earlier, this method has not been employed extensively within verbal generalization studies. Unconditioned OR paradigms also gave experimenters an opportunity to gleen natural response data from the standard stimulus, hitherto a difficult process since this stimulus was in the "active" conditioning phase.

There have been other aspects of disinhibition pertinent to the design of the present study which should be noted here. Several reported studies have shown that

OR generalization phenomena generally faded with increasing standard/test-stimuli trials; that is, it seemed as if the subject became habituated or knowledgeable about the whole procedure and there really was no longer any "novelty" about the fact that test stimuli were compared to standard ones.[93,94] This observation has suggested the need for restraint over the number of standard-test words under analysis, eliminating this serial habituation effect.

A further confounding problem in the GSR-OR studies has been the innumerable variety of methods used to quantify the observed data.

7. Quantification of GSR Data and the Law of Initial Values.

The most recent and frequently cited studies in the GSR literature have used a transducer which impressed a constant current across the subject and measured basal resistance and response resistance.[95] The data were kept in resistance or converted either to changes in conductance

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93 Williams, *op. cit.*, p. 59.

94 I. Maltzman and B. Langdon, "Semantic Generalization of the GSR as a Function of Semantic Distance or the Orienting Response," *Journal of Experimental Psychology*, Vol. 80, 1969, p. 29.

95 D. Lykken and P. Venables, "Direct Measurement of Skin Conductance: A Proposal for Standardization," *Psychophysiology*, Vol. 8, 1971, p. 659.

or changes in log conductance. The former basic transformation was recommended by several authors[96,97] who argued that the processes involved in the GSR were more in parallel (conductance) than in series (resistance). The latter transformation was preferred by Darrow, as reported by Montague and Coles[98] who suggested that biological responses were generally more logarithmic than linear.

Resistance, conductance and log conductance GSR were shown to exhibit different experimental results when the same "resistance" data base was used, therefore demonstrating that the measures may not always be equitable.[99] Moreover, the same author showed that a logarithmic transformation of the GSR more properly met the assumptions of the analysis of variance statistical procedure.[100]

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96 Ibid., p. 661.

97 C. Darrow, "The Rationale for Treating the Change in Galvanic Skin Response as a Change in Conductance," Psychophysiology, Vol. 1, 1964, p. 31-38.

98 J. Montagu and E. Coles, "Mechanism and Measurement of the Galvanic Skin Response," Psychological Bulletin, Vol. 65, 1966, p. 264.

99 E. Haggard, "On the Application of Analysis of Variance to GSR Data: II. Some Effects of the Use of Inappropriate Measures," Journal of Experimental Psychology, Vol. 39, 1949, p. 861-867.

100 --------, "On the Application of Analysis of Variance to GSR Data: I. The Selection of an Appropriate Measure," Journal of Experimental Psychology, Vol. 39, 1949, p. 378-392.

The observation that certain response measures correlated with basal levels was termed the Law of Initial Values (LIV) and first coined by Wilder.[101] It stated:

> The response to agents stimulating the function under investigation depends to a very large extent on the initial level of that function. If that level is low there is a tendency to marked increase; if that value is average this tendency is less marked; if the initial value is high we shall often find minimal or no increase and quite often a paradoxical drop in the examined function. (...) Disregard for this rule causes many false conclusions and overlooking of important results in therapy, diagnosis, and theory.[102]

Since the LIV was proposed, a controversy has raged over the advantages and disadvantages of quantifying and analyzing response measures dependent on resting basal levels, and the validity of LIV in GSR data generally.[103,104] Although a number of solutions have been proposed to counter the LIV, many are controversial, and none has gained widespread acceptance.

Studies of the OR using GSR have not bothered generally about distinguishing between the various methods

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101 J. Wilder, "The Law of Initial Values in Neurology and Psychiatry. Facts and Problems," Journal of Nervous and Mental Disease, Vol. 73, 1956, p. 392.

102 Ibid.

103 Lykken and Venables, op. cit., p. 668.

104 J. Germana, "Rate of Habituation and the Law of Initial Values," Psychophysiology, Vol. 5, 1968, p. 31-36.

of quantifying GSR data and LIV, even though a logarithmic conversion of conductance scores was shown to be relatively independent of LIV.[105]

On the basis of the presented review on the OR, several statements, important to the present study, can be made. The disinhibiting GSR-OR and Sokolov's model will be used to test whether physiological differences in orienting behavior, reflecting differences in memory storage between compound and co-ordinate bilinguals and concrete-abstract words, can be demonstrated. That is, variations in degree of interlanguage memory relationships proposed by psychological studies on the subject and stimulus variables should be reflected by the OR following the cortical-match model of Sokolov. The non-conditioned OR paradigm is preferred and chosen by the present writer over a design using more confounding GSR-OR conditioning techniques. Furthermore, since many inequitable methods have been used to quantify the GSR, the present writer has decided to quantify the GSR-OR using several popular methods in order to test more comprehensively the different subject and stimulus variables with Sokolov's model of the OR.

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105 D. Raskin, "Semantic Conditioning and Generalization of Autonomic Responses," Journal of Experimental Psychology, Vol. 79, 1969, p. 74.

These sections have presented the theoretical and research contexts from which the principal hypotheses for this study have emerged. The last section closes this chapter with a summary of ideas leading to the major predictions, a brief review of research leading to the minor sub-study, and a statement of all the predictions tested.

8. Summary and Statement of the Hypotheses.

Bilingual subjects provide the interested investigator a unique way of studying psychological and physiological correlates of memory processes and interactions. Although a great number of studies using psychological tools have indexed certain aspects of bilingual memory processes, there has been little physiological empirical data.

There is impressive evidence from McGill showing that bilinguals typed along a continuum of "fused" memory (compound), or "independent" memories (co-ordinate), demonstrate these memory differences on a great variety of psychological measures. Furthermore, Kolers proves that stimuli, classed as "concrete," demonstrate greater interlanguage semantic associative equivalence than words typed as "abstract." Using physiological measures, further investigation of both these subject and stimuli variables is the principal consideration of the present study. The Orienting Response (OR) and Sokolov's memory model are used in this study in an attempt to reflect physiologically the compound-co-ordinate subject interlanguage memory distinction and to investigate further the concrete-abstract stimulus variable.

A sub-study uses only dominant French bilingual subjects and English vs. French stimuli testing what effect language familiarity has on the OR. Two studies show that the presentation of a blurred slide (high level of uncertainty) evokes longer EEG desynchronization than the presentation of its clear counterpart when presented in the order blurred slide, clear slide, not vice versa.[106,107] The authors interpret the results as due to the effect of initial "subjective uncertainty," this uncertainty not being present when the entropy or confusion is removed by the presentation of the clear slide in the clear slide-blurred slide order However, in one of the studies, the effect is not demonstrated

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106 D. E. Berlyne and D. M. Borsa, "Uncertainty and the Orientation Reaction," Perception and Psychophysics, Vol. 3, 1968, p. 77-79.

107 R. M. Nicki and J. F. Shea, "Subjective Uncertainty, the Orientation Reaction and the Reinforcement of an Instrumental Response," Perception and Psychophysics, Vol. 7, 1970, p. 374-376.

with GSR-OR. The purpose of the present sub-study using only dominant French bilinguals is to investigate the above reported effect on "uncertainty" using GSR-OR and low level of entropy French verbal stimuli and high level of entropy English verbal stimuli.

For the major study, the independent variables are compound balanced vs. co-ordinate balanced bilinguals, and concrete stimuli vs. abstract stimuli. The sub-study uses only dominant French bilinguals and the independent variable is English word stimuli vs. French word stimuli. For both studies the dependent variables are magnitude of GSR-OR quantified in resistance, conductance and change in log conductance values.

In this physiological phase of the major study, the method will be to present auditorally to each subject a concrete or abstract stimulus word in a set number of trials for habituation, followed immediately by a similar number of presentations of the word's dictionary translated other language equivalent. Language order will be counterbalanced. According to Sokolov's model three predictions can be made:

1. Following habituation of the OR to a word a change of language will cause OR return (disinhibition).

2. Co-ordinates will show a greater degree of disinhibition over compounds since the memory model for the bilingual stimuli presented is more semantically distinct.

3. Concrete words will show less disinhibition than abstract words based on Kolers' conclusion that abstract words are semantically more different across languages than concrete words.

The physiological phase for the dominant French subjects will consist of presenting to half of them, an English word for a set number of trials followed similarly by its translated French equivalent. The other half will receive the French word first. The following prediction can be made:

4. Dominant French subjects will show greater initial ORs to the English word since this word is operationally less familiar to them than the French equivalent.

CHAPTER II

EXPERIMENTAL DESIGN

The methodology of this thesis is the subject of the present chapter. The first section describes the subjects and the method used for their classification into categories: balanced compounds (Comp), balanced co-ordinates (Co-ord), dominant French co-ordinates (DFC). Following the description of the subjects there will be an account of the stimuli selection procedure across the concrete-abstract dimension and the manner in which they were prepared for presentation. The fourth section describes the GSR recording technique and apparatus used. This will be followed by a section giving a detailed report on the experimental procedure used in conducting the study. The chapter ends with a presentation of the statistical designs used in the analysis of data and a statement of the null hypotheses.

1. Subjects.

Eighty-two bilingual (French-English) paid females, whose first language is French, were the subjects used in this study. All subjects were undergraduate students enrolled at the University of Ottawa. In the first phase of testing, approximately one thousand female students had been given a questionnaire in order to classify types along the compound-co-ordinate dimension and to assess their degree of proficiency in English. A sample of the questionnaire is found in Appendix 1. Because of desired supplementary information on bilateral GSR differences, only right-handed subjects were considered for this study. As well, those subjects who were proficient in more than the two languages were excluded. All subjects used in the study ranged in age from seventeen to twenty-three, with a mean age of 18.9 years. Ten subjects were eliminated from analysis in this study because of equipment failure and/or experimenter error, leaving a total of 72 subjects--24 within each of the three categories described above.

Many methods have been proposed for distinguishing bilingual subjects along the compound-co-ordinate dimension.[1] This study used the criterion employed in the most recent studies on this dimension.[2,3] Subjects learning and becoming proficient in their second language before age six were considered operationally compound; whereas, those

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1 L. Jacobovits, "Dimensionality of Compound-Co-ordinate Bilingualism," Language Learning, Vol. 17-18, 1967-68, p. 41-47.

2 W. E. Lambert and C. Rawlings, "Bilingual Processing of Mixed Language Associative Networds," Journal of Verbal Learning and Verbal Behaviour, Vol. 8, 1969, p. 606.

3 N. Segalowtiz and W. Lambert, "Semantic Generalization in Bilinguals," Journal of Verbal Learning and Verbal Behaviour, Vol. 8, 1969, p. 560.

subjects introduced to their second language and becoming proficient after age six were considered co-ordinate. The above authors suggested this as a valid and reliable method of classification.

Self-ratings on second-language ability were used as indirect measures of bilingual proficiency. This procedure was recommended by MacNamara,[4] and used often by the McGill group in their studies.[5,6] Only those subjects who scored within the "(d) as well as" on at least three proficiency dimensions and only deviated plus or minus one on the fourth were considered as balanced bilinguals. Those co-ordinates who rated themselves less proficient in English by at least "(e) worse than" on all dimensions were considered dominant French. Another indirect measure of language proficiency advocated by MacNamara and used in the McGill studies was the difference in time required to read an English text as compared to an equally difficult French text. These "speed of reading" measures and English

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3 J. MacNamara, "How Can One Measure the Extent of a Person's Bilingual Proficiency?" in L. Kelly, Description and Measurement of Bilingualism (an international seminar), Toronto, University of Toronto Press, 1969, p. 90.

4 Lambert and Rawlings, op. cit., p. 606.

5 Segalowitz and Lambert, op. cit., p. 560.

association tests[7] were taken, as other indices of language proficiency, after the physiological data were collected.

2. Stimuli Selection and Preparation.

High frequency words belonging to Paivio et al.'s[8] list were divided into two groups: those which had high concrete values, that is, greater than 6.80; those which had more abstract values, that is, less than 3.00. All words were rated as high in frequency and an attempt was made to control for Noble's "m" ("meaningfulness" values measured by frequency of verbal associations elicited by a word).[9]

Three words from each level were selected at random from this prepared list. Each of these English words was then translated into its French language equivalent, so that there were three pairs of English/French concrete interlanguage dictionary equivalents and three pairs of English/French abstract equivalents. The selected

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7 W. Lambert, "Developmental Aspects of Second-language Acquisition: I. Associational Fluency, Stimulus Provocativeness, and Word-order Influence," Journal of Social Psychology, Vol.43, p. 85.

8 A. Paivio, J. Yuille and S. Madigan, "Concreteness, Imagery and Meaningfulness Values for 925 Nouns," Journal of Experimental Psychology, Monograph Supplement, Vol. 76, No. 1 (Pt. 2), January 1968.

9 C. Noble, An Analysis of Meaning," Psychological Review, Vol. 59, 1952, p. 421-430.

words and their (English) reported "concreteness" values are found in Appendix 2.

The six English words and six French language equivalents were then individually recorded on audio tape loops, using the facilities of the Communications Center of the University of Ottawa. A balanced bilingual male was used to utter the selected English and French words.

One channel of the audio tape was used for the stimulus word, while the other channel was used to record an event pulse at the moment of onset of the word. In all, twelve tape loops were constructed with one word/one pulse per loop.

A tape loop with the one stimulus word and pulse was played on one machine while both channel were re-recorded on a reel of tape on another machine. Re-recording of the stimulus word was at random intervals of twenty to forty seconds, and each stimulus word was recorded fifteen times.

On the same tape reel as above, and immediately following the first word, the translated-equivalent stimulus was re-recorded in the same fashion for fifteen presentations. The interval between one language stimulus and the other language equivalent was set at thirty seconds.

Altogether, twelve stimulus-pair tapes were constructed using the above procedure. Two tapes were constructed for each stimulus pair: one tape with fifteen

English word presentations, followed by fifteen French language dictionary equivalent presentations; the other tape went from French to English. Six of the tapes contained concrete pairs, while six contained abstract pairs. The audio levels of all stimuli recorded were kept constant.

A flow diagram of the recording procedure is contained in Appendix 3.

3. Stimulus Presentation and Recording of GSR.

The audio tapes were played through a Concord Type R-1100 tape recorder to a speaker immediately behind and central to a stuffed comfortable chair.

White sound at 55db was generated by an exhaust fan in a ceiling corner and the stimuli were presented at a fixed loudness level of 65db. Loudness measures were taken using a Bruel and Kjoer type 2204 sound level meter. White noise was used to filter out any extraneous sounds, as well as moderate any extreme frequency characteristics of the stimulus word.

Four Lafayette Instruments E-2 GSR chrome finger electrodes were used for the active sites in the GSR measure. Two of the four active electrodes were used on each hand on the volar distal segment of the first and third finger in order to take a measure of bilateral basal skin resistance and GSR. Each electrode site was cleansed with alcohol, wiped and allowed to dry.

A 10ua D.C. constant current was impressed across the electrodes, and a multiplexing technique was used as the bilateral transducer. A schematic diagram of the GSR apparatus is found in Appendix 4.

Measures of baseline and GSR were recorded on a Nihon-Kohden multipurpose polygraph. As well, response measures were taken on Hewlett-Packard 7004A type X-Y plotters having a greater degree of pen excursion than the Nihon-Kohden, in order to provide a back-up system for response analysis.

Both raw baseline resistance measures and response resistance measures were also fed into a digital equipment PDP-8L computer through an analog to digital interface. A program to quantify bilateral baseline values, response latencies, and peak (response) magnitudes was developed to objectively quantify the physiological data.

Bilateral GSR measures were taken from all subjects in order to establish the status in our laboratory of reported differences and to add to the growing body of research in this area. No hypotheses were generated for the analyses of differences in basal and response measures, but the results have been presented at the end of the third chapter and only briefly discussed.

All physiological GSR measures reported in the main body of this study, except in the above bilateral comparison, were those of the right hand.

Each subject received one stimulus word-pair; that is, thirty presentations, the first 15 in one language, the second 15 in the other language. As each of the thirty presentations occurred, the concomitant pulse on the other channel triggered an event marker on the Nihon-Kohden and began a sweeping of the X-Y plotters and the computer for a recording and storage of the data.

The Nihon-Kohden was constantly recording both base-line resistance and response activity, whereas both the X-Y plotters (measuring responses) and computer (measuring basal, latency, and responses) only recorded activity from the moment of pulse (stimulus word) onset to fifteen seconds after presentation.

Both X-Y plotters and PDP-8L computer were programmed to stack the measures elicited by each of the thirty presentations of stimuli. A systems diagram on the following page illustrates the connections. The computer stored the required information until the end of all thirty stimuli presentations and the attached teletype then printed out these data.

Before and after each subject, all equipment was checked and calibrated for reliability and accuracy of

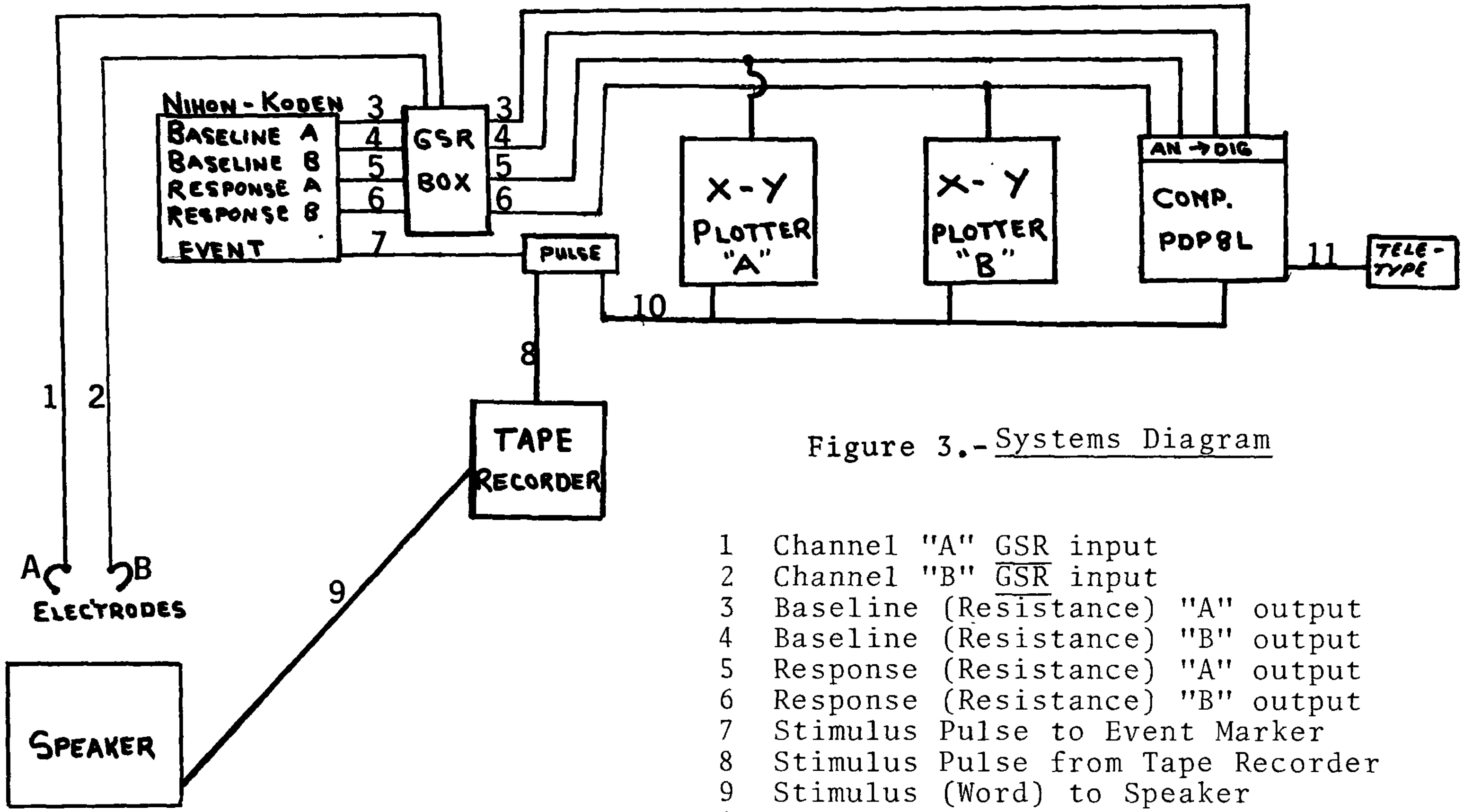

Figure 3.-Systems Diagram

1 Channel "A" GSR input
2 Channel "B" GSR input
3 Baseline (Resistance) "A" output
4 Baseline (Resistance) "B" output
5 Response (Resistance) "A" output
6 Response (Resistance) "B" output
7 Stimulus Pulse to Event Marker
8 Stimulus Pulse from Tape Recorder
9 Stimulus (Word) to Speaker
10 Stimulus Pulse to X-Y Plotters and PDP 8L Computer.
11 Stored Computer Data to teletype printer.

resistance measures. In addition, GSR channels "A" and "B" were alternated systematically between subjects to counterbalance any immeasurable differences between the two GSR systems.

A GSR (resistance) occurring within one to five seconds of stimulus onset and at least of 200 ohms/cm^2 was considered a measurable response.

Resistance measures were produced from the computer and quantified thusly:

$$R_a - R_b = R_r$$

where: R_a is equal to the resistance level (basal) at point of response inflection; R_b is equal to the resistance level at point of maximum response inflection; R_r is equal to the change in resistance (GSR).

Conductance change (C_r) was then quantified thusly:

$$\frac{1}{R_a} - \frac{1}{R_b} = C_r \text{ (GSR)}$$

Change in log conductance was also quantified:

$$\log_{10}\frac{1}{R_a} - \log_{10}\frac{1}{R_b} = \text{Change in log conductance (GSR)}$$

4. Additional Measures.

After the physiological measurement phase, other psychological measures were taken. The following tests were administered to the compound and co-ordinate balanced bilingual subjects: (a) one-minute association tests to all stimuli in Appendix 2 for an additional measurement of language ability[10] and Nobel's "m";[11] (b) ratings on ten dimensions of Osgood's differential[12] used by Lambert _et al_.[13] for each English and French stimulus, plus ratings for concreteness, imagery, and familiarity; (c) speed of reading tests on English and French passages of equal length for auxillary measures of English language ability;[14] (d) Eysenck Personality Inventory[15] because of reported

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10 Lambert, _op. cit_., p. 85.

11 Noble, _op. cit_., p. 421-430.

12 C. Osgood and Z. Luria, "A Blind Analysis of a Case of Multiple Personality Using the Semantic Differential," _Journal of Abnormal and Social Psychology_, Vol. 49, 1954, p. 579-591.

13 W. Lambert, J. Havelka and C. Crosby, "The Influence of Language Acquisition Contexts on Bilingualism," _Journal of Abnormal and Social Psychology_, Vol. 56, 1958,

14 MacNamara, _op. cit_., p. 90.

15 H. J. Eysenck and S. B. Eysenck, _Eysenck Personality Inventory_, London, University of London Press, 1964.

effects of the extraversion and neuroticism dimensions on the OR.[16]

The dominant French subjects received all the following tests, although only the last one was quantified for purposes of this study: (a) one-minute association test of only the French stimuli; (b) Osgood's scale and concreteness, imagery, and familiarity ratings on only French stimuli; (c) speed of reading for English and French passages.

Samples of all the above tests are found in Appendix 5.

5. The Experiment.

The experiment, therefore, is divided into three phases: initial selection and screening phase for bilinguals along the compound-co-ordinate, balanced-dominent French dimensions using the Language Questionnaire; physiological measurement phase for GSR-OR, lasting approximately thirty minutes; the third phase for collection of other measures lasting approximately forty minutes.

Each subject initially classified by the Language Questionnaire within the three types, compound balanced, co-ordinate balanced, and co-ordinate dominant French, had been randomly assigned to one of twelve taped stimulus pairs. This procedure was followed until all groups had

16 M. Coles, A. Gale and P. Kline, "Personality and Habituation of the Orienting Reaction: Tonic and Response Measures of Electrodermal Activity," Psychophysiology, Vol. 8, 1971, p. 54-63.

twenty-four subjects with two subjects in each group receiving the same stimulus tape. Subjects were then coded after appointment dates were randomly made.

As each subject came for the experiment, she was greeted in whatever language she used upon arrival. Each subject was then given two sets of instructions, in English and in French, in a counterbalanced order for all groups:

> I am interested in taking physiological measures from two fingers of each hand. You are requested to sit quietly and relaxed for approximately twenty minutes. Your only task is to listen. Please do not speak and please move about as little as possible.
>
> For approximately five minutes you will hear nothing from a loudspeaker which is behind the chair. After five minutes, I will begin to present words to you through the loudspeaker from a tape recorder. These words will be spoken by the same bilingual male.
>
> Remember, your only task is to listen. Please try not to move about.
>
> Are there any questions?
>
> (French version is presented in Appendix 6.)

After responding to any questions, without revealing the true purpose of the study, and again in whatever language they were asked, the experimenter requested the subjects to sit down in the anechoic chamber. The electrodes were then attached and the subjects was requested to settle into a comfortable position, remain relaxed, but not become drowsy. The room doors were then closed, the lighting was reduced to two foot-lamberts and the <u>GSR</u> transducer, Nihon-Kohden polygraph and a stop-watch were turned on. Following five minutes of allowing basal skin resistance levels to settle, the tape recorder was turned on and the thirty stimuli were presented to the subject.

Upon completion of the physiological phase, the subject was taken to another room where she was given several other tests listed below. At this point it was necessary to determine from the experiment's coding book whether the subject was <u>either</u> balanced or dominant French.

All balanced bilingual subjects were given the following tests: speed of reading (English), speed of reading (French), association test (English, association test (French), Osgood's differential (English), Osgood's differential (French), Eysenck's Personality Inventory, post-experimental questionnaire.

All dominant French subjects received the following tests: speed of reading (English), speed of reading (French), association test (French), Osgood's differential (French), post-experimental questionnaire.

All the tests cited above for all groups were presented in a random order, and one minute was allowed between tests.

6. Statistical Analysis of Data.

Generalization was defined using a trial block (<u>TB</u>) of five averaged trial responses in one analysis, and magnitude of the sixteenth trial disinhibiting response in the other analysis. In the first analysis, trial responses for each subject were averaged for six TB of five trials each, with TB 1 - 3 representing initial stimulus magnitudes (trials 1 - 15) and TB 4 - 6 representing translated stimulus magnitudes (trials 16 - 30).

As mentioned earlier, all GSR data reported for analysis below were taken from the right hand. A comparison of left vs. right basal and response measures has been reported at the end of the results section.

All GSR data were quantified in resistance, conductance and change in log conductance and have been analyzed using analysis of variance (ANOVA).

Two main statistical models were used for the Comp-Co-ord, Concrete-Abstract, main study. The first was a 6 X 2 X 2 ANOVA with repeated measures on the first factor.[17] Factors were, respectively: Trial Blocks 1 to 6; Comp vs. Co-ord; Concrete stimulus vs. Abstract stimulus. The second model was a 2 X 2 X 2 ANOVA with repeated measures on the first factor. Factors were, respectively: first trial response vs. sixteenth trial response; Comp vs. Co-ord; Concrete stimulus vs. Abstract stimulus. Furthermore, *a priori* *t* tests were performed both on the fourth disinhibition TB, and the sixteenth disinhibiting trial

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17 R. E. Kirk, *Experimental Design: Procedures for the Behavioral Sciences*, Belmont, California, Brooks/Cole, 1968, p. 283.

responses to test generalization differences between *Comp* vs. *Co-ord* bilinguals.[18]

Similarly, two statistical factorial designs were used for the dominant French, English vs. French word stimuli sub-study: a 6 X 2 ANOVA with first factor *TB*[19] 1 to 6, second factor English to French, French to English; a 2 X 2 ANOVA with first factor trials 1 and 16, second factor English to French, French to English. *A priori t* tests were also used to test the prediction that *DFC* would show greater initial *OR*s to English words.

All other data including subject selection and other measures reported used ANOVA.

All significant main effects were tested using the Tukey *post hoc* procedure, and the 0.05 level of probability was selected for all analyses as the critical point beyond which significance was declared.

7. Statement of the Null Hypotheses.

For physiological measures using *Comp*-*Co-ord* bilinguals and Concrete-Abstract stimuli, the null hypotheses are the following:

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18 *Ibid*., p. 292.

19 *Ibid*., p. 248.

1. There is no difference between the GSR magnitude on the third TB and fourth TB.

2. There is no difference in the GSR disinhibition on TB 4 between Comp and Co-ord bilinguals.

3. There is no difference in the GSR disinhibition on TB 4 between Concrete and Abstract stimuli.

4. There is no difference in the (GSR) magnitude on the sixteenth (disinhibiting) trial between Comp and Co-ord bilinguals.

5. There is no difference in the GSR magnitude on the sixteenth (disinhibiting) trial between Concrete and Abstract stimuli.

For physiological measures using dominant French subjects and English vs. French stimuli, the null hypotheses are the following:

6. There is no difference in the GSR magnitude on the first TB between English and French stimuli.

7. There is no difference in the GSR magnitude on the first (initial orienting) trial between English and French stimuli.

CHAPTER III

PRESENTATION AND DISCUSSION OF RESULTS

Contained within this chapter are the results of the subject and stimuli selection data, the analyses used to test the null hypotheses, and a discussion of the results.

The first section deals with subject selection data, and a report on resting basal skin resistance levels. The second section presents the rating results along the concreteness-abstractness dimension for the stimuli used in the study. The third section deals with the physiological response measures used to test the hypotheses comparing the balanced compounds to balanced co-ordinates and the concrete vs. abstract stimuli; supplementary data and other analyses relevant to the subject variable are also included in this section. The fourth section includes the physiological results of the dominant French subjects, while the results of data on bilateral GSR are found in the fifth section. The sixth, seventh, eighth, and ninth sections discuss the presented results.

1. Selection Data for Operational Classification into Comp, Co-ord or DFC Bilinguals.

The subjects were initially selected on the basis of a Language Questionnaire which tapped their language acquisitional history for Compoundness-Co-ordinateness, and which generated self-ratings on second language (English) abilities. A speed of reading test was later administered individually to all subjects to add further to a measurement of language ability.

The mean age for English language onset for the Comp, Co-ord, and DFC were, respectively, 0.63 years, 8.50 years, and 10.58 years. Their respective means for self-rating measures on language abilities were 16.12, 16.29, and 23.50. The means and standard deviations for both these dimensions are found in Table I.

Means (in seconds) for Comp, Co-ord, and DFC in speed of reading for English and French passages are, respectively: 76.04, 67.87; 76.42, 63.95; and 106.00, 63.50. No differences were found between the three groups in the French reading $F = 0.87$ (not significant). ANOVA on the English reading times revealed a significant difference $F = 35.98$ ($p < .00001$). Tukey *post hoc* tests indicated a significant difference between DFC vs. Comp, and DFC vs. Co-ord on this language. No differences were found between the Comp vs. Co-ord. Furthermore, there were no differences in total number of English associations between Comp and Co-ord, as measured by eight one-minute association tests. Means were, respectively, 34.82, 35.65; $F = 0.1107$ (not significant).

Table I.-

Information from the Language Questionnaire (Means and Standard Deviations)

		Comp	Co-ord	DFC
Age of Onset (in years) of English Lang.	$\bar{x}$	0.63	8.50	10.58
Acquisition	sd	0.97	1.95	3.28
Total of Self Ratings on Four Dimensions of	$\bar{x}$	16.12	16.29	23.50
Lang. Ability	sd	0.34	0.69	2.06

The above results then clearly established the operational definitions of the three types of bilinguals used in the present study. A Compound (Comp) and Co-ordinate (Co-ord) group were defined as balanced; another co-ordinate group was defined as dominant in French (DFC).

Before a presentation of the response measures (GSR) associated with the Comp, Co-ord and DFC, the resting basal skin resistance levels for all three groups are given. An ANOVA on initial basal skin resistance levels for the three groups revealed an $F = 3.10$, $p < .06$. The respective means were 53.23 K ohms, 60.15 K ohms, and 44.59 K ohms.

Since the major thrust of this thesis concerns the Comp and Co-ord subjects only and the concrete-abstract stimuli treatment differences, these results are reported first. A presentation of the results from the DFC group comes later in this chapter.

2. Comp and Co-ord Subject Ratings on the Concreteness-Abstractness Dimension and Their Measures on the Eysenck Personality Inventory (EPI).

The means and standard deviations of the stimuli ratings on concreteness, familiarity, and number of associations are found in Table II. These results clearly supported the *a priori* selection from the Paivio *et al.*

Table II.-

Concreteness, Familiarity and Association (Noble's "m") Means and Standard Deviations for Stimulus Words by Compound and Co-ordinate Bilinguals Used in the Study

	Concreteness		Familiarity		Associations	
	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
E Table	6.64	0.94	6.60	0.83	9.44	3.04
F Table	6.56	0.94	6.32	1.00	9.79	3.16
E Pipe*	6.13	1.57	5.72	1.50	8.56	2.83
F Pipe*	6.25	1.50	5.15	2.03	9.17	2.64
E Chair	6.77	0.55	6.60	0.84	8.81	3.18
F Chaise	6.67	0.72	6.53	0.99	9.64	2.81
E Window	6.35	1.26	6.35	1.32	7.46	2.96
F Fenêtre	6.12	1.66	6.12	1.35	8.94	2.83
E Opinion	3.68	2.37	6.33	1.22	7.36	2.55
F Opinion	4.27	2.33	5.55	1.45	7.48	2.66
E Justice*	3.56	2.44	5.12	1.80	8.52	2.53
F Justice*	3.44	2.28	5.32	1.92	9.08	2.89
E Honor	3.08	2.21	5.37	1.50	6.81	2.57
F Honneur	2.91	2.06	5.40	1.50	9.19	13.64
E Life	4.35	2.57	6.50	1.97	9.66	3.00
F Vie	4.89	2.42	6.32	1.19	10.25	3.02

E English
F French

* These words were not used as stimuli in the physiological measurement phase.

list, and distinguished one sample of stimuli as more concrete than the other.

The means for the Comp and Co-ord on Form A of the EPI were, respectively: extraversion 12.50, 12.63; neuroticism 12.58, 12.00. ANOVAs revealed no differences on extraversion $F = 0.012$ and on neuroticism, $F = 0.168$. The two groups were then matched on two personality dimensions which might have had contaminating effects on the experimental outcome. As well, information from the post-experimental questionnaire revealed no differences between these two groups on physical variables (age, height, weight, position in menstrual cycle) which may have influenced GSR activity.[1]

3. Physiological Response Results on Comp vs. Co-ord Types and the Concrete-Abstract Dimension Treatment.

As was discussed in the second chapter, the physiological GSR results were quantified in three manners: change in resistance, change in conductance, and change in log conductance. These three methods of quantification allowed for a more comprehensive study of the GSR-OR. These results were analyzed using both 6 X 2 X 2 and 2 X 2 X 2 ANOVA.

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1 J. Montagu and E. Coles, "Mechanism and Measurement of the Galvanic Skin Response," Psychological Bulletin, Vol. 65, 1966, p. 275-276.

An observation of the variances entering into the 6 X 2 X 2 ANOVA suggested heterogeneity; therefore, variances were tested using F_{max} procedure.[2] The results are presented in Appendix 7. Since all of these tests for the TB 6 X 2 X 2 ANOVA were significant, all measures were square root (SQ RT) transformed.[3] All data entering into the 2 X 2 X 2 ANOVA were transformed in similar fashion. The means and standard deviations for untransformed data are found in Appendix 7.[3a]

The first prediction to be tested using the SQ RT scores was that following habituation to a word, GSR-OR results upon presentation of that word's other language dictionary equivalent. Means and standard deviations across TB for all methods of SQ RT quantification are found in Tables III and IV. The ANOVAs for SQ RT resistance, conductance and change in log conductance GSR across TB are found in Tables V, VI, and VII, respectively.

All ANOVAs showed a significant TB (A factor) main effect, all $p < .0001$. Tukey post hoc procedures on all these measures showed a significant ($p < .01$) increase in GSR-OR from TB 3 to TB 4.

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2 R. E. Kirk, *Experimental Design: Procedures for the Behavioral Sciences*, Belmont, California, Brooks/Cole, 1968, p. 62

3 *Ibid.*, p. 65.

3a All untransformed resistance and conductance units in the Appendices are quantified in K ohms and M mhos respectively. All sq. rt. transformed resistance and conductance units used in this chapter are in ohms and , mhos respectively.

Table III.-

Comp and Co-ord Means and Standard Deviations for Square Rooted GSR Measures (Averaged) Across Trial Blocks

		Trial Blocks					
		1	2	3	4	5	6
Square Root Resistance Measure							
Comp	$\bar{x}$	52.14	28.60	25.18	38.92	22.82	22.78
	sd	23.34	21.15	22.96	22.10	20.46	21.07
Co-ord	$\bar{x}$	68.33	37.54	29.08	51.42	31.90	27.77
	sd	25.63	26.85	25.65	26.09	19.63	21.88
Avg. Total	$\bar{x}$	60.24	33.07	27.13	45.17	27.36	25.28
	sd	25.59	24.33	24.16	24.74	20.36	21.40
Square Root Conductance Measure							
Comp	$\bar{x}$	40.18	23.04	18.70	29.29	18.33	19.94
	sd	19.63	19.81	17.25	19.72	18.22	24.87
Co-ord	$\bar{x}$	46.32	27.31	21.38	33.07	23.01	19.22
	sd	20.98	21.76	20.32	21.02	19.51	18.04
Avg. Total	$\bar{x}$	43.25	25.18	20.04	31.18	20.67	19.58
	sd	20.34	20.70	18.69	20.25	18.82	21.49
Square Root Change in Log Cond. Measure							
Comp	$\bar{x}$	16.60	9.41	7.77	12.23	7.51	7.69
	sd	6.94	7.31	7.02	7.29	6.76	8.07
Co-ord	$\bar{x}$	20.49	11.77	9.02	14.98	9.86	8.23
	sd	7.51	8.52	8.05	7.96	7.00	6.54
Avg. Total	$\bar{x}$	18.54	10.59	8.40	13.60	8.68	7.96
	sd	7.42	7.94	7.50	7.68	6.91	7.27

Table IV.-

Concrete and Abstract Stimuli Means and Standard Deviations for Square Rooted GSR Measures (Averaged) Across Trial Blocks

		Trial Blocks					
		1	2	3	4	5	6
Square Root Resistance Measure							
Concrete	$\bar{x}$	60.63	37.13	27.78	48.27	26.68	29.23
	sd	22.93	24.31	17.35	22.39	20.70	19.19
Abstract	$\bar{x}$	59.84	29.01	26.47	42.07	28.04	21.33
	sd	28.92	24.17	29.85	27.01	20.43	23.13
Avg. Total	$\bar{x}$	60.24	33.07	27.13	45.17	27.36	25.28
	sd	25.59	24.33	24.16	24.74	20.36	21.40
Square Root Conductance Measure							
Concrete	$\bar{x}$	44.71	27.95	20.59	32.98	19.68	22.66
	sd	18.31	20.45	15.71	17.51	19.19	23.52
Abstract	$\bar{x}$	41.80	22.40	19.49	29.38	21.67	16.51
	sd	22.48	21.01	21.61	22.90	18.80	19.26
Avg. Total	$\bar{x}$	43.25	25.18	20.04	31.18	20.67	19.58
	sd	20.34	20.70	18.69	20.25	18.82	21.49
Square Root Change in Log Cond. Measure							
Concrete	$\bar{x}$	18.90	11.81	8.64	14.44	8.15	9.10
	sd	6.41	7.70	5.68	6.61	6.95	7.06
Abstract	$\bar{x}$	18.19	9.37	8.15	12.77	9.22	6.83
	sd	8.43	8.16	9.08	8.68	6.97	7.45
Avg. Total	$\bar{x}$	18.54	10.59	8.40	13.60	8.68	7.96
	sd	7.42	7.94	7.50	7.68	6.91	7.27

Table V.-

Trial Blocks: Balanced Bilinguals--Analysis of Variance Using Square Root of Resistance Measure

"A" Factor: Trial Blocks 1 - 6
"B" Factor: Comp vs. Co-ord
"C" Factor: Concrete vs. Abstract Word Stimuli

Source of Variance	SS	df	MS	F Ratio
A	45486.63	5	9097.33	46.88****
AXB	1265.08	5	253.01	1.30
AXC	998.25	5	199.65	1.03
AXBXC	1248.88	5	249.78	1.29
AXD	42688.12	220	194.04	
B	6185.39	1	6185.39	2.67
C	1052.97	1	1052.97	0.45
BXC	432.78	1	432.78	0.19
D	101961.21	44	2317.30	

$F_{.95}$ (5,220) = 2.21

****$p < .0001$

$F_{.95}$ (1,44) = 4.06

Table VI.-

Trial Blocks: Balanced Bilinguals--Analysis of Variance Using Square Root of Conductance Measure

"A" Factor: Trial Blocks 1 - 6
"B" Factor: Comp vs. Co-ord
"C" Factor: Concrete vs. Abstract Word Stimuli

Source of Variance	SS	df	MS	F Ratio
A	20529.08	5	4105.81	34.29****
AXB	329.43	5	329.43	0.55
AXC	543.79	5	108.76	0.91
AXBXC	774.84	5	154.97	1.29
AXD	26343.50	220	119.74	
B	867.06	1	867.06	0.46
C	599.24	1	599.24	0.32
BXC	1631.78	1	1631.78	0.87
D	82561.38	44	1876.40	

$F_{.95}\ (5,220) = 2.21$

****$p < .0001$

$F_{.95}\ (1,44) = 4.06$

Table VII.-

Trial Blocks: Balanced Bilinguals--Analysis of Variance Using Square Root of Change in Log Conductance Measure

"A" Factor: Trial Blocks 1 - 6
"B" Factor: Comp vs. Co-ord
"C" Factor: Concrete vs. Abstract Word Stimuli

Source of Variance	SS	df	MS	F Ratio
A	4066.32	5	813.26	46.27****
AXB	82.78	5	16.56	0.94
AXC	104.97	5	20.99	1.19
AXBXC	118.77	5	23.75	1.35
AXD	3866.46	220	17.57	
B	345.96	1	345.96	1.39
C	84.59	1	84.59	0.34
BXC	153.80	1	153.80	0.62
D	10940.83	44	246.66	

$F_{.95}$ (5,220) = 2.21

**** $p < .0001$

$F_{.95}$ (1,44) = 4.06

The results clearly demonstrated that for all methods of quantifying GSR, disinhibition (TB 4) occurred upon presentation of the same word's other language dictionary equivalent. Therefore, the first null hypothesis can be unanimously rejected:

1. There is no differences between the GSR magnitude on the third TB and fourth TB.

The TB analyses showed no interactions or other main effects.

An illustration of the habituation and the disinhibition phenomenona for SQ RT change in log conductance measures is presented in Figure 4.

The planned one-tailed *t* tests were carried out between Comp and Co-ord on the fourth TB using the pooled MS_{error} generated by the TB ANOVA. The *t* values and *p* levels (df 46) for SQ RT resistance, conductance and change in log conductance GSR were, respectively: $t = 2.00$, $p < .05$; $t = 0.67$, $p < .30$; $t = 1.19$, $p < .15$. Therefore, the second null hypothesis:

2. There is no difference in the GSR disinhibition on TB 4 between Comp and Co-ord bilinguals.

can be rejected for the SQ RT resistance GSR values, but not for SQ RT conductance and change in log conductance GSR values. The habituation and disinhibition gradients for Comp and Co-ord using SQ RT resistance GSR values is presented in Figure 5. Means and standard deviations for

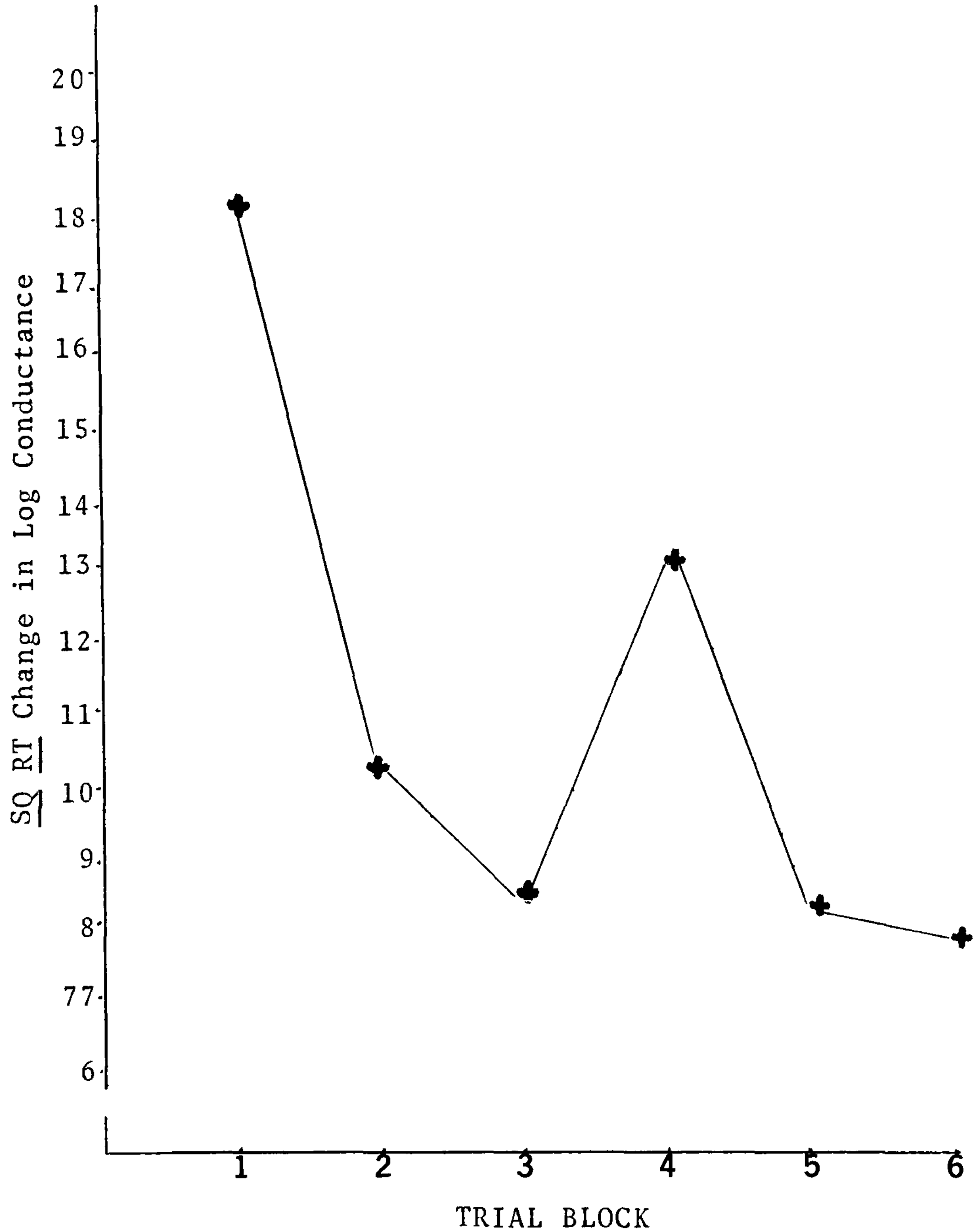

Figure 4.- Habituation and Disinhibition for SQ RT Change in Log Conductance.

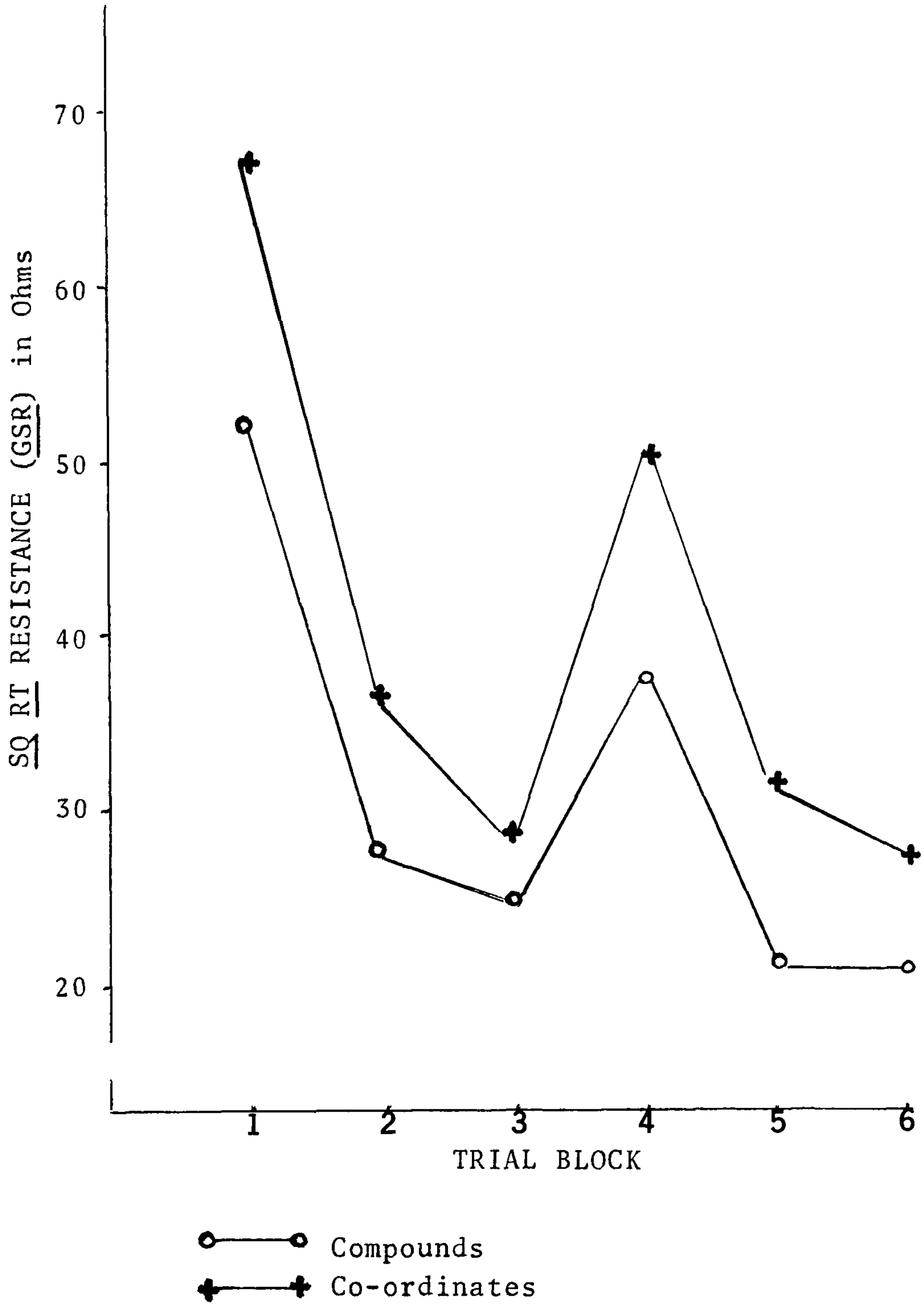

Figure 5.- Habituation and Disinhibition for SQ RT Resistance (Comp vs. Co-ord).

all methods of quantification have been presented, for the Comp vs. Co-ord, in Table III.

Furthermore, there were no differences shown on TB analyses on the concrete-abstract dimension for all methods of quantifying GSR. Null hypothesis three unanimously cannot be rejected:

3. There is no difference in the GSR disinhibition on TB 4 between Concrete and Abstract stimuli.

The means and standard deviations for the Concrete vs. Abstract treatment GSR for all methods of quantification are found in Table IV.

The means and standard deviations for the 2 X 2 X 2 factorial analyses are found in Tables VIII and IX. The ANOVAs for SQ RT resistance, conductance, and change in log conductance measures are presented in Tables X, XI and XII.

The planned t tests were carried out between Comp and Co-ord on the sixteenth trial response for all methods of quantifying GSR; resistance, conductance and change in log conductance. The t and p values were, respectively: $t = 1.35$, $p < .10$; $t = .20$, $p < .30$; $t = .74$, $p < .20$. Therefore, the fourth null hypothesis unanimously cannot be rejected:

4. There is no difference in the GSR magnitude on the sixteenth (disinhibiting) trial between Comp and Co-ord bilinguals.

Table VIII.-

Comp and Co-ord Means and Standard Deviations for Square Rooted GSR Measures on Trials 1 and 16

			Trial 1	Trial 16
Square Root Resistance Measure				
	Comp	$\bar{x}$	215.08	191.40
		sd	93.21	99.29
	Co-ord	$\bar{x}$	284.95	233.72
		sd	106.56	130.16
	Avg. Total	$\bar{x}$	250.02	212.56
		sd	105.14	116.50
Square Root Conductance Measure				
	Comp	$\bar{x}$	155.72	144.25
		sd	72.75	92.08
	Co-ord	$\bar{x}$	178.83	148.83
		sd	64.52	85.53
	Avg. Total	$\bar{x}$	167.28	146.54
		sd	69.02	87.94
Square Root Change in Log Cond. Measure				
	Comp	$\bar{x}$	20.98	19.24
		sd	8.24	10.50
	Co-ord	$\bar{x}$	25.90	21.65
		sd	7.71	11.05
	Avg. Total	$\bar{x}$	23.44	20.44
		sd	8.28	10.73

Table IX.-

Concrete and Abstract Means and Standard Deviations for Square Rooted GSR Measures on Trials 1 and 16

			Trial 1	Trial 16
Square Root Resistance Measure				
	Concrete	$\bar{x}$	242.23	236.56
		sd	86.97	114.40
	Abstract	$\bar{x}$	257.80	188.57
		sd	122.07	115.95
	Avg.	$\bar{x}$	250.02	212.56
	Total	sd	105.14	116.50
Square Root Conductance Measure				
	Concrete	$\bar{x}$	169.16	163.35
		sd	64.98	84.29
	Abstract	$\bar{x}$	165.39	129.74
		sd	74.18	90.06
	Avg.	$\bar{x}$	167.27	146.54
	Total	sd	69.02	87.95
Square Root Change in Log Cond. Measure				
	Concrete	$\bar{x}$	23.22	22.96
		sd	7.12	10.09
	Abstract	$\bar{x}$	23.65	17.93
		sd	9.44	10.97
	Avg.	$\bar{x}$	23.44	20.44
	Total	sd	8.28	10.73

Table X.-

Balanced Bilinguals--Analysis of Variance Using Square Root of Resistance Measure

"A" Factor: 1st vs. 16th stimulus
"B" Factor: Comp vs. Co-ord
"C" Factor: Concrete vs. Abstract Word Stimuli

Source of Variance	SS	df	MS	F Ratio
A	33666	1	33666	9.73***
AXB	4553	1	4553	1.32
AXC	24238	1	24238	7.01**
AXBXC	8957	1	8957	2.59
AXD	152148	44	3458	
B	75516	1	75516	3.78
C	6307	1	6307	0.32
BXC	5917	1	5917	0.30
D	879856	44	19997	

$F_{.95}$ (1,44) = 4.06

** $p < .01$
*** $p < .003$

Table XI.-

Balanced Bilinguals--Analysis of Variance Using Square Root of Conductance Measure

"A" Factor: 1st vs. 16th stimulus
"B" Factor: Comp vs. Co-ord
"C" Factor: Concrete vs. Abstract Word Stimuli

Source of Variance	SS	df	MS	F Ratio
A	10318	1	10318	5.05*
AXB	2060	1	2060	1.01
AXC	5342	1	5342	2.62
AXBXC	2899	1	2899	1.42
AXD	89864	44	2042	
B	4604	1	4604	0.44
C	8386	1	8386	0.81
BXC	17629	1	17629	1.70
D	456618	44	10378	

$F_{.95}$ (1,44) = 4.06

* $p < .03$

Table XII.-

Balanced Bilinguals--Analysis of Variance Using Square Root of Change in Log Conductance Measure

"A" Factor: 1st vs. 16th stimulus
"B" Factor: Comp vs. Co-ord
"C" Factor: Concrete vs. Abstract Word Stimuli

Source of Variance	SS	df	MS	F Ratio
A	214.20	1	214.20	7.10**
AXB	37.79	1	37.79	1.25
AXC	179.32	1	179.32	5.94*
AXBXC	63.17	1	63.17	2.09
AXD	1327.91	44	30.18	
B	321.98	1	321.98	2.20
C	126.53	1	126.53	0.86
BXC	142.52	1	142.52	0.97
D	6434.73	44	146.24	

$F_{.95}$ (1,44) = 4.06

* $p < .02$
** $p < .01$

All the above methods of quantifying GSR-OR showed a significant main effect on trial number 1 vs. 16. p values were: $< .003$, $< .03$, $< .01$, for resistance, conductance and change in log conductance SQ RT values, respectively. The GSR-OR to trial 16 was then, on the average, significantly less than the GSR-OR to trial 1.

Furthermore, SQ RT resistance and change in log conductance measures also showed a significant Trial by Stimulus level (Concrete-Abstract) (A X C) interaction, $p < .01$, $p < .03$, respectively. The simple effects analysis demonstrated that the first and sixteenth trial responses differed for abstract words, both at $p < .001$. The simple effects analyses are shown in Tables XIII and XIV, and the interactions are illustrated in Figures 6 and 7. Abstract words showed less GSR disinhibition on the sixteenth trial relative to its GSR at first presentation. Concrete words showed no differences.

SQ RT conductance GSR (A X C) interaction failed to reach significance, $p < .05$. A X C means for this measure are illustrated in Figure 8.

Because the SQ RT resistance and change in log conductance simple effects analyses C at A_2 were not significant, the fifth null hypothesis cannot be rejected:

5. There is no difference in the GSR magnitude on the sixteenth (disinhibiting) trial between Concrete and Abstract stimuli.

Table XIII.-

Analysis of Variance Summary Table for Simple Effects on Trial 1 vs. Trial 16 for Square Root of Resistance Measure

Source of Variability	SS	df	MS	F Ratio
A at c1	388.79	1	388.79	0.11
A at c2	57513.64	1	57513.64	16.63****
Error Term	152148	44	3458	
C at a1	2909.10	1	2909.10	0.25
C at a2	27636.68	1	27636.68	2.36
Error Term (pooled)	1032004	88	11727	

$F_{.95}$ (1,44) = 4.06

$F_{.95}$ (1,88) = 3.96

**** $p<.001$

Table XIV.-

Analysis of Variance Summary Table for Simple Effects on Trial 1 vs. Trial 16 for Square Root of Change in Log Conductance Measure

Source of Variability	SS	df	MS	F Ratio
A at c1	0.81	1	0.81	0.03
A at c2	392.62	1	392.62	13.01***
Error Term	1327.91	44	30.18	
C at a1	2.22	1	2.22	0.08
C at a2	303.61	1	303.61	3.44
Error Term (pooled)	7762.64	88	88.21	

$F_{.95}\ (1,44) = 4.06$

$F_{.95}\ (1,88) = 3.96$

**** $p < .001$

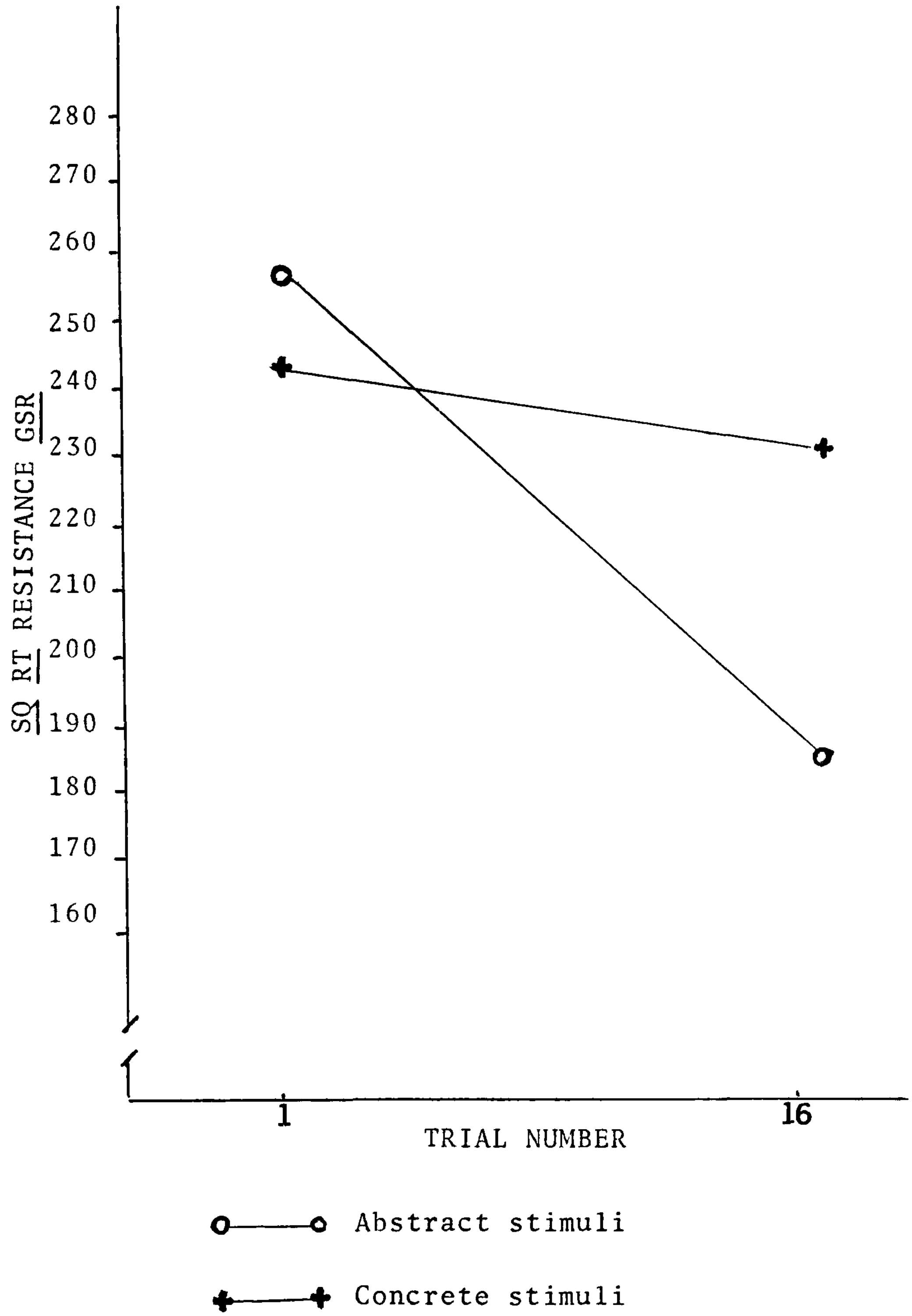

Figure 6.- SQ RT Resistance GSR Trial by Stimulus Level Interaction.

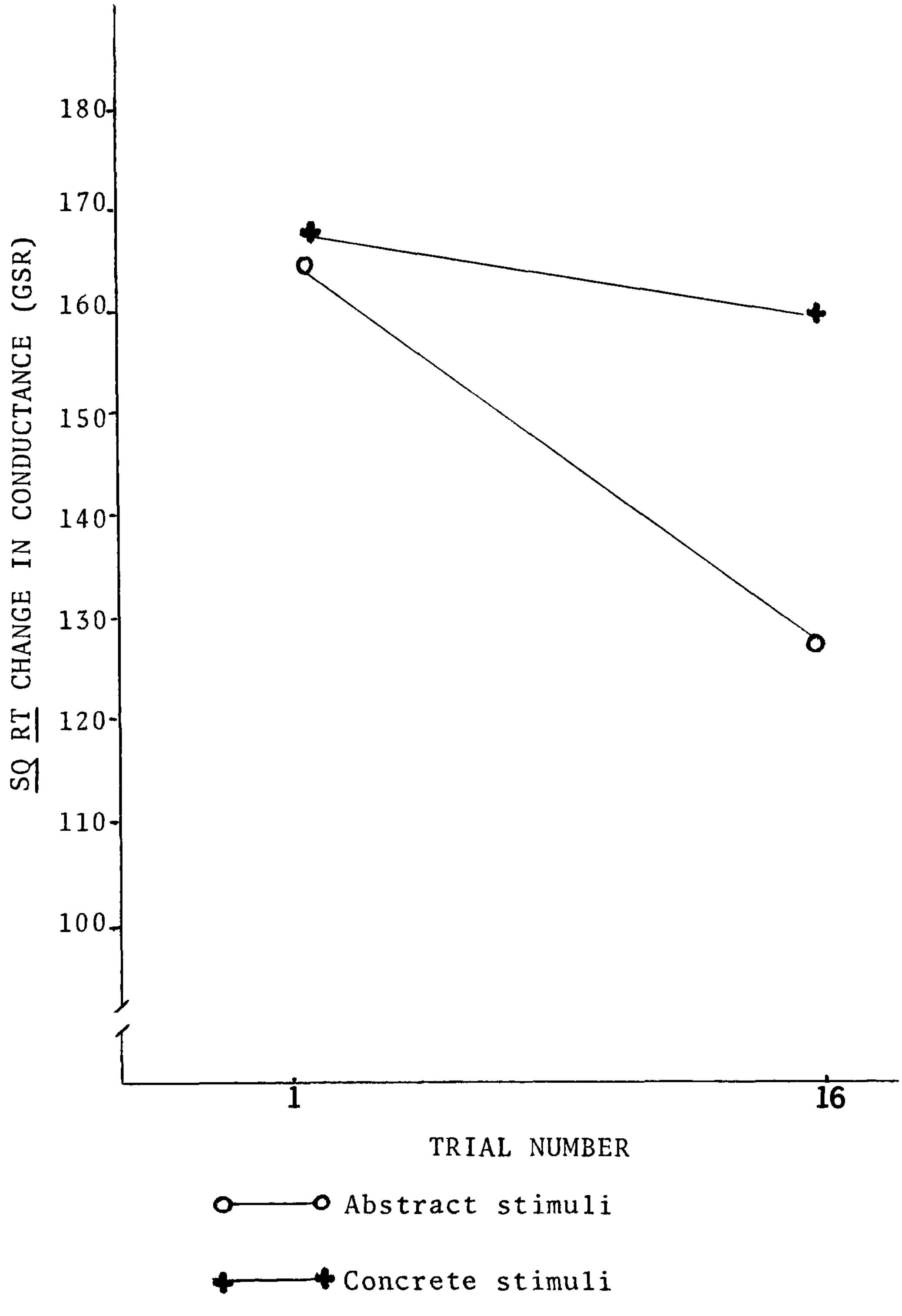

Figure 7.- SQ RT Conductance GSR Trial by Stimulus Level Means.

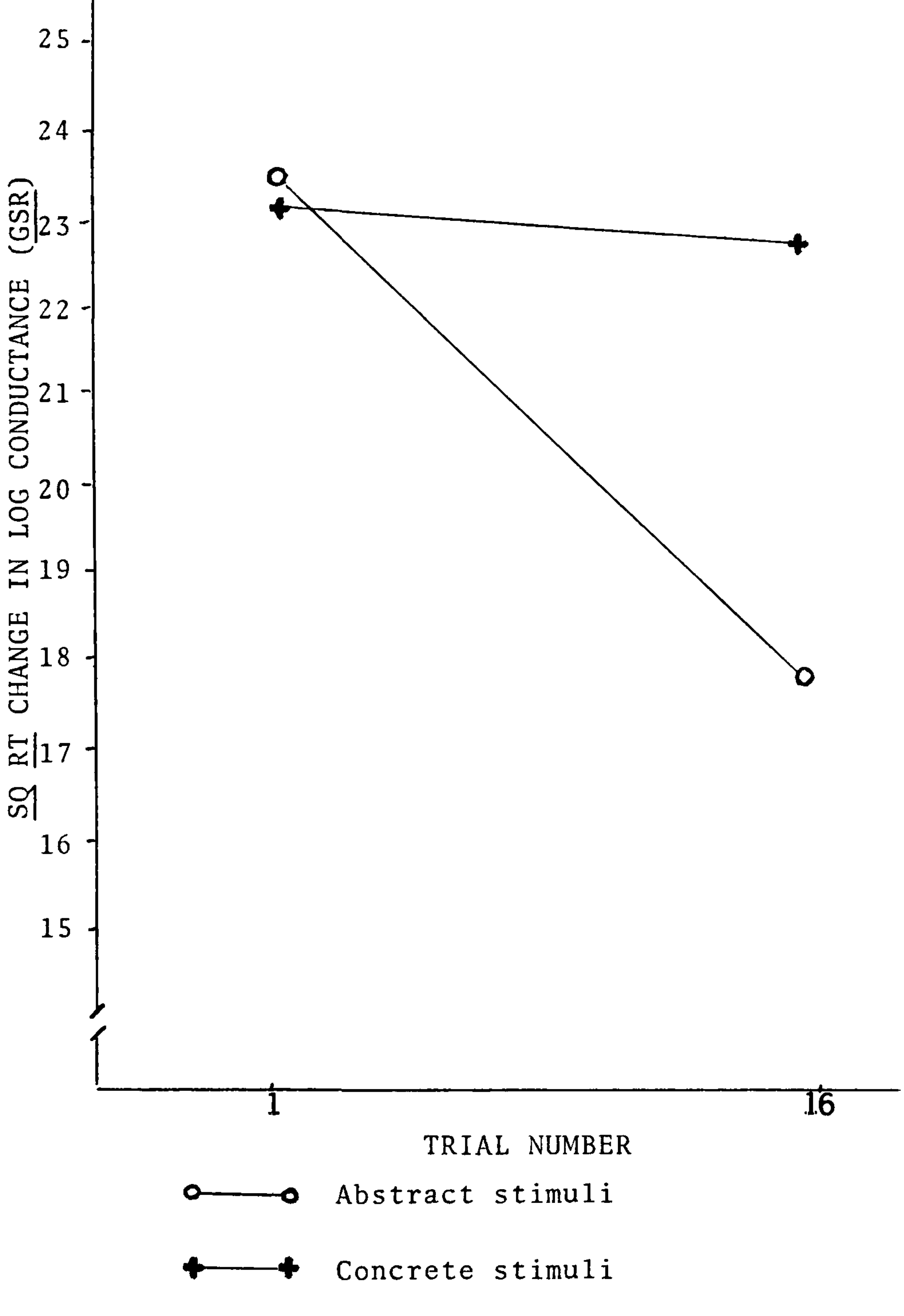

Figure 8.- SQ RT Change in Log Conductance GSR Trial by Stimulus Level Interaction.

All the above analyses, performed on the Comp-Co-ord and Concrete-Abstract dimension were also done with non square-rooted data. The results were identical; that is, only resistance TB 4 showed a Comp-Co-ord difference (Appendix 7), and the Abstract stimuli showed less GSR-OR return than Concrete on the sixteenth trial only for resistance and change in log conductance scores.

ANOVAs were applied to other data collected from the balanced bilinguals. Osgood's "D" score was defined as the $\sqrt{\Sigma d^2}$ where d = difference in the ratings for each dimension between each translated equivalent word. A 2 X 2 ANOVA, first factor Concreteness-Abstractness, second factor Comp-Co-ord, on subjects' total "D" scores between translated equivalent words, showed a main effect only on the first factor, $F = 4.54$ ($p < .04$). The means were: Concrete words, 19.45; Abstract words, 17.45. There were no significant differences between Comp (18.07) and Co-ord (18.90). Furthermore, a Mann Whitney U Test was performed between Comp and Co-ord ($z = 0.35$, not significant), and a Wilcoxon's Matched Paired Signed Ranks Test was performed between stimulus levels ($z = 1.93$, $p < .05$). These two tests were suggested by Osgood as more appropriate for "D" scores. The ANOVA results were confirmed.

A 2 X 2 ANOVA was performed on the total number of interlanguage dictionary-equivalent associations to translated-equivalent stimuli. A main effect (F - 53.14, p < .0001) was demonstrated on the Concreteness-Abstractness level with concrete words showing a greater total number of equivalent associations (means 16.75, 11.95). Expected differences between Comp vs. Co-ord bilinguals were not demonstrated.

4. Dominant French Subjects' Results.

Results of the DFC were analyzed using a 6 X 2 and 2 X 2 ANOVA. Resistance, conductance and change in log conductance variances entering into the TB (6 X 2) ANOVA were tested with F_{max} procedure (Appendix 8). Since all were significant, these measures, and those entering into the 2 X 2 ANOVA were SQ RT transformed. The untransformed means and standard deviations are also found in Appendix 8.

The first prediction to be tested using these SQ RT data is that English stimuli will elicit greater ORs than French stimuli. The means and standard deviations of all SQ RT TB data and first and sixteenth trials (2 X 2) data are found in Tables XV and XVI, respectively.

A priori *t* tests for the 6 X 2 TB analyses showed no differences between English vs. French stimuli responses on the first TB: t = 0.49, = 0.37, = 0.37 for SQ RT resistance, conductance and change in log conductance,

Table XV.-

Dominant French Subjects English vs. French Stimuli and Means, Standard Deviations for Square Rooted GSR Responses Across Trial Blocks

			Trial Blocks					
			1	2	3	4	5	6
Square Root Resistance Measure								
	Eng-Fr	$\bar{x}$	59.58	39.24	35.68	44.33	28.28	27.92
		sd	24.33	24.78	22.93	22.88	15.28	20.62
	Fr-Eng	$\bar{x}$	51.50	28.11	27.83	33.82	12.38	20.39
		sd	12.85	17.60	17.50	15.28	15.45	22.08
	Avg.	$\bar{x}$	55.54	33.67	31.75	39.08	20.33	24.16
	Total	sd	19.47	21.77	20.34	19.77	17.08	21.24
Square Root Conductance Measure								
	Eng-Fr	$\bar{x}$	53.70	35.10	33.23	43.28	27.87	25.17
		sd	31.49	23.71	21.99	28.53	19.53	16.26
	Fr-Eng	$\bar{x}$	48.59	26.82	27.93	31.15	13.96	20.09
		sd	25.76	20.83	24.77	19.20	16.53	25.26
	Avg.	$\bar{x}$	51.14	30.96	30.58	37.22	20.92	22.63
	Total	sd	28.26	22.23	23.06	24.58	19.07	20.94
Square Root Change in Log Cond. Measure								
	Eng-Fr	$\bar{x}$	20.49	13.50	12.48	15.50	10.38	10.32
		sd	9.09	8.43	8.01	8.53	5.67	8.02
	Fr-Eng	$\bar{x}$	18.21	10.03	10.10	12.01	4.51	7.52
		sd	6.81	6.84	7.44	5.82	5.90	8.54
	Avg.	$\bar{x}$	19.35	11.76	11.29	13.75	7.44	8.92
	Total	sd	7.94	7.72	7.66	7.36	6.40	8.22

Table XVI.-

Dominant French Subjects English vs. French Stimuli Means and Standard Deviations for Square Rooted GSR Measures (Trials 1 and 16)

			Trial 1 (lang. 1)	Trial 16 (lang. 2)
Square Root Resistance Measure				
	Eng-Fr	$\bar{x}$	239.89	210.62
		sd	73.36	109.91
	Fr-Eng	$\bar{x}$	232.21	200.25
		sd	38.89	91.49
	Avg.	$\bar{x}$	236.05	205.43
	Total	sd	57.56	99.04
Square Root Conductance Measure				
	Eng-Fr	$\bar{x}$	207.70	184.21
		sd	92.49	92.74
	Fr-Eng	$\bar{x}$	207.26	191.41
		sd	79.04	97.78
	Avg.	$\bar{x}$	207.48	187.81
	Total	sd	84.14	93.27
Square Root Change in Log Cond. Measure				
	Eng-Fr	$\bar{x}$	25.65	22.83
		sd	8.22	10.19
	Fr-Eng	$\bar{x}$	25.79	22.51
		sd	5.44	10.60
	Avg.	$\bar{x}$	25.72	22.67
	Total	sd	6.82	10.17

respectively; all $p > .25$, df = 22. Therefore, the sixth null hypothesis cannot be rejected:

> 6. There is no difference in the GSR magnitude on the first TB between English and French stimuli.

A priori t tests of the first stimulus presentation GSR-OR and English vs. French words showed similar results: t = 0.16, = 0.01, = 0.03; $p > .20$, df = 22. The seventh null hypothesis cannot be rejected:

> 7. There is no difference in the GSR magnitude on the first (initial orienting) trial between English and French stimuli.

The 6 X 2 and 2 X 2 ANOVAs for all SQ RT measures are found in Tables XVII, XVIII, XIX, XX, XXI, and XXII.

5. GSR and Basal Data from All Subjects on the First Stimulus Presentation.

Both resistance GSR and conductance GSR showed moderate and very significant correlations for all subjects on first trial response and first trial basal skin resistance levels. They are: r = .47, r = -.59, with both p's $< .001$ (df = 70), confirming the operation of LIV on these response measures. However, change in log conductance GSR was not significantly correlated with basal level; that is, r = -0.13 (df = 70). Furthermore, resistance (GSR) correlated r = 0.18 with conductance (GSR). Change in log conductance (GSR) correlated r = .75, r = .77 with resistance (GSR), and

Table XVII.-

Dominant French Subjects--Analysis of Variance Using Square Root of Resistance Measure

"A" Factor: Trial Blocks 1 - 6
"B" Factor: English-French vs. French-English Stimuli Presentation

Source of Variance	SS	df	MS	F Ratio
A	18687.90	5	3737.58	23.86****
AXB	303.57	5	60.71	0.39
AXC	17229.49	110	156.63	
B	3720.04	1	3720.04	2.41
C	33967.25	22	1543.97	

$F_{.95}$ (5,110) = 2.29

****$p < .0001$

$F_{.95}$ (1,22) = 4.30

Table XVIII.-

Dominant French Subjects--Analysis of Variance Using Square Root of Conductance Measure

"A" Factor: Trial Blocks 1 - 6
"B" Factor: English-French vs. French-English Stimuli Presentation

Source of Variance	SS	df	MS	F Ratio
A	14571.70	5	2914.34	16.28****
AXB	453.27	5	90.65	0.51
AXC	19693.46	110	179.03	
B	2481.89	1	2481.89	1.06
C	51677.63	22	2348.98	

$F_{.95}\ (5,110) = 2.29$

****$p < .0001$

$F_{.95}\ (1,22) = 4.30$

Table XIX.-

Dominant French Subjects--Analysis of Variance Using Square Root of Change in Log Conductance Measure

"A" Factor: Trial Blocks 1 - 6
"B" Factor: English-French vs. French-English Stimuli Presentation

Source of Variance	SS	df	MS	F Ratio
A	2108.55	5	421.71	20.08****
AXB	52.63	5	10.52	0.50
AXC	2309.92	110	21.00	
B	411.79	1	411.79	1.76
C	5141.86	22	233.72	

$F_{.95}(5,110) = 2.29$

****$p < .0001$

$F_{.95}(1,22) = 4.30$

Table XX.-

Dominant French Subjects--Analysis of Variance Using Square Root of Resistance Measure

"A" Factor: 1st vs. 16th stimulus
"B" Factor: English-French vs. French-English Stimuli Presentation

Source of Variance	SS	df	MS	F Ratio
A	4645.92	1	4645.92	2.29
AXB	175.14	1	175.14	0.09
AXC	44499.61	22	2022.71	
B	136.82	1	136.82	0.01
C	318096.21	22	14458.92	

$F_{.95}$ (1,22) = 4.30

Table XXI.-

Dominant French Subjects--Analysis of Variance Using Square Root of Conductance Measure

"A" Factor: 1st vs. 16th stimulus
"B" Factor: English-French vs. French-English Stimuli Presentation

Source of Variance	SS	df	MS	F Ratio
A	11248.57	1	11248.57	3.72
AXB	21.50	1	21.50	0.01
AXC	66549.31	22	3024.96	
B	977.11	1	977.11	0.09
C	234268.03	22	10648.55	

$F_{.95}$ (1,22) = 4.30

Table XXII.-

Dominant French Subjects--Analysis of Variance Using Square Root of Change in Log Conductance Measure

"A" Factor: 1st vs. 16th stimulus
"B" Factor: English-French vs. French-English Stimuli Presentation

Source of Variance	SS	df	MS	F Ratio
A	111.31	1	111.31	4.34*
AXB	.61	1	.61	0.02
AXC	564.65	22	25.67	
B	0.09	1	0.09	0.001
C	2883.69	22	131.08	

$F_{.95}$ (1,22) = 4.30
* $p < .05$

conductance (GSR), respectively. Scattergrams for all the above correlations are presented, along with the Pearson product-moment correlational values, in Appendix 9.

An analysis of bilateral basal resistance level and GSR data for all subjects on first stimulus response is presented below. On this trial, thirty-one subjects showed greater left-handed basal resistance, 3 showed no bilateral differences, and 38 showed greater right-handed basal resistance. A *t* test for correlated data was performed for all subjects, left vs. right basal, and no total group differences were demonstrated with $t = .26$, $p > .50$. However, *t* tests on all bilateral response data (GSR) for this trial showed greater responsiveness from the left hand: $t = 3.32$, $= 2.35$, $= 2.92$; $p < .001$, $p < .05$, $p < .01$ (two-tailed); $\overline{D}$ 570 ohms, 447 mhos, 52.47 units, for resistance, conductance and change in log conductance measures, respectively.

All physiological raw data entering into all of the analyses reported in this chapter are found in Appendix 10.

The following sections discuss the results presented in the first part of this chapter. The Comp-Co-ord data are discussed first, followed by a discussion of the Concrete-Abstract stimulus dimension results. The chapter then closes with a discussion of the dominant French subjects and their responses to English vs. French stimuli, and a short section on the GSR phenomenon, generally, and the bilateral GSR results, in particular.

6. Discussion of the Comp-Co-ord Results.

The main purpose of this research was to show physiological response differences between Compound and Co-ordinate bilingual subjects in a generalization of OR habituation paradigm. It was predicted that Compounds, because of their more interrelated interlanguage memories, would demonstrate less OR return to a word after habituating to that word's other language dictionary equivalent.

Only using resistance GSR values in the planned analyses was this prediction confirmed. Supplementary analyses between these two types of bilinguals were performed by subtracting TB 3 magnitudes from TB 4 magnitudes for resistance, conductance and change in log conductance. The means, t scores, and p values for Comp and Co-ord, and resistance, conductance and change in log conductance were, respectively: 0.844 K ohms, 1.820 K ohms, $t = 1.61$ $p < .06$ (one-tailed); 0.595 M mhos, 0.664 M mhos, $t = 0.23$ $p < .25$ (one-tailed); 92.50, 141,50, $t = 1.02$ $p < .16$ (one-tailed). All these measures showed a trend towards confirming the predictions, but all were far from unanimous in their degree of support. Furthermore, the analyses were weakened by the possible inflated alpha levels associated with the use of the many ANOVAs and _t_ tests in the study.

The possible reasons for the lack of greater distinctiveness between these two groups on the GSR-OR are several.

Two recent studies on the Compound-Co-ordinate dimension have come to this writer's attention. In the first, the authors[4] predicted, using a variation of Goggins and Wickens' method discussed earlier, that compounds would show less release from a proactive interference task than co-ordinates when the language was shifted because of the greater interrelatedness of their languages. This prediction was not supported. A second study also failed to confirm the Compound-Co-ordinate distinction.[5] These authors used a variation of a method previously employed by the McGill group on a task requiring subjects to search out key concepts when given clue words in both languages. It was predicted that compounds would demonstrate greater facility in this task than co-ordinates because of the greater interlanguage sharing of semantic clues.

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4 R. F. Dillon, P. D. McCormack, W. M. Petrusic, G. M. Cook, and L. Lafleur, "Release from Proactive Interference in Compound and Co-ordinate Bilinguals," Bulletin of the Psychonomic Society, Vol. 2, 1973, p. 293-294.

5 T. Arkwright and Andrée Viau, "Les processes d' association chez les biblingues," Working Papers in Bilingualism (OISE), No. 2, March 1974.

Both the above studies used the same operational definition of compound and co-ordinate bilingual systems as was used in the present study and several others reviewed in the first chapter; that is, compound bilinguals were defined as those bilinguals who acquired and became proficient in their second language before the age of six, whereas co-ordinate bilinguals must have acquired and become proficient after age six. This method of definition, although recommended by the McGill group, may not have distinguished or polarized these two types of bilinguals sufficiently along the Compound-Co-ordinate dimension to be indexed greater on all the methods of quantifying the GSR measures used in this study.

In the present investigation the subjects failed to show significant differences on the results of Osgood's "D" and on the number of dictionary-equivalent stimuli. In their first study on the Comp-Co-ord dimension, Lambert et al.[6] had shown that only those co-ordinates who learned their second language within a discrete and identifiably different context reflected these differences on Osgood's "D". Perhaps, then, the age method of classification into types may not have been as appropriate as other methods of definition which would have given more weight to the

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6 Lambert, Havelka and Crosby, op. cit., p. 239-244.

contexts of language learning and operations. Perhaps the compound-co-ordinate distinction is not a real or practically operationalized one.

The particular population from which the two types of bilinguals were drawn may have also contributed to the present results. All subjects were enrolled in a bilingual university. This milieu required a great deal of translation and, therefore, "age defined co-ordinates" may have developed a language system similar to that of compounds.

Yet another reason for not obtaining greater significant physiological response differences between these two types of bilinguals may have been due to the insensitivity of the GSR and/or weakness of the OR and Sokolov's model in indexing this particular subject variable. A similar study employing disinhibition of alpha EEG or a study of evoked potentials might be more successful in showing the differences between the Comp and Co-ord language systems.

It has been reported that evoked potentials were able to demonstrate greater left over right hemispheric activity to speech stimuli.[7] If, as Goldstein[8] suggested, the right hemisphere participates in storage of early language

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7 L. Morrell and J. Salamy, "Hemispheric Asymmetry of Electrocortical Responses to Speech Stimuli," Science, Vol. 174, 1971, p. 164-166.

8 Kurt Goldstein, Language and Language Disturbances, New York, Grune and Stratton, 1948, p. 51.

acquisition, then it might be expected that evoked potentials from this hemisphere during second-language processing would be more present, along with greater left hemispheric involvement, for compounds but perhaps not for co-ordinates.

Although the subject variable was not unanimously indexed by the disinhibiting GSR-OR, the concrete-abstract stimulus variable revealed some interesting and surprising results.

7. Discussion of the Concrete-Abstract Stimulus Dimension Results.

The interlanguage association test in this study further confirmed and extended similar results obtained elsewhere; that is, concrete English-French dictionary-equivalent stimuli produced more similar equivalent interlanguage associations than abstract stimuli. Paradoxically, however, GSR-OR disinhibition was less for translated abstract words compared to its first stimulus response, whereas the concrete stimuli did not differ in first or sixteenth stimulus magnitude. Furthermore, Osgood's "D" scores showed significant interlanguage differences between concrete and abstract stimuli, with concrete words showing greater between-language connotative differences than abstract words. Before further elaboration of all these results, this writer would like to introduce further the concreteness-abstractness dimension.

The most recent and prolific investigator in the concrete and abstract stimulus dimension within a language has been Allan Paivio. To his discussion he has reintroduced the importance of imagery along with verbal processes in memory functioning.

Paivio distinguished between three types of meaning (paraphrased):

1. Representational meaning: This type of meaning suggests that a code or word isometric with an object or verbal stimulus has been stored and is available for further psychological processing; that is, it is having or "knowing" the first order symbolic representation of the stimulus.

2. Referential meaning: This term refers to the close interconnections between the imaginal or verbal representational processes. For example, the time it takes to give the appropriate image to a particular word (word-image).

3. Associative meaning: Associative meaning involves the development of connections or structures involving different referents or concepts (word-word).[9]

There has been a great deal of evidence demonstrating that "image" coding (referential meaning) is easier for concrete over abstract stimuli, whereas representational meaning does not have this distinction.

Furthermore, the differential effect of concrete (high imagery) vs. abstract (low imagery) word stimuli on

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9 Allan Paivio, Imagery and Verbal Processes, Toronto, Holt, Rinehart and Winston, 1971, p. 53-59.

memory has become well established. Paivio defined imagery as:

> (...) nonverbal memory representations of concrete objects and events, or nonverbal modes of thought in which such representations are actively generated and manipulated by the individual. This will usually be taken to mean visual imagery although it is clear that other modalities could be involved.[10]

Both recognition and retrieval memory were better for concrete than for abstract words. Concrete stimuli were able to provide more distinct or "pictureable" images than abstract words. It was, then, according to Paivio, this process of "distinctiveness" which caused the differential memory effects. These effects were also shown to be independent of frequency, associative overlap and association value (Noble's "m").[11]

Paivio and others[12,13] also reported that abstract words evoked greater physiological (pupillary, GSR) responses than concrete. However, in all their studies, there was a task associated with the physiological measurement; for example, associating to a word, conjuring an image, remembering an association. The greater GSR and

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10 Ibid., p. 12.

11 Ibid., p. 184, 220.

12 Ibid., p. 180.

13 M. Smith and B. Harleston, "Stimulus Abstractness and Emotionality as Determinants of Behavioral and Physiological Responses in a Word-association Task," Journal of Verbal Learning and Verbal Behaviour, Vol. 5, 1966, p. 309-313.

pupillary responses for abstract words then might have reflected the greater amount of physiological and mental effort required to perform these tasks, as it had been demonstrated that all these tasks required a greater amount of time for abstract words and/or were less successful.

Paivio had suggested that abstract words were more affective than concrete.[14] The present study showed no significant differences between trial block analysis or magnitude of the first stimulus response for concrete vs. abstract words. Although Paivio may be correct, the abstract words in the present study did not differ significantly from concrete words along the affective dimension to have significantly influenced GSR physiological activity. The sixteenth disinhibition response, however, was significantly much less for interlanguage abstract stimuli than for interlanguage concrete stimuli, in two-thirds of the methods used in quantifying the GSR, when compared to their original GSR-OR. If bilingual subjects, according to Koler's conclusion based on studies of interlanguage verbal associative overlap, have more distinctiveness in memory stores for abstract words over concrete then the

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14 Paivio, *op. cit.*, p. 83.

opposite effect should have been demonstrated following Sokolov's postulates and the literature on semantic generalization. On the basis of the results in the present study and Paivio's ideas on "imagery processes" several interpretations could be made.

Verbal associations and imagery processes are two facets of "meaning." Since, according to Paivio, concrete words distinguished themselves as having more easily generated and specific images over abstract words, perhaps then, as the subject heard the translated other-language abstract equivalent stimulus during the sixteenth trial, the previous word's somewhat diffuse other language "imaginal representation" may have been covertly re-used or "saved" in this passive task. Conversely, because concrete words more quickly elicited a discrete image, they, as a class, may have provided additional or different "imaginal information." Research reviewed earlier had shown how "imagining" a stimulus prior to its actual presentation produced less OR behavior. Other research demonstrated that the OR was greater to stimuli having a greater amount of visual "informational load."[15]

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15 J. G. O'Gorman, "Habituation of the Orienting Reaction as a Function of Stimulus Information," Psychonomic Science, Vol. 22, 1971, p. 331-332.

An experiment designed to test whether ORs within a language are associated with high and low imagery words would clarify the present results found between languages. Such an investigation, using a long list of non-affective concrete and abstract words in a passive auditory listening task, might show that GSR-OR magnitudes may be generally less and habituate more quickly for abstract words.

Zaprozhets had suggested that an OR to a stimulus was necessary for learning to take place. It is possible that the difficulty in learning abstract words over concrete words in memory tasks is partially due to the fewer ORs to the abstract class of stimuli. In other words, abstract stimuli, because of their greater superordinate quality and natural difficulty in eliciting images, may be habitually less likely to provoke an OR, therefore being less specifically processed. Perhaps, since concrete stimuli are more closely associated with basic sensory and perceptual experiences than superordinate abstract stimuli, the concrete words might have been conditioned to produce greater ORs with a stimulus change.

Osgood's differential results supported the physiological findings in this study; that is, there were greater "D" scores for concrete words across languages than for abstract words. However, it may have been inappropriate to compare levels of concepts across languages using Osgood's technique.[16] There may have been, for example, differences in intercorrelations between the ten dimensions rated, across concrete-abstract word stimuli. That is to say, the ten dimensions may actually have indexed connotative meaning more validly and reliably for one class of stimuli than for the other. These results, in a sense, may reflect the artifact of subjects being forced to rate or judge a word on dimensions which are irrelevant; perhaps more arbitrary decisions were made for the concrete words and this would have been reflected by exaggerated "D" scores. Since Osgood's "D" analysis between abstract and concrete words was only an adjunct and exploratory one in terms of this study, the integrity and interpretation of these results should be deemed very speculative. However, the same discussion for the surprising physiological results can be argued here. Osgood's scales perhaps afforded the subject an opportunity to "rate" the "image" of the stimulus word. If the word was concrete and distinct it possibly had a more likely chance of being rated uniquely across languages, than if the word belonged to an abstract pool where the image was less distinct and possibly more prone to be "re-used."

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16 Y. Tanaka, T. Oyama and C. Osgood, "A Cross Cultural and Cross Concept Study of the Generality of Semantic Space," Journal of Verbal Learning and Verbal Behaviour, Vol. 2, 1963, p. 392-405.

Certainly, future studies using different techniques, like interlanguage memory recognition, would be of great value in adding further to our understanding of the interlanguage concreteness-abstractness stimulus question.

8. Discussion of the Dominant French OR Results.

The dominant French bilinguals exhibited nearly significant lower basal skin resistance levels than either the Comp or Co-ord on the first stimulus. This greater degree of arousal might have been due to an experimenter effect. Although able to speak French, the experimenter was probably perceived as dominant Anglophone by these subjects. This fact may have created more uncertainty in the total test situation for this particular group. There were no significant differences between the Comp and Co-ord on initial basal skin resistance levels.

The GSR-OR results showed no significant differences between initial English and French stimuli conditions, although there was a tendency in this direction. It may be that "degree of familiarity" of stimulus per se was not sufficiently polarized for these subjects; that is, they were not sufficiently unfamiliar with the English words used in this study to show significant differences in OR behavior. Since all subjects used in this sub-study were university students, they were probably quite familiar with English language high frequency words; sufficiently at least not to show differential GSR-OR behavior. Perhaps EEG-OR desynchronization would have been, like Berlyne's study, more successful in indexing this particular stimulus variable.

9. Bilateral Response Measures and a Discussion of the GSR Phenomenon Generally.

The results of bilateral measures on the first stimulus for all seventy-two subjects showed that there were no total differences in resting basal skin resistance between the left and right hand. However, analyses showed that there were significant intersubject basal differences with thirty-eight showing a greater right basal level and thirty-one showing a greater left basal level. These findings were in agreement with most of the literature in the area.[17] The results in the present study were independent of GSR channel used; that is, differences were not due to possible slight differences in transducers "A" and "B".

It was shown that for all methods of quantification, the left hand significantly showed greater first stimulus responsivity than the right. This result may have been due to several reasons, and certainly requires further and more

17 J. Varni, H. Doerr and J. Franklin, "Bilateral Differences in Skin Resistance and Vasomotor Activity," Psychophysiology, Vol. 8, 1971, p. 390-400.

elaborate study. It might have been that since all subjects used in this study were right-handed, the left hand may have been more free of hardened or scar tissues, which might have impeded the response measurement. Another reason is the possibility that the GSR was more of a reflection of hemispheric activity than previously entertained, although, in this study, it might have been predicted that the right hand would have shown greater GRSs since the stimulation was verbal. Further research is under way in our laboratories attempting to exhibit what relationship, if any, there is between hemispheric stimulation and contralateral GSR activity.

Change in conductance and change in resistance values were poorly correlated on the first stimulus presentation for all subjects. This result was due partially to the non-linear transformations required to generate change in conductance values from resistance values.

One possible reason for the seeming lack of sensitivity to the experimental effects for change in conductance measures may have been due to the manipulations required to generate these values. Resistance change was produced directly from the transducer and, as a response measure, had the greater amount of precision compared to basal levels; that is, both from the computer and X-Y plotter, small resistance changes were sensitively indexed. However, in order to convert to change in conductance (GSR), baseline values were required for the formula: $\frac{1}{R_a} - \frac{1}{R_b} = C_r$. Baseline values were not as accurate nor as sensitive since, for their measurement, a greater degree of range was selected on the computer and Nihon-Kohden in order to index the great variability in baseline levels between subjects. This greater range, however, effected a loss of measurement precision. Furthermore, this lack of precision, especially at low levels of basal resistance, possibly introduced more error since reciprocating for small numbers produced greater change in conductance values than reciprocating similar resistance changes at higher basal resistance values. Montagu and Coles stated:

> With constant-current method, conductance values are calculated from resistance measurements. The inverse relationship between these functions has certain effects which are worth noting. Since a small conductance is measured as a large resistance, the high resistance end of the scale becomes contracted during the process of reciprocation. Conversely, the low resistance end becomes expanded. As a result, a small error in the measurement of low resistance is magnified when these are expressed in terms of conductance.[18]

Since conductance seems to be the preferred method of quantifying GSR, this author supports the view by Lykken

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18 J. Montagu and E. Coles, "Mechanism and Measurement of the Galvanic Skin Response," Psychological Bulletin, Vol. 65, 1966, p. 267.

and Venables[19] for a general standardization of GSR measurement techniques and for measuring change in conductance values directly by using constant voltage, rather than computing it indirectly by using constant current transducers.

One fact seems clear from all the results presented in this study. The different methods of quantifying GSR, although related in direction, did not demonstrate equal differences in magnitude on the analyses. Some methods showed significant differences; others did not. Pearson "r"s and scattergrams (Appendix 9) demonstrated the low linear relationship between resistance and conductance GSR. Change in log conductance measures seemed to moderate these differences as demonstrated by its high correlation with both resistance and conductance measures.

The plethora of methods used in GSR measurement and quantification in the literature may be one reason why there is lack of agreement using these measures on certain variables. This study demonstrated, using an objective and sensitive method of measuring GSR, that different methods of quantification do not equally demonstrate certain effects. If this fact were true in other experiments using the GSR, then it

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19 D. Lykken and P. Venables, "Direct Measurement of Skin Conductance: A Proposal for Standardization," Psychophysiology, Vol. 8, 1971, p. 656-670.

becomes a difficult task, with several methods of measurement and quantification, to evaluate each study and its results and to compare it with other studies using different methods.

A short note on the Trial Block vs. first and sixteenth trial methods of analyses closes this chapter. It was apparent that the sixteenth trial and average of several trials (TB 4) did not effect similar statistical results, albeit they were in the same direction. A problem in GSR disinhibition and generalization studies is then also determining from which test trial or trials the generalization phenomenon should be investigated.

CONCLUSIONS

Only resistance measures supported the main prediction that compound bilinguals would demonstrate their greater interlanguage intimacy by showing less GSR-OR return to an habituated word's other language translated equivalent. The reasons for the lack of greater support for this prediction are several and include: insufficient polarization of subjects along the Compound-Co-ordinate dimension; insensitivity of the GSR-OR for indexing generalization phenomena for the subject variable under consideration; idiosyncrasies of the GSR itself.

The Concrete vs. Abstract stimulus conditions showed differential disinhibition results, however in a direction contrary to prediction. That is, concrete words showed greater OR disinhibition than abstract words relative to their first presentation. The results were interpreted using Paivio's suggestion that concrete words, at least within a language, offered greater distinctiveness. This "imagery" distinctiveness may have contributed more information <u>across</u> languages, and therefore evoked greater orienting behavior. The results of the Concrete-Abstract stimulus dimension suggested the need for further research into the relationships between imagery and physiological processes within a language. As well, additional studies directed to the Concrete-Abstract stimulus distinction between languages would be profitable, especially since the physiological results went contrary to predictions from both Kolers' and the present study's findings on associative interlanguage overlap.

Dominant French subjects failed to show significant differential OR behavior to English vs. French stimuli. These subjects may not have been sufficiently unfamiliar with English to show differential results.

The bilateral basal resistance findings generally supported the literature in this area; that is, although there were bilateral differences within each subject, on the average for all subjects there were no left vs. right basal resistance differences.

The demonstration that the different methods of quantifying GSR in the study did not equally demonstrate experimental effects, as well as comments from other investigators, suggested the need for better standardization of measurement and quantification techniques for this valuable index of psychological and physiological activity.

BIBLIOGRAPHY

Cole, M., and I. Maltzman, _A Handbook of Contemporary Soviet Psychology_, New York, Basic Books, 1969, x-887 p.

An excellent source book on Soviet psychology, a large portion of which is concerned with the conditioned reflex and higher nervous activity. This text has excellent chapter and article introductions by the Western editors.

Jacobovits, L., "Dimensionality of Compound-Co-ordinate Bilingualism," _Language Learning_, Vol. 17-18, 1967-1968, p. 29-55.

A comprehensive account of the Compound-Co-ordinate dimension with a list of the many ways of indexing bilinguals along it.

Lambert, W., "Psychological Studies of the Interdependencies of the Bilingual's Two Languages," in J. Puhvel (Ed.), _Substance and Structure of Language_, Berkeley, University of California Press, 1969, p. 99-126.

A review of several unpublished articles on the Compound-Co-ordinate dimension, as well as a resumé of published articles by the principal investigator in the area, makes this reference a very worthwhile one.

Lykken, D., and P. Venables, "Direct Measurement of Skin Conductance: A Proposal for Standardization," _Psychophysiology_, Vol. 8, 1971, p. 656-670.

These authors present a clear and rational argument for standardizing _GSR_ measurement techniques, using constant voltage rather than constant current.

Lynn, R., _Attention, Arousal and the Orienting Reaction_, London, Pergamon Press, 1966, viii-118 p.

A thin but informative book summarizing literature on the _OR_. Special emphasis is given to Sokolov and the Soviet writers, although there is a short section reviewing several theories on habituation.

Montagu, J., and E. Coles, "Mechanism and Measurement of the Galvanic Skin Response," _Psychological Bulletin_, Vol. 65, 1966, p. 261-279.

This article presents a clear account of the _GSR_ phenomenon and techniques for measurement. A list of subject and environmental variables influencing the _GSR_ is presented.

Paivio, Allan, Imagery and Verbal Processes, New York, Holt, Rinehart and Winston, 1971, xi-596 p.

A scholarly and exhaustive source book on imagery. Paivio reports impressive evidence, both published and unpublished, and discusses theoretical issues.

Sokolov, Y. N., Perception and the Conditioned Reflex, Oxford, Pergamon Press, 1963, x-309 p.

This is Sokolov's text on perception generally. There is a large review on signal vs. non-signal stimuli. He only briefly presents and discusses the orienting reflex and his idea of a neuronal model.

Sokolov, E. N., "The Modeling Properties of the Nervous System," in M. Cole and I. Maltzman (Eds.), A Handbook of Contemporary Soviet Psychology, New York, Basic Books, 1969, p. 671-716.

This article presents an account of Sokolov's "Nervous Model."

Voronin, L. G., A. N. Leintiev, A. R. Luria, E. N. Sokolov, and O. S. Vinogradova, "Orienting Reflex and Exploratory Behavior," in Russian Monographs on Brain and Behavior, Baltimore, Maryland, Garamond Press, 1965, xiv-462 p.

This is an edited review of Soviet research on the Orienting Reflex. Although lacking in statistical analyses of data, it provides a good idea of the various research themes, using the OR, in the Soviet Union.

APPENDIX 1

LANGUAGE QUESTIONNAIRE

APPENDIX 1

LANGUAGE QUESTIONNAIRE - QUESTIONNAIRE DE LANGUE

NOM
NAME : ______________________________ AGE
AGE : ____________

SEXE
SEX : ________________ TELEPHONE
PHONE NUMBER : ______________

ADRESSE
ADDRESS : __________________________

DROITER
RIGHT HANDED : ________ GAUCHER
LEFT HANDED : _______

. . . .

Combien de langues avez-vous eu l'occasion d'entendre? Encercler la bonne réponse.

How many languages have you been exposed to? Circle the right answer.

(a) One
Une

(b) Two
Deux

(c) Three or more
Trois et plus

. . . .

Si vous êtes familier avec l'anglais et le français, quelle langue considérez-vous comme votre première langue ou "langue maternelle"? Encercler la bonne réponse.

If you are familiar with French and English, which language do you consider your first or "mother language"? Circle the right answer.

(a) Français
French

(b) Anglais
English

. . . .

APPENDIX 1

A quel <u>âge</u> avez-vous fait vos <u>débuts</u> en <u>français</u>?
(Encercler l'âge approprié.)

At what <u>age</u> did you <u>first</u> begin to learn <u>French</u>?
(Circle the appropriate age.)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22+

....

A quel <u>âge</u> avez-vous fait vos <u>débuts</u> en <u>anglais</u>?
(Encercler l'âge approprié.)

At what <u>age</u> did you <u>first</u> begin to learn <u>English</u>?
(Circle the appropriate age.)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22+

....

A quel <u>âge</u> avez-vous l'impression que votre langue seconde est arrivée a son plus haut point?
(Encercler l'âge approprié.)

At what age do you feel your second language reached its highest level of fluency?
(Circle the appropriate age.)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22+

....

I SPEAK ENGLISH FRENCH

(a) very much better than
(b) much better than
(c) better than
(d) as well as
(e) worse than
(f) much worse than
(g) very much worse than

I UNDERSTAND ENGLISH FRENCH

(a) very much better than
(b) much better than
(c) better than
(d) as well as
(e) worse than
(f) much worse than
(g) very much worse than

I READ ENGLISH FRENCH

(a) very much better than
(b) much better than
(c) better than
(d) as well as
(e) worse than
(f) much worse than
(g) very much worse than

I WRITE ENGLISH FRENCH

(a) very much better than
(b) much better than
(c) better than
(d) as well as
(e) worse than
(f) much worse than
(g) very much worse than

....

APPENDIX 2

ENGLISH STIMULI AND CONCRETENESS VALUES

APPENDIX 2

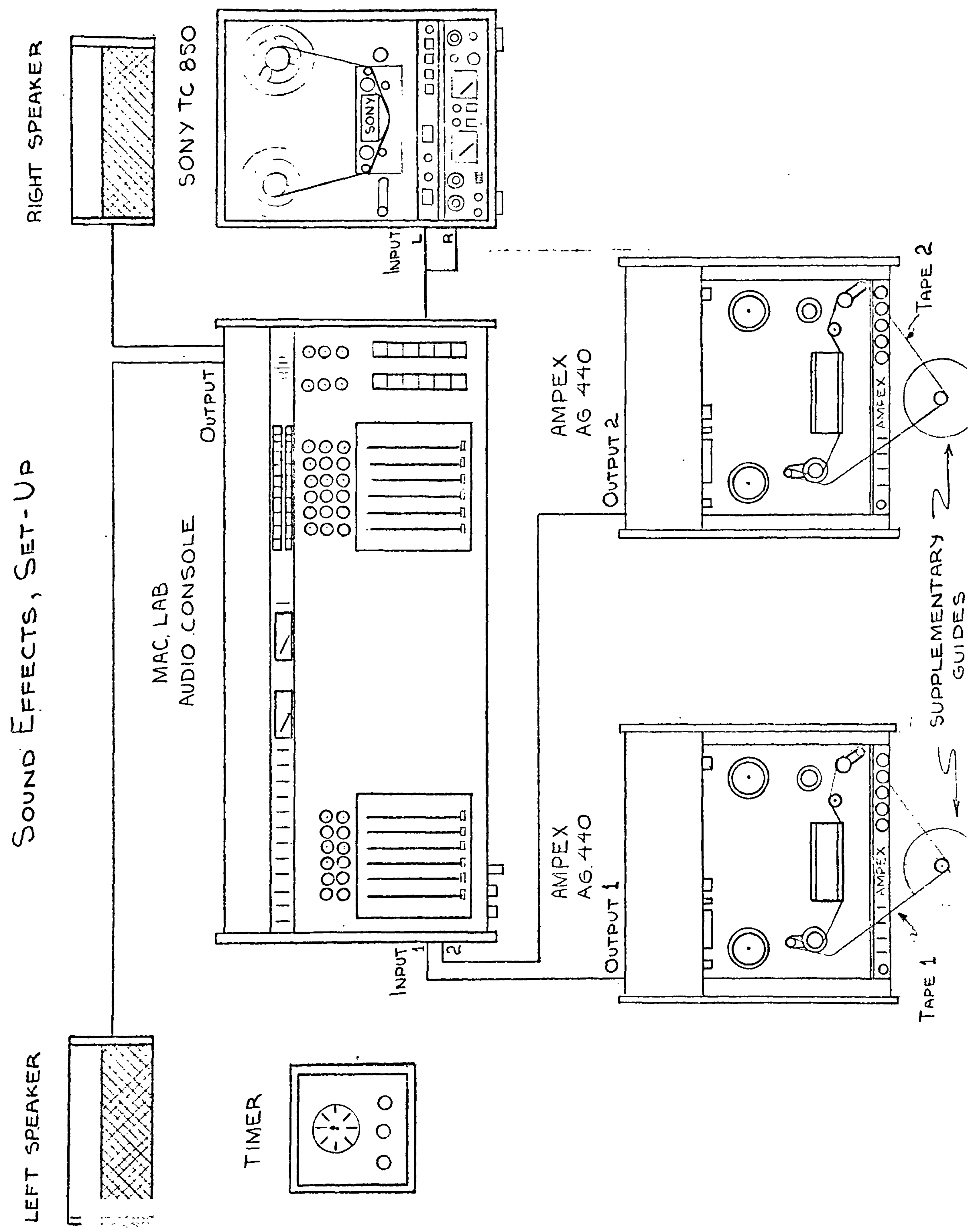
ENGLISH STIMULI AND CONCRETENESS VALUES

Means and Standard Deviations from Paivio's List

	Mean	Standard Deviation
TABLE	7.00	0.00
CHAIR	7.00	0.00
WINDOW	7.00	0.00
PIPE	6.90	0.58
JUSTICE	2.18	1.76
OPINION	2.29	1.54
HONOR	1.75	1.27
LIFE	2.96	1.97

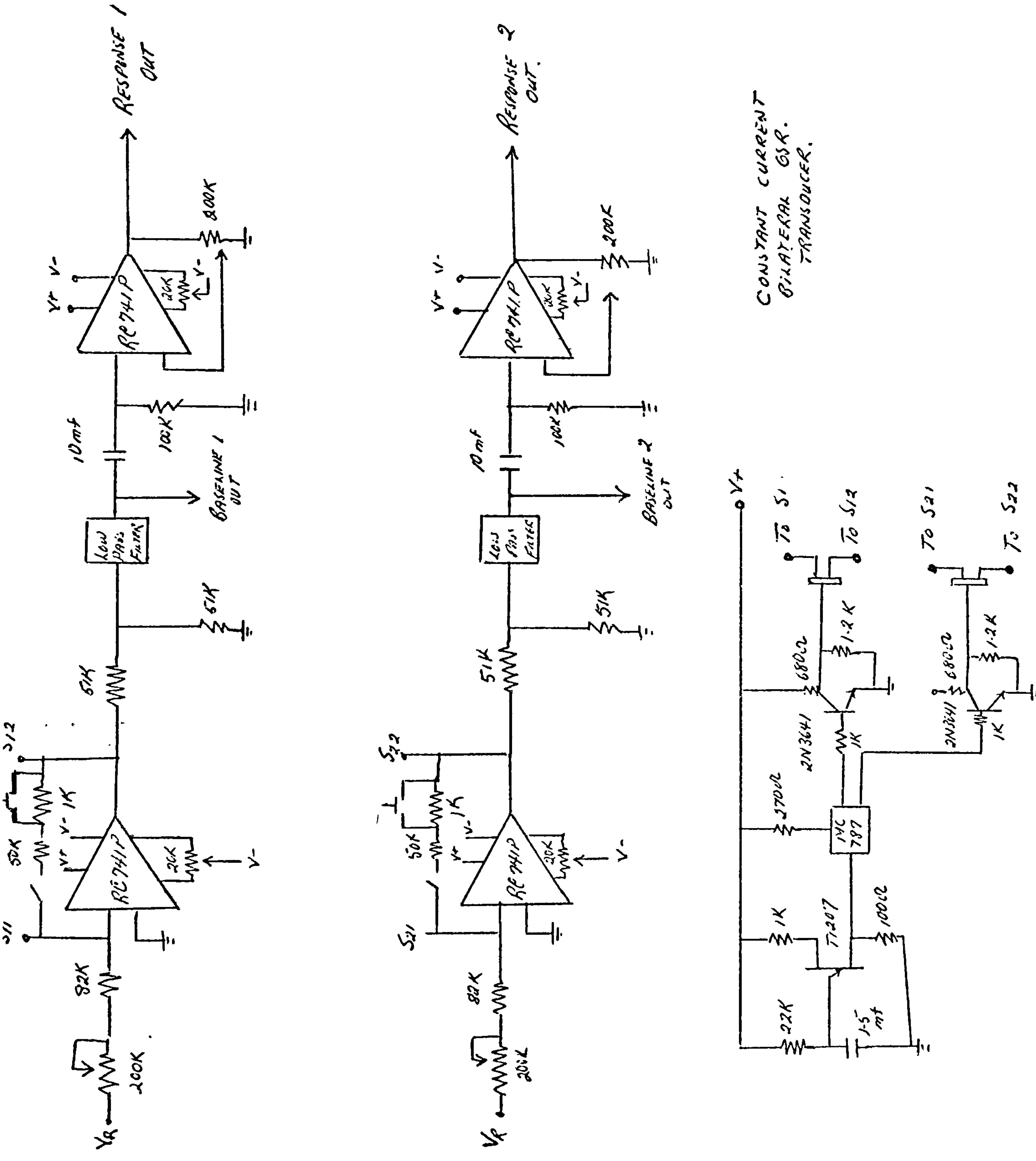
APPENDIX 3

DIAGRAM OF RECORDING PROCEDURE FOR EACH STIMULUS WORD-PAIR


SOUND EFFECTS, SET-UP
RIGHT SPEAKER
LEFT SPEAKER
SONY TC 850
SONY
INPUT
L
R
OUTPUT
MAC. LAB
AUDIO CONSOLE
INPUT
1
2
AMPEX
AG 440
OUTPUT 2
AMPEX
AG 440
OUTPUT 1
AMPEX
TAPE 2
TAPE 1
SUPPLEMENTARY
GUIDES
TIMER

APPENDIX 4

SCHEMATIC DIAGRAM FOR GSR TRANSDUCER


RESPONSE 1 OUT
RESPONSE 2 OUT.
CONSTANT CURRENT BILATERAL GSR. TRANSDUCER.
BASELINE 1 OUT
BASELINE 2 OUT
LOW PASS FILTER
RC741P
MC 787
2N3641
To S11
To S12
To S21
To S22
V+
V-
V_R

APPENDIX 5

SAMPLES OF TESTS GIVEN DURING PHASE THREE OF EXPERIMENT

*(1) Speed of Reading (English) 180 words
*(2) Speed of Reading (French) 167 words
(3) Sample of One-minute Association Test (English)
(4) Sample of One-minute Association Test (French)
(5) Sample of Osgood's Differential (English)
(6) Sample of Osgood's Differential (French)
(7) Eysenck's EPI

*Both taken from 1973 University of Ottawa Graduate School Calendar

APPENDIX 5

1. Speed of Reading (English)

For a correctional administrator and, especially, for a criminologist, it is important to understand new research techniques. In this century any knowledge quickly gets out of date. To learn how one can continue to improve one's knowledge and to make new discoveries, whether of a scientific or a practical nature, is more important than knowing current theories and practice in criminology and corrections. The main function of eduction is not merely to impart existing knowledge but to lay a foundation of future learning by providing basic skills, including a sensitivity to theoretical and practical problems, and by fostering a spirit of enquiry and creative endeavour. In this respect the Department is fortunate to be fully integrated with the Centre of Criminology, specializing in applied criminological research. The Centre concentrates on using and developing scientific techniques for the solution of the practical problems which face those responsible for corrections and the administration of justice, and on providing a scientific basis for penal reform. The students take part in the activities of the Centre and are kept fully informed of its program.

APPENDIX 5

2. Speed of Reading (French)

Un cadre interdisciplinaire est nécessaire au programme en criminolgie si les étudiants doivent bien comprendre les systèmes juridiques actuels, les théories de la loi et du crime, les services de traitement et de reéhabilitation ainsi que les différences existant dans la personnalité et dans le comportement de groupe. Un criminologiste se doit d'être capable d'évaluer les rapports psychologiques ainsi que les analyses sociologiques. Il lui faut acquérir de l'expérience pratique dans l'application de données obtenues, par l'observation et au moyen d'entrevues, de questionnaires et de tests psychologiques. En plus de savoir comment préparer des expériences, choisir un échantillon, assortir des individus et des groupes et établir une série de techniques appropriées, l'étudiant doit se familiariser avec les analyses statistiques et les méthodes de prédiction. Il doit aussi connaître l'administration de la justice, les principes de législation et ceux de l'application de la loi, le fonctionnement d'une cour (procès et condamnation) et toute la gamme de mesures préventives et correctionnelles.

APPENDIX 5

3. Sample of One-minute Association Test (English)

This is a test to see how many words you can think of and write down in a short time.

You will be given a <u>key</u> word and you are to write down as many <u>other</u> words which the key word brings to mind as you can. These other words which you write down may be things, places, ideas, events, or whatever you happen to think of when you see the key word.

For example, think of the word KING. Some of the words or phrases which KING might bring to mind are written below:

queen	Kingdom
King Cole	England
ruler	imperial
Sky-King	kingfish

No one is expected to fill in all the spaces on a page, but write as many words as you can which each key word calls to mind. Be sure to think back to the key word after each word you write down because the test is to see how many other words the key word makes you think of. A good way to do this is to repeat each key word over and over to yourself as you write.

APPENDIX 5

HONOR

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

HONOR: ______________________

APPENDIX 5

4. Sample of One-Minute Association Test (French)

Ceci est un test pour voir combien de mots vous pouvez penser et écrire pendant un temps limité.

Vous allez reçevoir un mot-clé et vous devez écrire d'autres mots que le mot-clé évoque dans votre esprit. Vous devez essayer d'en écrire le plus possible. Les mots que vous écrivez peuvent être des choses, des endroits, des idées, des évênements ou tout ce qui vous passe par la tête lorsque vous voyez le mot-clé.

Par exemple, pensez au mot ROI. Voici quelques mots ou expressions que le mot ROI peut évoquer dans votre esprit.

reine	gouverneur
royauté	autorité
Angleterre	
empire	

On ne s'attend pas à ce que vous puissiez remplir tous les espaces sur une page, mais écrivez autant de mots que vous pouvez. Soyez certain que vous revenez au mot clé après chaque mot que vous écrivez parce que le test veut mesurer combien d'autres mots, le mot-clé vous fait penser. Une façon efficace est de vous répéter continuellement le mot-clé pendant que vous écrivez.

APPENDIX 5

VIE

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

VIE: ______________________________

APPENDIX 5

5. Sample of Osgood's Differential (English)

In this booklet you will find a word at the top of each page. For each scale underneath, indicate towards which pole the word in question falls. Make an "X" in the space which you spontaneously judge to be the most appropriate.

APPENDIX 5

WINDOW

Non-familiar	____	____	____	____	____	____	____	Familiar
Clean	____	____	____	____	____	____	____	Dirty
Abstract	____	____	____	____	____	____	____	Concrete
Tasty	____	____	____	____	____	____	____	Distasteful
Strong	____	____	____	____	____	____	____	Weak
Large	____	____	____	____	____	____	____	Small
Valuable	____	____	____	____	____	____	____	Worthless
Fast	____	____	____	____	____	____	____	Slow
Tense	____	____	____	____	____	____	____	Relaxed
Active	____	____	____	____	____	____	____	Passive
Does not evoke sensory images	____	____	____	____	____	____	____	Evokes sensory images
Deep	____	____	____	____	____	____	____	Shallow
Hot	____	____	____	____	____	____	____	Cold

APPENDIX 5

Dans ce livret vous trouverez un mot à l'en-tête de chaque page. Pour chacune des échelles sous-jacentes, vous devez indiquer vers quel pôle le mot en question s'associe le mieux. Faîtes un "X" dans la case que vous jugez spontanément être la plus appropriée.

APPENDIX 5

HONNEUR

Rapide	____:____:____:____:____:____:____	Lent
Propre	____:____:____:____:____:____:____	Sale
Profond	____:____:____:____:____:____:____	Superficiel
Fort	____:____:____:____:____:____:____	Faible
Grand	____:____:____:____:____:____:____	Petit
Non-familier	____:____:____:____:____:____:____	Familier
Abstrait	____:____:____:____:____:____:____	Concret
Chaud	____:____:____:____:____:____:____	Froid
Savoureux	____:____:____:____:____:____:____	Dégoûtant
Précieux	____:____:____:____:____:____:____	Sans valeur
Tendu	____:____:____:____:____:____:____	Détendu
N'évoque pas des images sensorielles	____:____:____:____:____:____:____	Evoque des images sensorielles
Actif	____:____:____:____:____:____:____	Passif

EYSENCK PERSONALITY INVENTORY

FORM A

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

Name____________________ Age________ Sex________

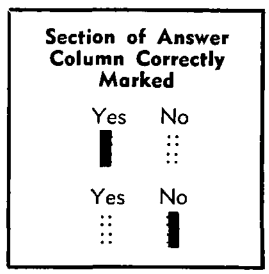
Grade or Occupation ____________________ Date________

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.

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ɔ you often long for excitement?. . . . . . Yes No

ɔ you often need understanding friends to cheer you ı? . . . . Yes No

re you usually carefree? . . Yes No

ɔ you find it very hard to take no for an answer? Yes No

o you stop and think things over before doing any-ıing? . . . Yes No

you say you will do something do you always keep ɔur promise, no matter how inconvenient it might ɜ to do so? . . Yes No

oes your mood often go up and down? Yes No

o you generally do and say things quickly without ɔpping to think? Yes No

o you ever feel "just miserable" for no good reason? Yes No

'ould you do almost anything for a dare?. Yes No

o you suddenly feel shy when you want to talk to an ttractive stranger? Yes No

nce in a while do you lose your temper and get ngry? . . Yes No

o you often do things on the spur of the moment? Yes No

o you often worry about things you should not have one or said?. . . . . . . Yes No

enerally do you prefer reading to meeting people? Yes No

re your feelings rather easily hurt? Yes No

o you like going out a lot? Yes No

o you occasionally have thoughts and ideas that you ould not like other people to know about? Yes No

re you sometimes bubbling over with energy and ometimes very sluggish? . . Yes No

o you prefer to have few but special friends? Yes No

o you daydream a lot? . . Yes No

/hen people shout at you, do you shout back? . . Yes No

ɹre you often troubled about feelings of guilt?. . . Yes No

ɹre all your habits good and desirable ones? Yes No

:an you usually let yourself go and enjoy yourself a ɔt at a gay party? Yes No

Vould you call yourself tense or "highly-strung"? Yes No

o other people think of you as being very lively? Yes No

ɹfter you have done something important, do you often ome away feeling you could have done better? Yes No

ɹre you mostly quiet when you are with other people? Yes No

o 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

APPENDIX 6

EXPERIMENTAL INSTRUCTIONS IN FRENCH

APPENDIX 6

EXPERIMENTAL INSTRUCTIONS IN FRENCH

Je vais prendre des mesures physiologiques en plaçant des électrodes sur deux doigts de chaque main. Veuillez vous asseoir confortablement pour environ vingt minutes. La seule chose qu'on vous demande c'est d'écouter. Veuillez ne pas parler et bouger le moins possible. Au cours des cinq premières minutes vous n'entendrez rien du haut-parleur placé derrière vous. Puis je vais vous présenter l'enregistrement des mots toujours prononcés par la même personne du sexe masculin et bilingue. Rappelez-vous que votre seule tâche est d'écouter tout en bougeant le moins possible.

Avez-vous des questions?

APPENDIX 7

(1) F_{max} TEST RESULTS FOR COMP-CO-ORD GSR

(2) MEANS AND STANDARD DEVIATIONS FOR UNTRANSFORMED COMP-CO-ORD RESULTS

(3) ANOVA AND SIMPLE EFFECTS FOR UNTRANSFORMED RESISTANCE MEASURES (COMP-CO-ORD)

APPENDIX 7

GSR and Square Rooted GSR Measures—F_{max} Test for Homogeneity of Variance for Balanced Bilingual Subjects.

	Trials 1 & 16	Trials 1 & 16 Comp/Co-ord	Trials 1 & 16 Conc/Abst	TB 1-6	TB 1-6 Comp/Co-ord	TB 1-6 Conc/Abst
Resistance	1.10(NS)	3.26(NS)	3.11(NS)	5.73*	9.84*	15.00*
$\sqrt{\text{Resistance}}$	1.23(NS)	1.95(NS)	1.97(NS)	1.58(NS)	1.87(NS)	2.95(NS)
Conductance	1.58(NS)	1.77(NS)	1.93(NS)	2.72*	5.90*	7.38*
$\sqrt{\text{Conductance}}$	1.62(NS)	2.04(NS)	1.92(NS)	1.32(NS)	2.08(NS)	2.24(NS)
Change in Log Cond.	1.39(NS)	2.29(NS)	2.26(NS)	3.03*	6.58*	9.31*
$\sqrt{\text{Change in Log Cond.}}$	1.68(NS)	2.05(NS)	2.37(NS)	1.32(NS)	1.32(NS)	2.56(NS)
	$F_{max}(2,24) = 2.62$	$F_{max}(4,12) = 6.9$	$F_{max}(4,12) = 6.9$	$F_{max}(6,48) = 2.4$	$F_{max}(12,24) = 4.2$	

* $p < .01$

NS - not significant

APPENDIX 7

Concrete and Abstract Stimuli Means and Standard Deviations for GSR Measures (Averaged) Across Trial Blocks

		Trial Blocks					
		1	2	3	4	5	6
Resistance Measure							
Concrete	$\bar{x}$	4.157	1.945	1.060	2.810	1.122	1.207
	sd	2.716	2.090	.996	2.550	1.556	1.329
Abstract	$\bar{x}$	4.383	1.402	1.555	2.470	1.186	.968
	sd	3.858	1.975	2.401	2.960	1.209	1.616
Avg. Total	$\bar{x}$	4.270	1.673	1.308	2.640	1.154	1.087
	sd	3.302	2.030	1.836	2.739	1.379	1.469
Conductance Measure							
Concrete	$\bar{x}$	2.320	1.182	.660	1.382	.740	1.044
	sd	1.572	1.522	.866	1.177	1.286	2.352
Abstract	$\bar{x}$	2.232	.925	.828	1.366	.808	.628
	sd	2.077	1.526	1.329	2.263	1.096	1.126
Avg. Total	$\bar{x}$	2.276	1.053	.744	1.374	.774	.836
	sd	1.822	1.513	1.113	1.784	1.182	1.836
Change in Log Cond. Measure							
Concrete	$\bar{x}$	396.54	196.38	105.62	250.33	112.70	130.58
	sd	219.66	197.58	107.76	189.86	169.72	209.10
Abstract	$\bar{x}$	399.17	151.62	145.46	235.25	131.67	99.79
	sd	317.46	226.08	225.64	328.79	143.83	162.77
Avg. Total	$\bar{x}$	397.85	174.00	125.54	242.79	122.19	115.19
	sd	270.06	211.25	176.07	265.70	155.92	186.02

APPENDIX 7

Comp and Co-ord Means and Standard Deviations for GSR Measures (Averaged) Across Trial Blocks

		Trial Blocks 1	2	3	4	5	6
Resistance Measure							
Comp	$\bar{x}$	3.241	1.246	1.139	1.983	.922	.944
	sd	2.521	1.596	1.620	1.988	1.181	1.397
Co-ord	$\bar{x}$	5.299	2.100	1.476	3.296	1.387	1.230
	sd	3.704	2.343	2.050	3.236	1.542	1.554
Avg. Total	$\bar{x}$	4.270	1.673	1.308	2.640	1.154	1.087
	sd	3.302	2.030	1.836	2.739	1.379	1.469
Conductance Measure							
Comp	$\bar{x}$	1.984	.907	.635	1.230	.654	.990
	sd	1.569	1.333	.883	1.365	.909	2.305
Co-ord	$\bar{x}$	2.568	1.199	.852	1.517	.894	.682
	sd	2.036	1.691	1.314	2.145	1.414	1.235
Avg. Total	$\bar{x}$	2.276	1.053	.744	1.374	.774	.836
	sd	1.822	1.513	1.113	1.784	1.182	1.836
Change in Log Cond. Measure							
Comp	$\bar{x}$	321.62	139.83	107.67	200.58	100.17	121.59
	sd	212.40	179.41	148.70	205.68	122.36	221.20
Co-ord	$\bar{x}$	474.08	208.17	143.42	285.00	144.21	108.79
	sd	302.97	237.84	201.43	313.44	183.57	147.31
Avg. Total	$\bar{x}$	397.85	174.00	125.54	242.79	122.19	115.19
	sd	270.06	211.25	176.07	265.70	155.92	186.02

APPENDIX 7

Comp and Co-ord Means and Standard Deviations for GSR Measures on Trials 1 and 16

			Trial 1	Trial 16
Resistance Measure	Comp	$\bar{x}$	5.459	4.608
		sd	4.449	3.939
	Co-ord	$\bar{x}$	9.208	7.086
		sd	6.991	7.108
	Avg. Total	$\bar{x}$	7.333	5.847
		sd	6.098	5.821
Conductance Measure	Comp	$\bar{x}$	2.932	2.893
		sd	2.289	2.762
	Co-ord	$\bar{x}$	3.597	2.916
		sd	2.291	3.044
	Avg. Total	$\bar{x}$	3.265	2.901
		sd	2.290	2.876
Change in Log Cond. Measure	Comp	$\bar{x}$	505.13	476.04
		sd	332.71	381.07
	Co-ord	$\bar{x}$	727.54	585.88
		sd	394.15	503.30
	Avg. Total	$\bar{x}$	616.33	530.96
		sd	377.92	445.09

Concrete and Abstract Means and Standard Deviations for GSR Measures on Trials 1 and 16

			Trial 1	Trial 16
Resistance Measure	Concrete	$\bar{x}$	6.593	6.850
		sd	4.266	6.476
	Abstract	$\bar{x}$	8.074	4.844
		sd	7.527	5.020
	Avg. Total	$\bar{x}$	7.333	5.847
		sd	6.098	5.821
Conductance Measure	Concrete	$\bar{x}$	3.266	3.349
		sd	2.203	2.666
	Abstract	$\bar{x}$	3.263	2.460
		sd	2.422	3.062
	Avg. Total	$\bar{x}$	3.265	2.905
		sd	2.290	2.876
Change in Log Cond. Measure	Concrete	$\bar{x}$	587.67	624.96
		sd	302.47	423.61
	Abstract	$\bar{x}$	645.00	436.95
		sd	445.71	454.90
	Avg. Total	$\bar{x}$	616.33	530.95
		sd	377.92	445.08

Analysis of Variance Using
Resistance Measures

Factor A: Trial Blocks 1 - 6
Factor B: Comp vs. Co-ord
Factor C: Concrete vs. Abstract Word Stimuli

Source of Variability	SS	df	MS	F Ratio
A	36924.06	5	7384.81	34.96****
AXB	2873.76	5	574.75	2.72**
AXC	899.45	5	179.89	0.85
AXBXC	1123.32	5	224.66	1.06
AXD	46473.73	220	211.24	
B	5646.30	1	5646.30	2.96 NS
C	22.97	1	22.97	0.01
BXC	0.01	1	0.01	0.00
D	83752.30	44	1903.46	

$F_{.95}$ (5,220)= 2.21
****p < .0001
*p < .02

$F_{.95}$ (1,44) = 4.06
NS - not significant

Analysis of Variance Summary Table for Simple Effects on Trials by Type of Bilingual Interaction (Resistance)

Source of Variation	SS	df	MS	F Ratio	p
A at b1	9744.40	5	1948.88	9.23	.01
A at b2	30036.24	5	6007.24	28.44	.001
Error Term	46473.73	220	211.24		
B at a1	5082.43	1	5082.43	10.30	.01
B at a2	871.01	1	871.01	1.77	NS
B at a3	136.28	1	136.28	0.28	NS
B at a4	2068.76	1	2068.76	4.19	.05
B at a5	259.47	1	259.47	0.53	NS
B at a6	98.16	1	98.16	0.20	NS
Error Term	130226.03	264	493.28		

$F_{.95}(5,220) = 2.26$
$F_{.99}(5,220) = 3.11$

$F_{.95}(1,264) = 3.89$
$F_{.99}(1,264) = 6.76$

APPENDIX 8

(1) F_{max} TEST FOR DOMINANT FRENCH BILINGUALS

(2) MEANS AND STANDARD DEVIATIONS FOR UNTRANSFORMED DOMINANT FRENCH DATA

APPENDIX 8

GSR and Square Rooted GSR Measures F_{max}–Test for Homogeneity of Variance for Dominant French Subjects

	Trials 1 & 16	Trials 1 & 16 Eng-Fr/Fr-Eng	TB 1 - 6	TB 1 - 6 Eng-Fr/Fr-Eng
Resistance	2.08(NS)	6.42(NS)	9.50*	26.05*
$\sqrt{\text{Resistance}}$	2.96(NS)	7.99*	1.55(NS)	3.72(NS)
Conductance	1.33(NS)	2.07(NS)	11.67*	38.27*
$\sqrt{\text{Conductance}}$	1.23(NS)	1.53(NS)	2.20(NS)	3.75(NS)
Change in Log Cond.	1.09(NS)	2.69(NS)	9.96*	25.33*
$\sqrt{\text{Change in Log Cond.}}$	2.22(NS)	3.80(NS)	1.65(NS)	2.57(NS)
	$F_{max}(2,24) = 3.32$	$F_{max}(4,12) = 6.9$	$F_{max}(6,24) = 4.9$	$F_{max}(12,12 = 10.6$

*$p < .01$
NS = not significant

APPENDIX 8

Dominant French Subjects English vs. French Stimuli and Means, Standard Deviations for GSR Responses across Trial Blocks

		Trial Blocks					
		1	2	3	4	5	6
Resistance Measure							
Eng-Fr	$\bar{x}$	4.092	2.103	1.755	2.445	1.014	1.169
	sd	3.047	2.017	1.761	1.881	.820	1.442
Fr-Eng	$\bar{x}$	2.804	1.074	1.055	1.358	.372	.863
	sd	1.305	.863	1.036	.916	.597	1.250
Avg.	$\bar{x}$	3.448	1.588	1.405	1.901	.693	1.016
Total	sd	2.385	1.606	1.458	1.550	.774	1.329
Conductance Measure							
Eng-Fr	$\bar{x}$	3.793	1.747	1.548	2.620	1.127	.876
	sd	4.918	2.092	1.462	3.131	1.529	.710
Fr-Eng	$\bar{x}$	2.970	1.117	1.342	1.309	.445	.988
	sd	2.745	1.210	1.905	1.114	.795	1.496
Avg.	$\bar{x}$	3.381	1.432	1.445	1.964	.786	.932
Total	sd	3.918	1.702	1.664	2.394	1.241	1.147
Change in Log Cond. Measure							
Eng-Fr	$\bar{x}$	495.42	247.42	214.67	306.92	137.17	165.42
	sd	458.04	248.00	207.68	295.46	125.81	241.66
Fr-Eng	$\bar{x}$	374.17	143.50	152.75	175.25	52.25	123.33
	sd	243.05	125.90	176.62	116.37	90.95	184.35
Avg.	$\bar{x}$	434.79	195.45	183.71	241.08	94.71	144.37
Total	sd	363.90	199.53	191.18	229.67	115.79	211.30

APPENDIX 8

Dominant French Subjects English vs. French Stimuli Means and Standard Deviations for GSR Measures (Trials 1 and 16)

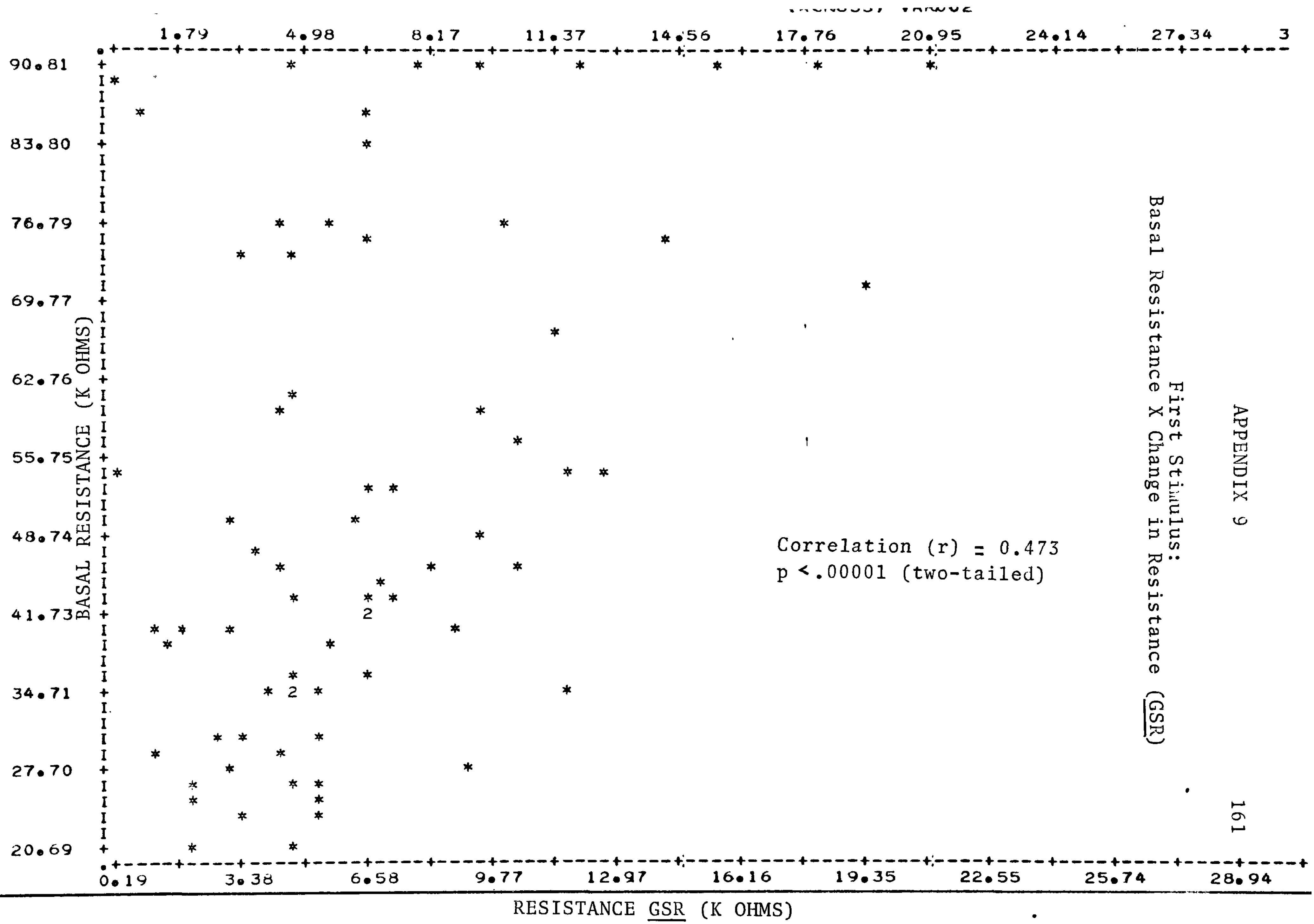
			Trial 1 (lang 1)	Trial 16 (lang 2)
Resistance Measure	Eng-Fr	$\bar{x}$	6.248	5.543
		sd	3.580	4.755
	Fr-Eng	$\bar{x}$	5.531	4.777
		sd	1.877	3.425
	Avg. Total	$\bar{x}$	5.890	5.160
		sd	2.819	4.071
Conductance Measure	Eng-Fr	$\bar{x}$	5.098	4.182
		sd	4.396	3.058
	Fr-Eng	$\bar{x}$	4.868	4.540
		sd	3.463	3.768
	Avg. Total	$\bar{x}$	4.983	4.361
		sd	3.872	3.361
Change in Log Cond. Measure	Eng-Fr	$\bar{x}$	719.83	616.25
		sd	448.39	383.63
	Fr-Eng	$\bar{x}$	692.00	609.91
		sd	273.60	393.20
	Avg. Total	$\bar{x}$	705.92	613.08
		sd	363.53	379.92

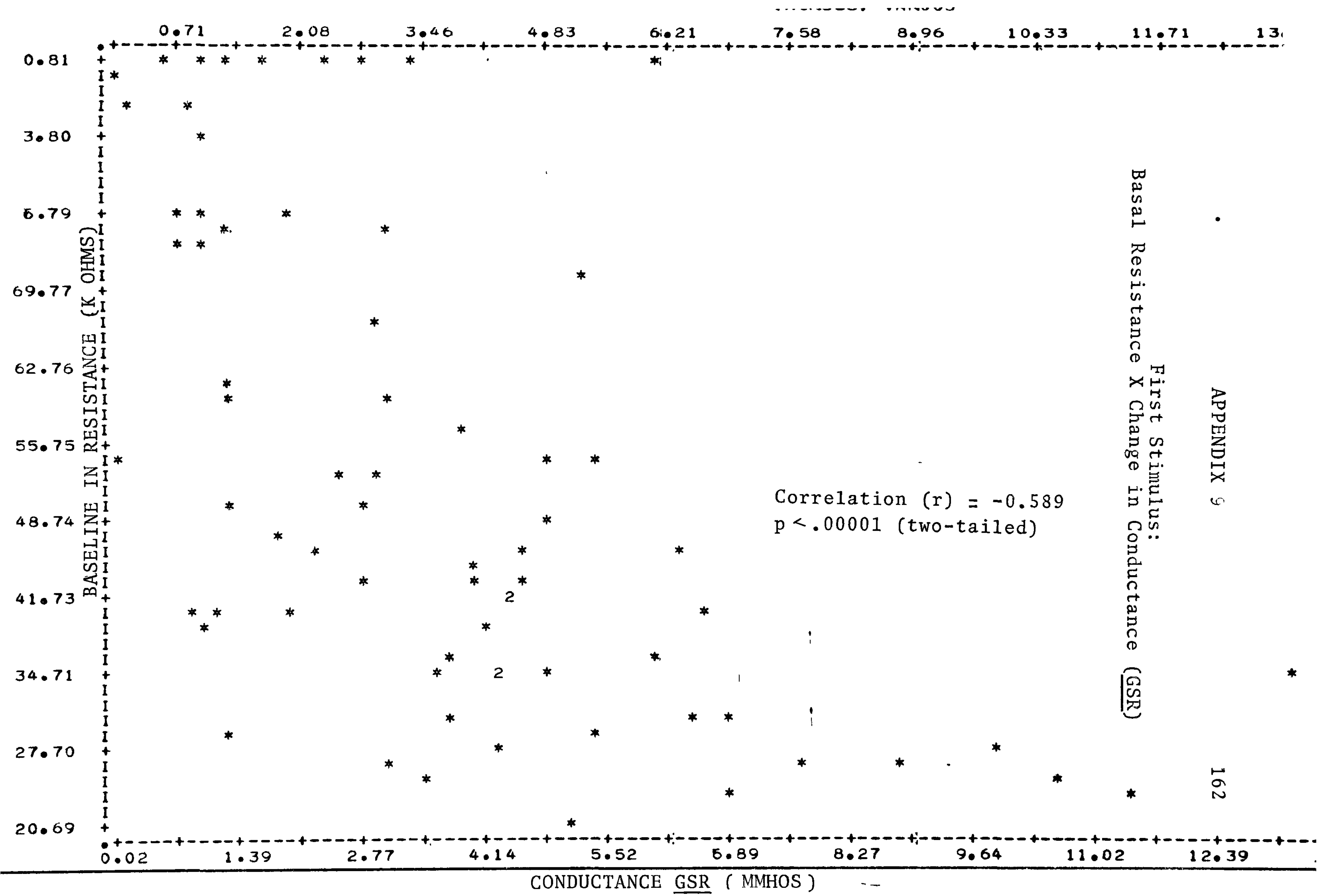
APPENDIX 9

SCATTERGRAMS AND PEARSON'S "r" FOR BASAL RESISTANCE MEASURES AND ALL METHODS OF QUANTIFYING GSR USED IN THE STUDY (FIRST STIMULUS ONLY)

APPENDIX 9

First Stimulus:
Basal Resistance X Change in Resistance (GSR)



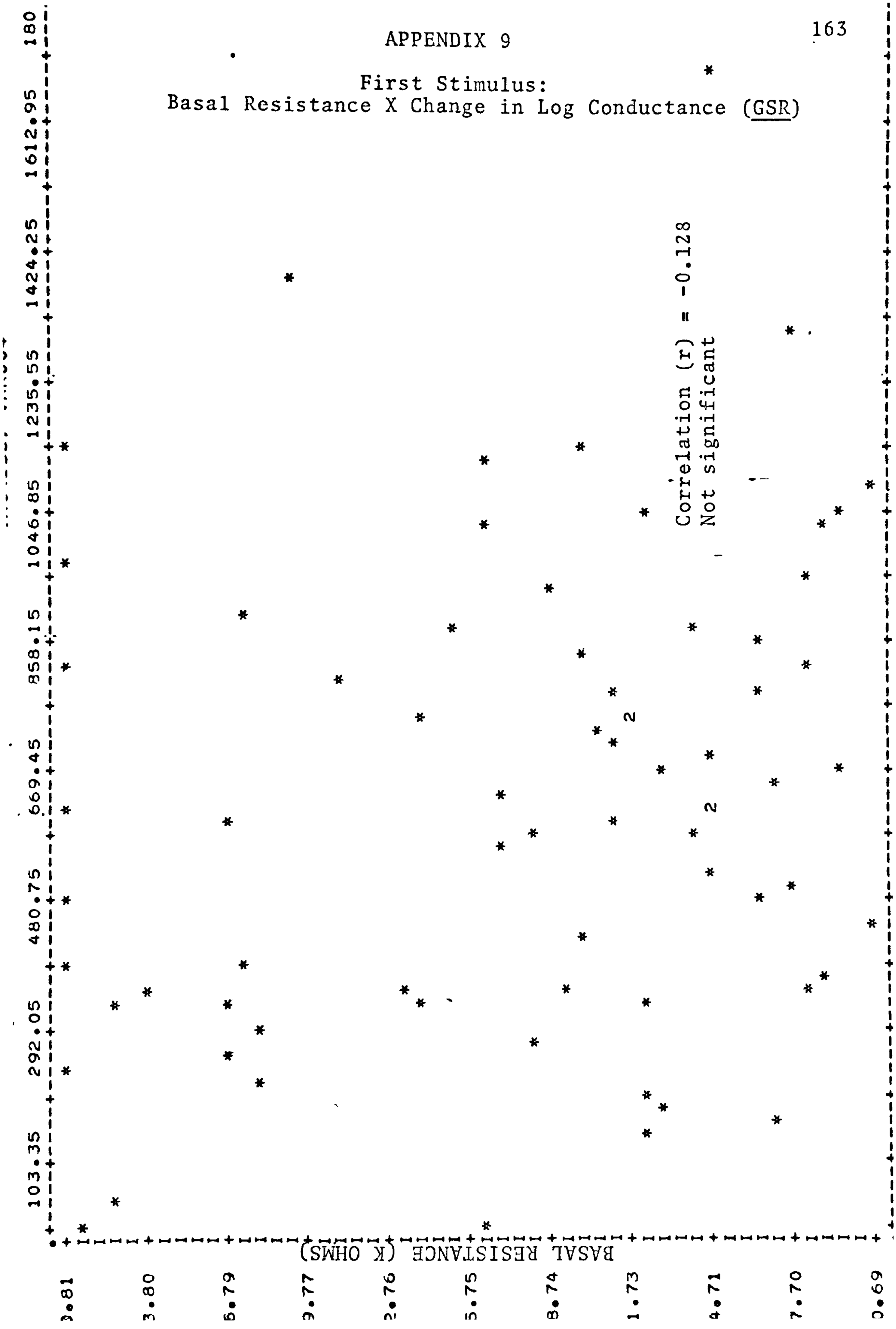


APPENDIX 9

First Stimulus:
Basal Resistance X Change in Conductance (GSR)

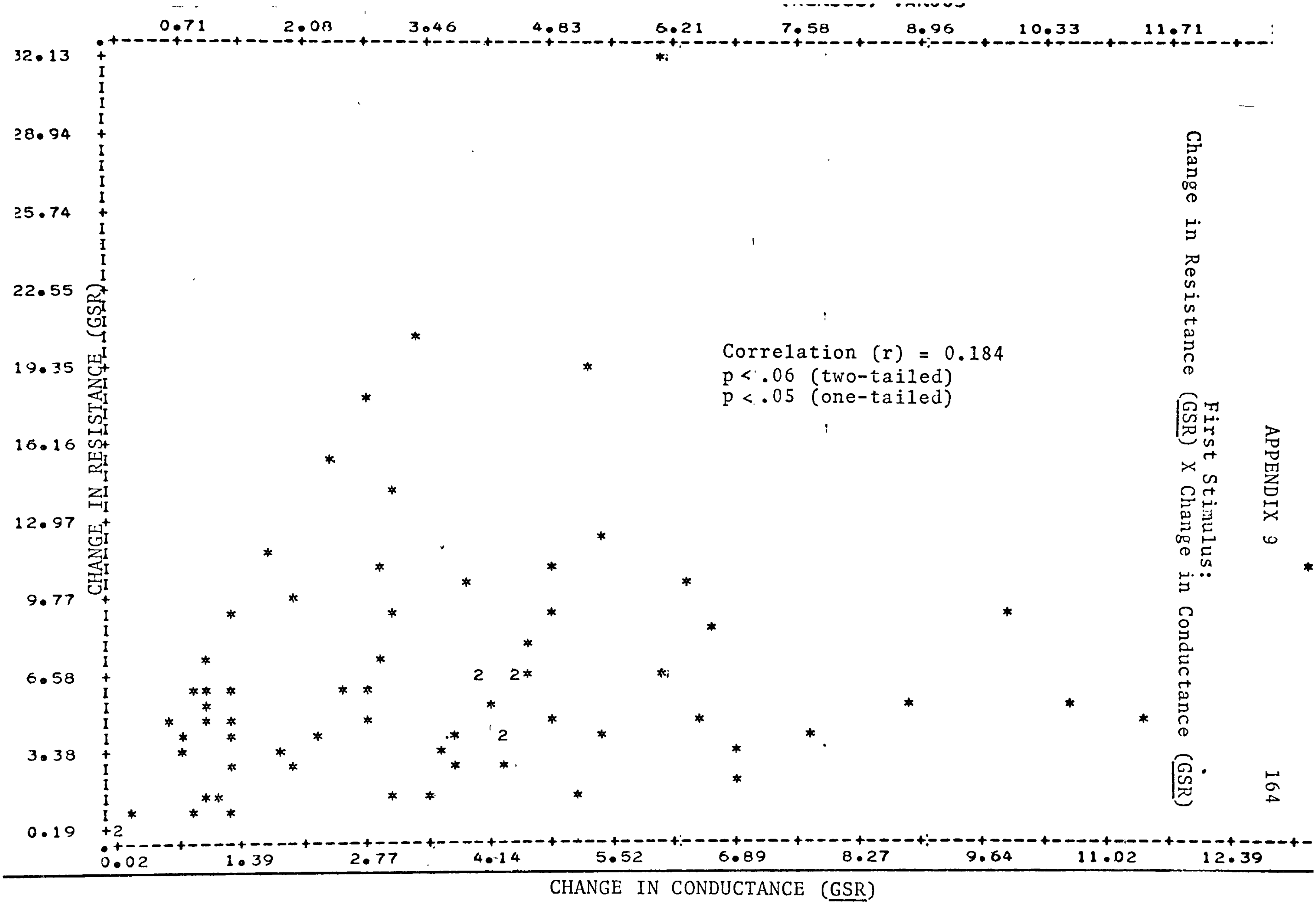
APPENDIX 9

First Stimulus:
Basal Resistance X Change in Log Conductance (GSR)



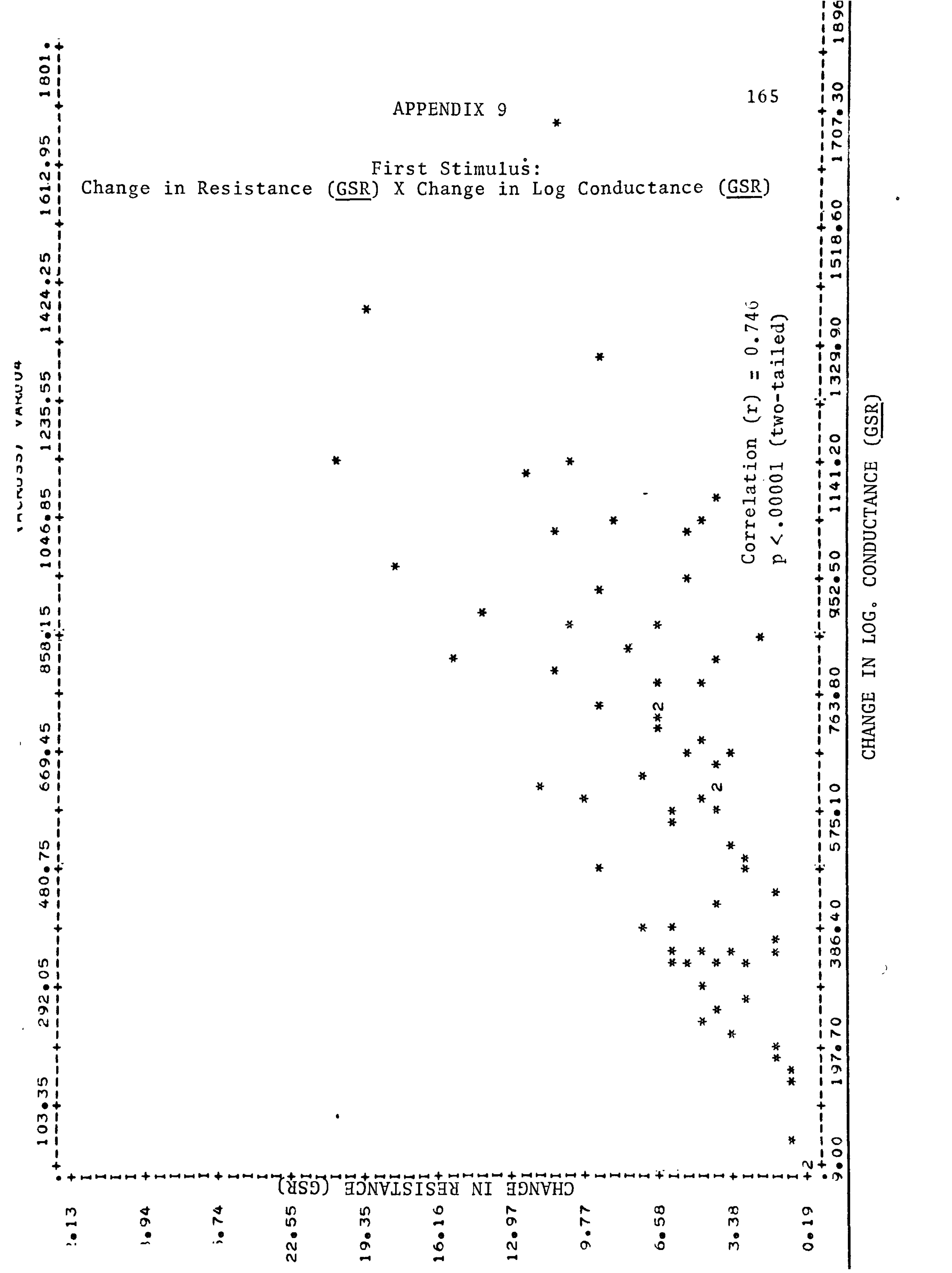
APPENDIX 9

First Stimulus:
Change in Resistance (GSR) X Change in Conductance (GSR)



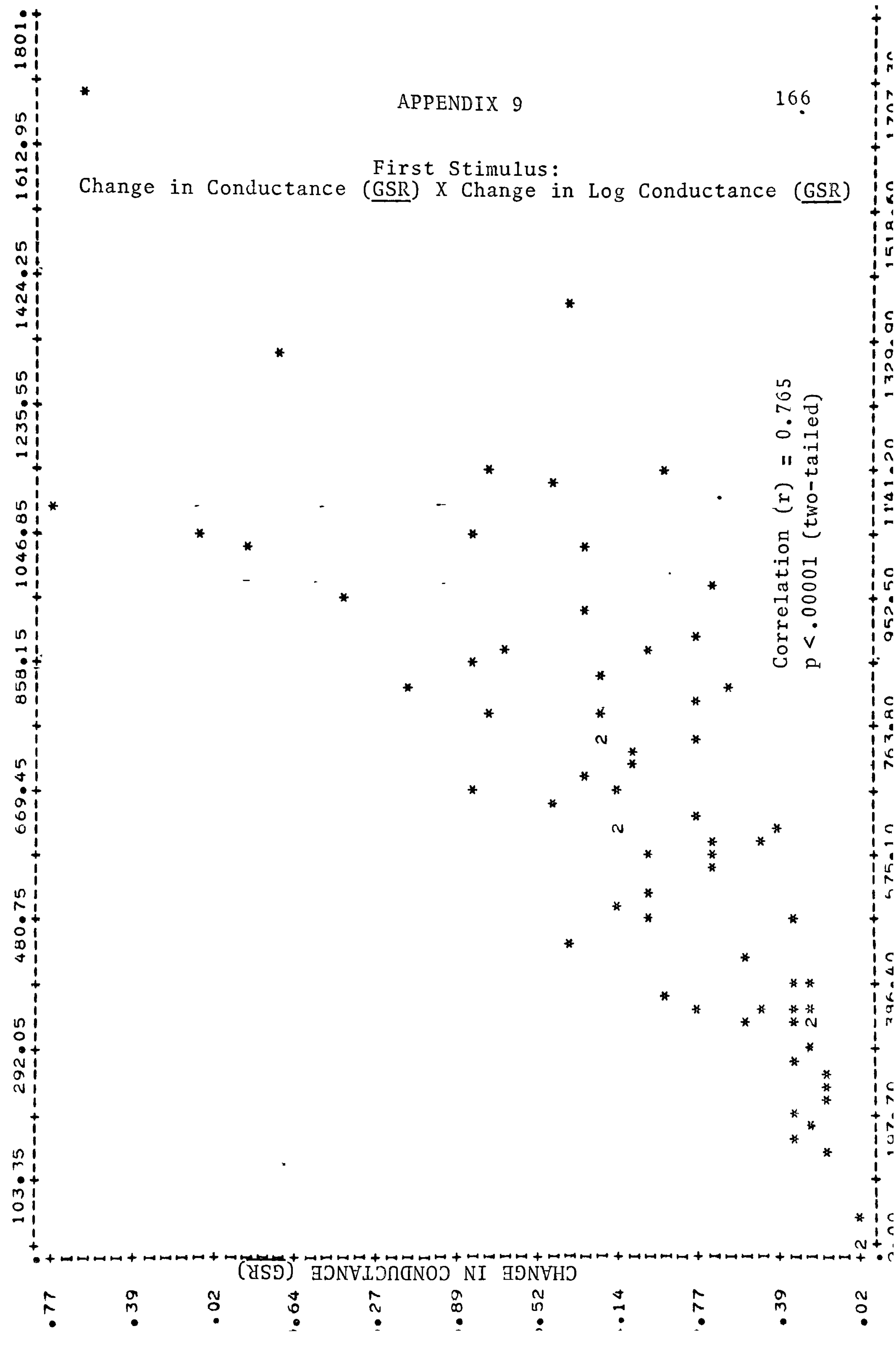
APPENDIX 9

First Stimulus:
Change in Resistance (GSR) X Change in Log Conductance (GSR)



APPENDIX 9

First Stimulus:
Change in Conductance (GSR) X Change in Log Conductance (GSR)



APPENDIX 10

RAW PHYSIOLOGICAL DATA

Code: For first six numbers of each trial or TB

ABCDEF
000000

"A"	(for 1st and 16th trial):	1	1st
		2	16th
	(for Trial Blocks)	1	1st TB
		2	2nd TB
		3	3rd TB
		4	4th TB
		5	5th TB
		6	6th TB
"B"	(for 1st, 16th and TB):	1	Compounds
		2	Co-ordinates
		3	DFC
"C"	(for 1st, 16th and TB):	1	Concrete words
		2	Abstract words
"D"	(for 1st, 16th and TB):	1	English to French
		2	French to English
"E" "F"	(for 1st, 16th and TB):	1-72 (Subject number)	

. . . .

Lt. = Left hand
Rt. = Right hand
ΔR = Change in resistance
ΔC = Change in conductance
ΔLOG = Change in log conductance

Means show where decimal point belongs and units of measurement.

APPENDIX 10

Compounds and Co-ordinates Trial 1

	Basal Lt.	Basal Rt.	Latency Lt.	Latency Rt.	Response ΔR Lt.	Response ΔR Rt.			Response ΔC Lt.	Response ΔC Rt.		Response (Log) Lt.	Response (Log) Rt
1111 1 1	8539	7695	2880	2800	574	574	1171	1299	84	105	573	0302	0337
11110201	5065	5798	2320	2320	956	1051	4974	1724	459	382	1004	0909	0869
1112 3 1	3774	2738	2240	2240	764	535	2649	3651	673	887	650	0984	0945
1112 4 1	3185	3025	2720	2800	115	115	3140	3305	117	130	115	0159	0168
1111 5 1	3869	4523	2250	2250	803	688	2584	2210	677	396	746	1010	0717
1111 6 1	2675	2419	1680	1680	478	344	3738	4133	813	685	411	0855	0667
1112 7 1	2658	2579	2000	2000	210	210	3761	3877	323	344	210	0358	0370
111208 1	2962	3105	1920	2000	611	516	3376	3220	879	642	564	1005	0790
1111 9 1	6515	9081	2720	2720	478	478	1535	1101	122	61	478	0331	0235
111110 1	5766	5431	2000	2000	573	650	1734	1841	191	250	611	0455	0554
111211 1	7519	7646	2160	2240	1434	1434	1329	1307	313	302	1434	0919	0902
111212 1	3646	3965	1800	1800	210	152	2742	2521	168	101	181	0258	0171
112113 1	5384	4746	2500	2500	382	363	1857	2106	142	175	373	0320	0346
112114 1	7121	7136	2240	2320	1944	1944	1404	1401	527	524	1944	1385	1381
112215 1	8061	8794	1600	208	574	650	1240	1137	95	91	612	0321	0334
112216 1	5049	6117	2160	2240	956	956	1980	1635	463	303	956	0912	0738
112117 1	7727	8986	4000	3600	19	19	1294	1113	03	02	19	0011	0009
112118 1	7089	7447	3000	2000	344	343	1410	1308	72	65	354	0216	0212
112219 1	9081	5543	3500	3500	19	19	1101	1804	02	06	19	0009	0015
112220 1	6005	7439	2882	2880	439	478	1665	1344	132	92	459	0330	0289
112121 1	5160	4429	2000	2080	841	669	1938	2258	377	402	755	0773	0712
112122 1	4013	2850	2080	2080	429	305	2491	3508	307	422	373	0504	0493
112223 1	3344	2738	2480	2560	229	210	2990	3652	221	304	219	0309	0347
112224 1	3758	3519	2480	2480	430	398	2660	2841	344	366	414	0528	0522
121125 1	2276	3089	2000	2000	191	325	4393	3237	402	380	258	0381	0483
121126 1	7631	9081	2160	2240	1224	1186	1310	1101	250	165	1205	0759	0608
121227 1	3838	4236	2240	2320	650	669	2605	2360	531	442	659	0806	0747
121228 1	6226	5527	1840	1840	1721	1262	1606	1809	613	535	1491	1405	1126
121129 1	5097	4322	1760	1760	899	708	1962	2308	420	450	803	0843	0775
121130 1	3105	4077	2160	2160	127	127	3220	2452	137	79	127	0182	0138
121231 1	9081	8762	3000	3000	114	95	1101	1141	14	12	105	0055	0048
121232 1	9001	9081	2200	2200	1606	1568	1110	1101	241	229	1587	0854	0823
121133 1	4507	5368	2800	2800	707	726	2218	1862	413	291	707	0742	0632
121134 1	2483	3710	1800	1800	382	458	4026	2694	733	380	420	0726	0574
121235 1	5575	5511	2240	2240	1223	1166	1793	1814	504	487	1195	1077	1033
121236 1	7918	9081	2720	2720	631	785	1263	1101	109	104	707	0360	0392
122137 1	7583	7679	2400	2320	841	994	1319	1302	164	193	917	0511	0602
122138 1	8459	7758	2400	2400	516	439	1182	1288	76	77	478	0274	0254
122239 1	9081	9081	2500	2500	1051	937	1101	1101	144	126	994	0535	0473
122240 1	1909	2674	2000	2000	382	458	5236	3738	1311	774	420	0971	0818
122141 1	3153	3949	1680	1680	517	558	3171	2532	621	416	537	0777	0661
122142 1	4496	4221	1760	1760	727	669	2226	2369	429	447	698	0767	0750
122243 1	3376	2829	1840	1840	1033	918	2962	2829	1305	992	975	1586	1306
122244 1	9081	9081	2400	2320	2103	1817	1101	1101	332	275	1960	1144	0970
122145 1	2818	3535	2320	2320	344	459	3548	2829	494	422	401	0566	0604
122146 1	4109	3535	2240	2160	516	459	2434	2829	349	422	488	0583	0604
122247 1	9081	9081	2640	2560	2677	2103	1101	1101	460	332	2390	1517	1144
122248 1	9081	9081	1440	1360	3457	3213	1101	1101	758	603	3499	2343	1896
Means	55.61	56.69	2.29	2.24	7.80	7.33			3.82	3.26		685.97	616.33
	(K OHMS)		(SECONDS)		(K OHMS)				(MMHOS)			(UNITS LOG)	

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Compounds and Co-ordinates Trial 16

2111 1	5	9081	8427	3360	3200	248	248	1101	1186	31	36	249	0121	0130
2111 2	5	5177	6005	3230	2320	994	975	1932	1665	459	323	985	0909	0869
2112 3	5	6914	4858	2640	2640	784	516	1446	2058	185	245	650	0523	0488
2112 4	5	2595	2499	2720	2720	96	96	3854	4001	147	159	96	0163	0170
2111 5	5	7344	7790	2560	2720	115	57	1363	1284	21	09	86	0068	0032
2111 6	5	2770	2515	2080	2080	574	401	3509	3976	943	755	488	1008	0756
2112 7	5	2674	2483	2160	2150	515	478	3738	4027	894	959	497	0932	0929
211208	5	3854	3981	1950	1920	764	445	2597	5211	642	578	755	0961	0901
2111 9	5	7152	9081	2720	2640	325	325	1398	1101	66	40	325	0202	0158
211110	5	4428	4237	3100	3100	611	650	2258	2360	362	428	631	0646	0724
211211	5	6897	7376	2480	2480	1784	1673	1449	1355	506	397	1729	1300	1118
211212	5	3726	4029	2160	2160	458	478	2683	2481	376	334	468	0571	0549
212113	5	9081	9081	3120	2880	344	363	1101	1101	43	45	353	0168	0177
212114	5	5065	5160	2560	2560	803	803	1974	1937	372	357	803	0750	0735
212215	5	6274	7408	2720	2720	439	516	1593	1349	120	101	478	0316	0314
212216	5	3630	4826	2000	2000	631	708	2754	2072	579	356	669	0823	0689
212117	5	8061	9081	0000	0000	0000	0000	1240	1101	0000	0000	0000	0000	0000
212118	5	8300	8858	296	2880	325	249	1205	1129	49	33	289	0174	0124
212219	5	9081	6739	0000	0000	0000	0000	1101	1484	0000	0000	0000	0000	0000
212220	5	6213	7408	2560	2800	134	133	1609	1349	35	25	134	0095	0079
212121	5	5607	4682	2000	2000	1377	1147	1783	2135	580	693	1262	1224	1221
212122	5	3854	2643	2320	2240	439	363	2595	5784	334	603	401	0526	0642
212223	5	3567	3025	3220	3120	57	38	2803	3305	46	42	48	0071	0055
212224	5	3790	3264	2000	2000	430	398	2638	3063	338	426	414	0523	0565
221125	5	2419	3152	2480	2480	325	458	4132	3171	641	540	392	0627	0683
221126	5	6053	7073	2240	2240	1319	1262	1652	1413	460	307	1290	1068	0854
221227	5	4220	4555	1260	1260	841	784	2369	2195	590	456	812	0966	0820
221228	5	5798	5017	2400	2400	917	688	1724	1993	324	316	803	0749	0641
221129	5	9081	6977	2400	2400	2103	1606	1101	1433	331	425	1855	1144	1136
221130	5	4858	6053	3520	3440	19	19	2058	1652	08	05	19	0017	0014
221231	5	9081	9081	3280	3360	38	38	1101	1101	14	04	38	0018	0018
221232	5	9081	9081	1840	1920	2103	2932	1101	1101	331	525	2517	1144	1694
221133	5	5448	6627	2800	2960	631	478	1836	1509	240	117	555	0535	0532
221134	5	2356	3296	1000	1000	458	688	4244	3033	1026	800	573	0941	1018
221235	5	6260	6021	2640	2640	726	726	1597	1660	209	227	726	0536	0559
221236	5	7423	9081	2640	2640	325	420	1347	1101	61	53	372	0195	0206
222137	5	5479	5288	2800	2800	497	573	1824	1890	182	230	535	0413	0499
222138	5	5415	5209	1680	1600	325	305	1846	1919	117	119	316	0269	0263
222239	5	8427	7535	2720	2720	401	420	1196	1327	59	78	411	0212	0250
222240	5	1830	2531	2240	2320	267	325	5464	3950	936	582	296	0687	0597
222141	5	2929	3758	2560	2640	229	210	3413	2661	290	158	219	0354	0250
222142	5	3344	3153	3040	3040	133	77	2990	3172	125	79	105	0178	0107
222243	5	4172	4189	1840	1840	1606	1492	2396	2387	1500	1320	1549	2111	1912
222244	5	9081	9081	3600	3200	19	19	1101	1101	02	02	19	0009	0009
222145	5	2610	3631	2400	2560	229	115	3829	2454	369	89	172	0400	0140
222146	5	5256	4129	2880	2080	153	153	1902	2425	57	93	153	0128	0164
222247	5	9081	9081	2480	2480	2486	1626	1101	1101	415	240	2056	1389	0857
222248	5	9018	9081	1500	1500	1721	1593	1109	1101	262	234	1657	0920	0838

131149	1	4794	3535	1840	1680	765	516	2086	2829	396	484	640	0755	0686
131150	1	4810	5129	1920	1840	727	631	2079	1949	369	274	679	0711	0570
131251	1	2563	3184	1680	1740	478	273	3901	3140	895	689	526	0897	0863
131252	1	2610	3025	1900	1900	497	420	3829	3305	90	533	459	0918	0650
131153	1	3727	4077	1360	1120	249	305	2683	2453	191	199	277	0300	0339
131154	1	4364	5017	3280	3280	267	305	2291	1993	149	129	286	0275	0273
131255	1	4666	4603	1760	1440	860	803	2143	2172	484	459	831	0885	0833
131256	1	4587	4618	2500	2500	344	420	2180	2164	177	216	382	0339	0415
131157	1	2451	2132	2720	2720	210	210	4078	4688	382	513	210	0390	0451
131158	1	2850	3599	2000	2000	1086	1163	3508	2778	2003	1327	1099	1962	1696
131259	1	4953	4427	2560	2560	516	478	2018	2258	234	273	297	0678	0596
131260	1	8619	7678	2640	2560	841	650	1160	1302	125	120	745	0446	0384
132161	1	5431	4077	2000	2000	808	871	1841	2452	369	667	890	0795	1045
132162	1	8316	6818	2000	2000	1491	1147	1202	1466	262	296	1319	0859	0800
132263	1	6148	6276	3000	3000	516	478	1626	1593	149	131	497	0380	0344
132264	1	7089	6085	3280	3360	516	439	1410	1643	110	128	478	0329	0326
132165	1	1974	2069	1680	1680	363	458	5067	4832	1143	1377	411	0884	1089
132166	1	4204	4109	1840	4840	248	191	2378	2433	149	118	219	0265	0207
132267	1	3663	3663	2080	2080	803	669	2730	2730	767	610	736	1075	0876
132268	1	4220	4937	2080	2080	956	956	2369	2025	694	486	956	1116	0935
132169	1	7981	8395	2240	2320	650	650	1252	1191	111	99	650	0369	0350
132170	1	5527	4618	2240	2240	1553	1051	1809	2164	707	635	1302	0433	1132
132271	1	2403	2403	1840	1840	631	516	4160	1160	1480	1138	573	1323	1050
132272	1	2340	2531	2080	2000	478	535	4273	3950	1097	1059	507	0993	1032

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Dominant French Trial 16

231149	5	3535	2754	2320	2240	612	478	2829	3630	592	763	545	0826	0828
231150	5	3694	3503	1840	1920	611	535	2707	2854	537	515	574	0787	0720
231251	5	2356	2850	2400	2480	229	249	4244	3508	458	335	239	0445	0396
231252	5	2866	2754	2400	2560	573	478	3489	3630	873	762	525	0970	0828
231153	5	2961	3456	1440	1290	229	287	3377	2893	283	261	258	0350	0376
231154	5	5129	6149	0000	0000	0000	0000	1949	1626	0000	0000	0000	0000	0000
231255	5	6388	2578	1680	1680	1434	1262	1565	1701	453	165	1348	1104	1050
231256	5	6021	5925	2960	2880	95	191	1660	1687	26	56	143	0070	0143
231157	5	2164	1941	2560	2640	174	152	4619	5150	399	240	162	0360	0357
231158	5	2483	3073	2000	2000	430	509	4026	3254	843	647	470	0826	0788
231259	5	4061	3662	2480	2400	516	516	2462	2730	358	448	516	0591	0660
231260	5	9081	7280	0000	0000	0000	0000	1101	1373	0000	0000	0000	0000	0000
232161	5	5017	3790	2000	1920	949	872	1993	2638	465	788	910	0912	1135
232162	5	9081	8093	2320	2240	1300	1051	1101	1235	184	184	1176	0671	0605
232263	5	6786	6913	3600	3600	114	114	1473	1446	25	244	114	0074	0073
232264	5	4618	3949	2500	2500	669	535	2164	2531	366	397	602	0680	0633
232165	5	2101	2148	1920	1920	344	344	4759	4653	932	887	344	0777	0758
232166	5	4778	4730	2720	2720	114	76	2092	2113	51	34	95	0106	0071
232267	5	4396	4715	1920	1920	956	879	2275	2121	632	487	917	1065	0897
232268	5	3152	3822	2320	2400	439	439	3171	2616	514	340	439	0653	0531
232169	5	5766	6117	2160	2160	650	650	1734	1634	220	194	650	0520	0488
232170	5	8858	6706	2400	2160	1195	1698	1128	1491	176	505	1447	0630	1269
232271	5	2563	2563	1760	1760	631	478	3901	3901	1274	894	554	1228	0897
232272	5	2196	2435	2560	2480	516	592	4552	4105	1398	1320	554	1164	1211

APPENDIX 10

Compounds and Co-ordinates

TRIAL BLOCK 1

	ΔC	ΔR	ΔLOG C
111101	00712	03674	0222
111102	03064	05355	0547
111203	06117	03404	0625
111204	00822	00612	0097
111105	01283	02359	0239
111106	04208	01951	0392
111207	03281	01988	0356
111208	02801	02371	0353
111109	00421	03289	0162
111110	02449	04666	0462
111211	02523	09785	0679
111212	01477	02180	0246
112113	00583	01147	0112
112114	02702	08248	0644
112215	00679	04360	0236
112216	02265	06885	0542
112117	00004	00038	0002
112118	00158	00867	0051
112219	00036	00115	0009
112220	00965	03366	0245
112121	04032	05724	0658
112122	03665	02218	0391
112223	01032	00727	0119
112224	02349	02454	0330
121125	03093	03557	0453
121126	02255	09485	0623
121227	02403	03939	0423
121228	03247	06885	0647
121129	04942	07382	0820
121130	00158	00233	0028
121231	00066	00487	0025
121232	01200	08376	0435
121133	01586	03557	0326
121134	03828	04131	0541
121235	03338	06923	0659
121236	00413	03174	0157
122137	02009	06081	0471
122138	00224	01224	0072
122239	00667	04169	0228
122240	05388	03022	0549
122141	01887	03028	0387
122142	02938	03748	0455
122243	08637	08032	1139
122244	01260	08491	0449
122145	01963	02295	0291
122146	03593	03442	0482
122247	01231	08070	0432
122248	05296	17442	1286
Means	2.280 (UMHOS)	4.270 (K OHMS)	397.85 (LOG)

TRIAL BLOCK 2

	ΔC	ΔR	ΔLOG C
211101	00055	00344	0019
211102	01016	02142	0203
211203	05500	02601	0513
211204	00473	00287	0051
211105	00170	00420	0037
211106	02122	01797	0337
211207	01121	00842	0133
211208	00027	00038	0004
211109	00046	00306	0016
211110	01238	01989	0216
211211	00808	02913	0210
211212	00626	00994	0109
212113	00101	00497	0031
212114	00120	00574	0036
212215	00138	01071	0053
212216	01987	05011	0433
212117	00000	00000	0000
212118	00000	00000	0000
212219	00000	00000	0000
212220	00048	00153	0012
212121	03750	06196	0661
212122	00979	00574	0103
212223	00139	00115	0017
212224	01306	01052	0162
221125	00972	01377	0158
221126	02220	05967	0498
221227	00425	00880	0084
221228	02048	04131	0399
221129	01198	03174	0267
221130	00000	00000	0000
221231	00000	00000	0000
221232	01407	08185	0464
221133	00533	01224	0111
221134	05709	04819	0718
221235	00652	02218	0164
221236	00004	00038	0002
222137	00715	01797	0155
222138	00019	00115	0007
222239	00039	00191	0012
222240	00717	00574	0088
222141	00632	00918	0105
222142	01761	01874	0249
222243	06770	06426	0902
222244	00000	00000	0000
222145	01037	01147	0192
222146	00728	00688	0097
222247	00037	00306	0015
222248	01174	04360	0309

Compounds and Co-ordinates

TRIAL BLOCK 3

	ΔC	ΔR	ΔLOG C
311101	00011	00C76	0004
311102	00542	01835	0137
311203	01191	01300	0170
311204	00544	00325	0057
311105	0C021	00114	0007
311106	02966	01224	0226
311207	00201	00153	0024
311208	00810	01300	0141
311109	0C093	00726	0036
311110	00349	00574	0062
311211	00294	01587	0093
311212	00624	00956	0106
312113	0C093	00076	0004
312114	01540	03786	0328
312215	00302	01835	0102
312216	02004	05163	0441
312117	000CC	00000	0000
312118	00000	00000	0000
312219	00000	00000	0000
312220	00000	00000	0000
312121	02910	05852	0566
312122	00749	00459	0080
312223	00000	00000	0000
312224	00000	00000	0000
321125	0C531	00765	0087
321126	01105	03455	0266
321227	00272	00606	0056
321228	01593	02716	0283
321129	00422	01568	0111
321130	00000	00000	0000
321231	00000	00000	0000
321232	00018	00153	0007
321133	00244	00803	0061
321134	03273	02881	0421
321235	00747	02333	0180
321236	00000	00000	0000
322137	01734	02639	0245
322138	00154	00727	0046
322239	00014	00115	0006
322240	01556	00612	0128
322141	00100	00192	0019
322142	0C824	00879	0117
322243	05698	06655	0842
322244	00C00	00000	0000
322145	00577	00688	0087
322146	000CC	00000	0000
322247	0000C	00000	0000
322248	01606	07642	0480

TRIAL BLOCK 4

	ΔC	ΔR	ΔLOG C
411101	00095	00650	0034
411102	01064	03289	0257
411203	02230	03481	0380
411204	00865	00529	0093
411105	00446	02167	0135
411106	02765	01568	0286
411207	03641	01951	0365
411208	01539	01836	0230
411109	00173	01376	0067
411110	01220	01912	0209
411211	02317	07139	0534
411212	00883	01339	0149
412113	00140	01147	0053
412114	CC836	01950	0175
412215	00460	02167	0137
412216	02030	04360	0408
412117	00000	00000	0000
412118	00065	00497	0025
412219	00000	00000	0000
412220	00068	00344	0021
412121	05608	07573	0891
412122	01780	01071	0189
412223	00084	00C76	0011
412224	01221	01179	0165
421125	01C80	00918	0137
421126	02400	08491	0618
421227	C1849	03328	0339
421228	01525	02938	0289
421129	02153	06196	0495
421130	00020	00382	0006
421231	CCCC8	00115	0005
421232	01546	09460	0522
421133	00277	01147	0078
421134	04426	03901	0570
421235	00535	01721	0132
421236	00102	01606	0078
422137	00661	01492	0136
422138	00761	01989	0169
422239	00231	01262	0074
422240	02205	01300	0232
422141	01062	01683	0196
422142	01093	01071	0149
422243	10453	11474	1492
422244	00198	01530	0076
422145	01028	01262	0156
422146	00618	01147	0116
422247	01133	07840	0409
422248	01043	06859	0366

Compounds and Co-ordinates

TRIAL BLOCK 5

	△C	△R	△LOG C
511101	00000	00000	0000
511102	C0352	00956	0079
511203	00074	00153	0014
511204	01034	00612	0109
511105	00867	03825	0249
511106	01367	00841	0148
511207	02641	01683	0289
511208	000CC	00000	0000
511109	00037	00306	0031
511110	00150	00306	0029
511211	00297	01339	0087
511212	00484	00726	0082
512113	00009	00076	0004
512114	01419	01995	0231
512215	00245	00905	0065
512216	01387	02792	0270
512117	00000	00000	0000
512118	00000	00000	0000
512219	00000	00000	0000
512220	0000C	00000	0000
512121	02219	03927	0404
512122	03034	01568	0299
512223	00000	00000	0000
512224	0CC88	00115	0014
521125	00123	00191	0021
521126	02428	06426	0541
521227	00463	01033	0095
521228	00577	00745	0090
521129	00971	01563	0105
521130	00021	00765	0006
521231	00000	00000	0000
521232	00065	00535	0026
521133	00005	00038	0002
521134	05713	04131	0665
521235	00000	00000	0000
521236	00C96	00764	0037
522137	00379	00988	0084
522138	00071	00306	0020
522239	00322	00612	0121
522240	01535	00880	0160
522141	00118	00229	0023
522142	00801	00765	0108
522243	04292	03901	0554
522244	00257	01912	0093
522145	01528	01721	0223
522146	00623	01147	0184
522247	00768	02601	0194
522248	003C8	02037	0109

TRIAL BLOCK 6

	△C	△R	△LOG C
611101	00097	00650	0035
611102	00159	00574	0042
611203	00000	00000	0000
611204	00548	00287	0055
611105	00344	00880	0076
611106	02377	01569	0265
611207	10918	04743	0983
611208	00019	00076	0005
611109	0000C	00000	0000
611110	00412	00727	0075
611211	00174	01326	0066
611212	00297	00497	0053
612113	00023	00191	0009
612114	00444	00918	0088
612215	00113	00382	0029
612216	02425	05087	0482
612117	00000	00000	0000
612118	COCCC	00000	0000
612219	0000C	00000	0000
612220	00000	00000	0000
612121	01410	02767	0270
612122	03429	01568	0317
612223	00000	00000	0000
612224	00577	00421	0068
621125	00221	00268	0033
621126	01387	03685	0308
621227	00436	01033	0092
621228	00839	01237	0130
621129	00130	00497	0035
621130	0065C	00344	0065
621231	00000	00000	0000
621232	00086	00688	0034
621133	00073	00574	0028
621134	04893	02779	0405
621235	00547	03251	0183
621236	00444	03289	0166
622137	00151	00535	0042
622138	0CC31	00115	0008
622239	00011	00077	0004
622240	00320	00153	0030
622141	00314	00459	0052
622142	000C0	C0000	0000
622243	04112	04360	0575
622244	00000	00000	0000
622145	00809	01033	0126
622146	C0050	00106	0011
622247	00026	00076	0006
622248	00830	04972	0278

APPENDIX 10

Dominant French Group

TRIAL BLOCK 4

	ΔC	ΔR	ΔLOG
431149	05698	03690	0627
431150	01605	01759	0230
431251	01542	01264	0191
431252	02142	01568	0250
431153	01194	01326	0173
431154	00000	00000	0000
431255	01319	03404	0290
431256	00112	00382	0029
431157	03534	01262	0192
431158	11145	05865	1097
431259	00896	01033	0132
431260	00000	00000	0000
432161	01917	01917	0271
432162	00748	04398	0249
432263	00000	00306	0020
432264	00829	01147	0134
432165	03144	01147	0260
432166	00069	00153	0014
432267	01084	01951	0199
432268	01279	01683	0201
432169	00988	03117	0219
432170	01395	04705	0351
432271	03394	02027	0360
432272	03107	01529	0297

TRIAL BLOCK 5

	ΔC	ΔR	ΔLOG
531149	01395	00918	0155
531150	00096	00153	0017
531251	00841	00727	0108
531252	00000	00000	0000
531153	00929	01007	0133
531154	00145	00727	0045
531255	00355	00191	0011
531256	00000	00000	0000
531157	02278	00650	0167
531158	05535	02263	0478
531259	00866	01492	0158
531260	00000	00000	0000
532161	01033	00477	0177
532162	00651	01683	0143
532263	00065	00000	0000
532264	00000	00000	0000
532165	00255	00115	0024
532166	00000	00000	0000
532267	00000	00000	0000
532268	00143	00217	0024
532169	00608	02027	0152
532170	00594	02142	0155
532271	00315	00191	0034
532272	02760	01645	0292

TRIAL BLOCK 6

	ΔC	ΔR	ΔLOG
631149	01841	01147	0199
631150	00799	00956	0120
631251	04300	03289	0514
631252	01995	01721	0250
631153	00443	00437	0060
631154	00000	00000	0000
631255	00079	00574	0029
631256	00000	00268	0022
631157	01454	00497	0117
631158	01349	01147	0171
631259	00000	00000	0000
631260	00000	00000	0000
632161	01972	05132	0901
632162	00010	00076	0004
632263	00000	00000	0000
632264	00000	00000	0000
632165	01378	00459	0109
632166	00000	00000	0000
632267	03354	03354	0451
632268	00000	00000	0000
632169	00659	02180	0165
632170	00606	02002	0139
632271	01481	00688	0139
632272	00652	00459	0075

APPENDIX 10

Dominant French Group

TRIAL BLOCK 1

	ΔC	ΔR	ΔLOG
131149	02741	02754	0371
131150	01637	03213	0314
131251	03776	02907	0450
131252	03985	03634	0518
131153	01483	02218	0249
131154	00654	01224	0122
131255	02188	03672	0388
131256	00843	01415	0150
131157	02117	00969	0197
131158	18270	08861	1717
131259	01091	01759	0190
131260	00298	01606	0095
132161	05698	06228	0813
132162	01432	05890	0398
132263	00295	01058	0077
132264	00439	01377	0107
132165	05681	02065	0489
132166	00404	00650	0071
132267	03944	04284	0562
132268	02749	04857	0501
132169	00955	05508	0315
132170	04446	09530	0889
132271	08119	03175	0691
132272	07901	03901	0761

TRIAL BLOCK 2

	ΔC	ΔR	ΔLOG
231149	01263	00975	0153
231150	02165	02932	0347
231251	01735	01415	0215
231252	00036	00076	0007
231153	01236	01836	0207
231154	00000	00000	0000
231255	00301	01033	0077
231256	00000	00000	0000
231157	00312	00128	0027
231158	07134	03442	0673
231259	01063	01186	0154
231260	00030	00229	0012
232161	02417	03334	0396
232162	00593	02486	0166
232263	00000	00000	0000
232264	00875	01683	0166
232165	00843	00306	0070
232166	00086	00153	0016
232267	01203	01606	0191
232268	02025	02792	0326
232169	00582	02677	0171
232170	04316	06961	0743
232271	03992	01721	0359
232272	02147	01147	0215

TRIAL BLOCK 3

	ΔC	ΔR	ΔLOG
331149	01510	01033	0171
331150	01089	01300	0163
331251	00744	00612	0093
331252	00556	00803	0092
331153	01378	01747	0173
331154	00000	00000	0000
331255	00189	00497	0042
331256	00000	00000	0000
331157	01141	00459	0099
331158	04803	04666	0645
331259	00915	01033	0133
331260	00077	00612	0030
332161	03024	03024	0453
332162	00131	00803	0045
332263	00000	00000	0000
332264	00158	00382	0034
332165	02686	01109	0237
332166	00000	00000	0000
332267	00606	00880	0099
332268	02658	03442	0414
332169	00359	01415	0097
332170	02449	05501	0493
332271	04722	02142	0417
332272	05482	02257	0479

APPENDIX 11

ABSTRACT OF

Bilingual Memory and the
Orienting Reflex

APPENDIX 11

ABSTRACT OF

Bilingual Memory and the Orienting Reflex[1]

This research investigated whether bilinguals, typed according to second language acquisitional history as either Compound or Co-ordinate would show differences in disinhibition of the OR when presented with the habituated stimuli's other language dictionary equivalent.

Furthermore, concreteness and abstractness of stimuli were varied to test whether this variable would demonstrate differences in OR disinhibition across languages.

Previous research had shown that compound bilinguals demonstrated, using a great variety of behavioral measures, the greater intimacy of their two languages over the more independent systems of the co-ordinate bilinguals. Furthermore, dictionary-equivalent bilingual concrete words were shown to effect a greater number of dictionary-equivalent interlanguage associations than abstract words.

Sokolov's model of the OR proposed that disinhibition of the OR was proportional to the degree of cortical mismatch

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1 Daniel Crocco, doctoral thesis presented to the School of Graduate Studies of the University of Ottawa, Ontario, 1974 xii-180 p.

between habituated stimulus and new stimulus presented. It was predicted, then, that compound bilinguals would show less disinhibition to a word when habituated to that word's other language dictionary-equivalent; and concrete words would similarly show less disinhibition over abstract words, across languages, because of the greater associative inter-language strength of this class of stimuli.

The Compound-Co-ordinate prediction was confirmed using only resistance measures, and the concreteness-abstractness dimension showed significant results contrary to prediction; that is, the abstract words showed less GSR-OR magnitude on the disinhibition (16th) trial relative to their first presentation, whereas the concrete words were not significantly different on these two trials.

Results of a dominant French subjects sub-study showed that although these subjects effected a slight trend towards greater initial ORs to English words over French, the results failed to reach a significant level.

The lack of greater confirmation for the Comp-Co-ord distinction was related to the possible inadequacy of the operational definition used to classify bilinguals in this study. The surprising concreteness-abstractness results were related to the "imagery" processes in memory functioning generally.

APPENDIX 11

The absence of greater confirmation and support between methods of quantifying GSR values was also discussed, supporting further the need for greater standardization of GSR measurement techniques and quantification.