DOES THE CONCEPT OF LATERALIZATION SUFFICIENTLY EXPLAIN DICHOTIC LISTENING PERFORMANCE ?

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ABSTRACT

Three performance dimensions on a verbal dichotic listening (DL) test were investigated. Experiment I assessed DL performance as a function of task difficulty. Accuracy and laterality preference in repeating 2,3 and 4 word pairs (WP) of dichotic stimuli in English and French were determined in 80 right-handed subjects (Anglophone/Francophone, Male/Female), who were tested in both their native language (NL) and non-native language (OL). Relative performance accuracy decreased as a function of WP (from 2 to 4) and language (NL to OL). Right lateral preference in turn increased as a function of WP (from 2 to 4) as well as language (NL to OL). Right lateral preference in OL decreased as a function of language proficiency (low to high).

Experiment II focused on order effects and cognitive processes in the framework of DL. Accuracy and laterality of ear preference in repeating words on a 3 WP DL stimulation task (NL) under suggestion, (none, left ear better, right ear better) and order of recall (free, left ear first, right ear first) were assessed in 216 right-handed native Englishspeakers (Male/Female). Laterality of ear preference varied significantly as a function of order of recall, with right lateral preference for free recall and right ear first recall and left lateral preference for left ear first recall. A suggestion effect was not obtained.

Experiment III addressed the issue of DL performance as a function of cognitive style (field dependent (FD)/field independent (FID)) and vulnerability to suggestion (none, left ear better, right ear better, left and right ear equally good). Laterality of ear preference was investigated in 120 right- handed native Anglophones (FD/FID), (Male/Female). Ear preference varied significantly as a function of FD/FID and suggestion. Lateral preference reversal occurred from the neutral suggestion (FD low right lateral preference, FID high right lateral preference) to any of the three suggestion conditions (FD high right lateral preference, FID low right lateral preference) regardless of suggestion content. The implications of

1. task difficulty
2. order and suggestion effects
3. cognitive style

for DL performance were discussed.

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DEDICATION

This dissertation is gratefully dedicated to my father, Dr. Harald Mohr and to my American host parents, Dr. Richard and Gladys Pearson.

Diese Dissertation ist meinem Vater, Dr. Harald Mohr und meinen amerikanischen Gasteltern, Dr. Richard und Gladys Pearson in Dankbarkeit gewidmet.

GENERAL INTRODUCTION

> ... 'there lurks the possibility of many factors affecting the observed left-right difference that may have nothing to do with cerebral asymmetry. If we are to assess cerebral asymmetry, we must identify and control such extraneous factors. Very simply we must think when we do our experiments, and not assume that all left-right differences are immutably linked to cerebral asymmetry' (M.P. Bryden, 1980).

Background

The dichotic listening paradigm, which was developed by Broadbent (1954; 1956; 1957; a,b; 1958) to examine human short term memory, requires the rapid, simultanecus presentation of two competing messages, one to each ear respectively. Stimuli are generally presented via stereophonic headphones and may be digits (i.e. Kimura, 1961, a,b), words (i.e. Curry, 1967), syllables (i.e. Shankweiler and Studdert-Kennedy, 1967, a,b,) tones (Spreen, Spellacy and Reid, 1970) or melodies (Kimura, 1964).

Within a single series, dichotic pairs generally succeed each other every 1/2, 1 or 2 seconds (Deegener, 1973). The subject's task is to reproduce the stimuli freely or according to particular types of instructions, depending on the dimension of the investigation (i.e. Broadbent, 1957 a; Broadbent and Gregory, 1964, a,b; Bryden 1964; Inglis, 1965; Satz, Achenbach, Pattishall and Fennell, 1965; Bartz, Satz and Fennell, 1967; Treisman, 1964, a,b; 1967; 1969; Abe and Aiba, 1976; Bookbinder and Osman, 1979; Teng, 1981). While obtaining a variety of different results, researchers employing these variables all reach one and the same conclusion as far as the underlying construct is concerned. Stimuli of a verbal nature lead to the observation of a 'Right Ear Advantage' (REA) in the vast majority of right-handed subjects and in more than half of sinistrals (Satz et al, 1965; Satz, Achenbach and Fennell, 1967).

Speech dominance is purported to be located in the left hemisphere in 94% of dextrals and 70% of sinistrals (Geffen and Traub, 1980), as determined by unilateral intracarotid sodium amytal injection and unilateral electroconvulsive therapy (Rossi and Rosadini, 1967; Fleminger, Horne and Nott, 1970; Warrington and Pratt, 1973; Annett, Hudson and Turner, 1974; Rasmussen and Milner, 1975; Davis and Wada, 1977; Geffen, Traub and Stierman, 1978).

DL results generally fall somewhat short of expected values if handedness is taken as the basis of laterality determination. While results vary from study to study, the estimates of 75% (Teng, 1981) or 80 % (Wexler, Halwes and Heninger, 1981) of right-handed subjects showing a REA in DL are comparatively conservative figures (i.e. compare to Satz et al, 1967 with 87%). On the other hand up to 40% of strong sinistrals have been shown to display an LEA for verbal material (Lishman and McMeekan, 1977).

Non-verbal stimuli in turn have been shown to lead to a 'left ear advantage' (LEA) in right-handers (Kimura, 1964; Chaney and Webster, 1966; Spellacy and Blumstein, 1970, a,b; Spreen et al, 1970).

Speech dominance however is mentioned only as one possible explanation of the REA vs. LEA in DL in the literature. Several hundred publications pertaining to the issue, since the inception of the technique in the mid-1950's, present a confusing, often contradictory picture.

While the notion that the neural substrate necessary for language production is localized primarily in one of the two cerebral hemispheres is universally accepted, the issue of cerebral lateralization of language processors has not yet been resolved in any conclusive manner (Gazzaniga, 1974). The point of contention is whether linguistic cerebral processors are lateralized to the same extent as expressive mechanisms, or whether there is actual bilateral processing of such stimuli (Springer and Gazzaniga, 1975). DL and the observed ear advantages have been instrumental tasks in addressing this problem.

Representative of the most important schools of thought, four researchers deserve mentioning in this framework: Doreen Kimura, proponent of a perceptual model of DL; James Inglis, advocate of an order-effect model; Anne Treisman, with a selective attention model and finally Philip Bryden, whose position might best be described as 'eclectic', since it incorporates some aspects of the other models and perhaps best represents a multidimensional approach to the issue at hand.

Perceptual Model

Kimura (1961a) employed DL with patients with unilateral temporal lobe damage. Unilateral temporal lobectomy resulted in a marked impairment in the report of dichotically presented digits arriving at the ear contralateral to the excision. Performance decrement was even more marked in patients with excisions including the Gyrus of Heschl. Overall performance decrement (accuracy for both ears) was more pronounced in patients with left temporal lobe damage as compared to lesions on the right side.

Further work (Kimura, 1961b) employed Wada's Sodium Amytal Test (Wada and Rasmussen, 1960) to determine language lateralization in patients with epileptogenic foci. Kimura (1961b) was able to show that regardless of epileptogenic focus site, verbal DL stimuli arriving at the ear contralateral to the speech dominant hemisphere, as determined by the Wada test, were more frequently reproduced than those arriving at the ipsilateral ear. Conversely, a LEA was reported by Kimura (1964) for the recognition of melodies, a finding which lead her to conclude that there is 'a clear-cut differentiation between relative ear superiority on the two types of stimulus material' (Kimura, 1964, p.356). When comparing dichotic versus monotic presentation of single syllable words, Kimura (1967) showed that the REA can be observed only under dichotic conditions, while monaural stimulation showed even a slight LEA.

Part of the reason for the occurrence of the REA in DL for verbal material (Kimura, 1961 a,b; 1967; Dirks, 1964), can according to the perceptual model be found in the evidence, which relates lateral asymmetry in auditory perception to the asymmetrical functioning of the brain (Kimura, 1967). Left hemisphere dominance for speech she contended, is reflected by superior right ear performance for stimuli of verbal content, while the observed LEA for melodies is reflective of right-hemisphere dominance for melodic pattern perception (Kimura, 1967). This model for dichotic listening, which has come to be called by some the 'Bilateral Asymmetry of Brain Function (BAF) hypothesis' (Spellacy and Blumstein, 1970 a), has its basis in electrophysiological data from animal experiments.

Tunturi (1946) and Rosenzweig (1951) established that in animals, the contralateral or crossed pathways from ear to cortex are more numerous as well as functionally stronger. Kimura (1967) contended that her own data as well as the Bocca, Calearo, Cassinari and Migliavacca (1955) and Sinha (1959) findings permit generalization of the cited electrophysiological evidence from animals to man. It is thus presumed that ipsilateral impulses in DL are less efficiently processed than those relayed via contralateral pathways. The functional superiority of one hemisphere over the other for particular types of stimuli (verbal versus nonverbal) further enhances observed ear advantages, since mainly contralateral processing makes for shorter pathways for right ear linguistic input or left ear musical input as compared to the respective other ear in Kimura's model. Since these effects are observable only under dichotic conditions, Kimura (1967) presumed that some competition between pathways has to occur in DL. Stimuli arriving via the weaker ipsilateral pathway would hence be partially occluded under these conditions, enhancing the advantage of the contralateral over the ipsilateral pathway. Kimura (1967) contended further that 'afferent overlap of this type may not be the total explanation for the sensitivity of dichotic presentation to asymmetry. Presumably there is a factor of central occlusion as well, i.e. when two different speech sounds must compete for overlapping pathways in the dominant hemisphere, the slight advantage for contralateral input over the ipsilateral input may be further enhanced by central competition' (p. 171).

While most investigators have accepted the basic notion of the perceptual model (Kimura, 1961 a,b) that lateral asymmetries are reflective of hemispheric asymmetries (Studdert-Kennedy, 1975), the structural account of contralateral functional prepotency has met with some criticism.

Research in connection with specific central nervous system pathology, namely by administering DL to commissurotomy patients, patients who have undergone surgical disconnection of the two cerebral hemispheres (Milner, Taylor and Sperry, 1968), in order to relieve intractable epilepsy (Bogen and Vogel, 1962), has shed further light on the issue.

Of particular interest in this framework is the fact that surgically disconnected hemispheres continue to function relatively normally; however, as in normals, only the left hemisphere in right-handers seems to show propositional speech abilities, while the right hemisphere appears to have only a very rudimentary command of language (Milner et al, 1968), an issue which is central to DL performance. While commissurotomy patients showed equal accuracy for right and left ear in a monaurally presented digit identification task, Milner et al (1968) found that under DL conditions an almost complete suppression of left ear input occurs for DL stimuli of a verbal character, while suppression of right-ear input was reported for DL stimuli of a non-verbal nature. 'These findings highlight the dominance of the contralateral over the ipsilateral auditory projection system' (Milner et al, 1968, p.184).

Sparks and Geschwind (1968) independently confirmed these findings and reported complete left ear extinction with either digits or animal names serving as dichotic stimuli. Their reaffirmation of the two pathway system (ipsilateral and contralateral) was based on physiological evidence in animals, showing the presence of a callosal pathway for auditory stimuli (Bremer, Brihaye and Andre -Balisaux, 1956).

More recent evidence of this massive left-ear loss phenomenon in commissurotomy patients with DL stimuli, summarized by Cullen, Berlin, Hughes, Thompson and Samson (1975) as 'no difficulty with monaural perception, chance performance for the left ear and near perfect performance for the right ear' (p.113), was supplied by Zaidel (1974), Spinger and Gazzaniga (1975) and most recently by Musiek and Wilson (1979).

Geffen and Traub (1980) concluded that these split-brain findings give support to (1) 'the contralateral pathways from the ears to the cerebral cortex are more efficient than the ipsilateral connections and with competitive stimulation there is suppression of the ipsilateral input by the contralateral input' and (2) 'words initially presented to the non-dominant ear-hemisphere are transmitted across the corpus callosum for processing and response by the speech dominant hemisphere' (p.83).

The importance of these commissural pathways was underlined by the work of Bryden and Zurif (1970) who showed that a patient with callosal agenesis, unlike the described commissurotomy patients, did not display any pronounced laterality effect. Lassonde, Lortie, Ptito and Geoffroy (1981) reported even a slight LEA in two patients with callosal agenesis for familiar words, nonsense words as well as pure tones as DL stimuli. Berlin (1972) interpreted the absence of a pronounced REA in callosal agenesis patients as suggesting that the brain develops as two independent entities in such a case, with little interaction or communication. In terms of actual DL performance, Bryden and Zurif (1970) concluded that the evidence supplied by their patient may be more indicative of suppression and interference at the cortical level than of contralateral occlusion mechanisms blocking the ipsilateral pathway at a subcortical level.

Another independent source of support for this model was an investigation performed by Sparks, Goodglass and Nickel (1970). They reported that right-hemisphere lesioned patients showed exclusive extinction of signals received by the contralateral left ear under dichotic stimulation, while left hemisphere lesioned patients showed contralateral as well as in some cases ipsilateral (paradoxical) extinction. While contralateral extinction is explained by the perceptual model, the causes for ipsilateral extinction are less apparent. Sparks et al (1970) attributed this seemingly paradoxical phenomenon to a lesion of the auditory pathway located at the dominant association area of the left temporal lobe, immediately after the corpus callosum crossing point, suggesting that input via the contralateral fibers from the left ear (left ear to right hemisphere back to left hemisphere) does arrive in the left hemisphere but cannot be processed. The fact that ipsilateral extinction does not occur in split-brain patients was explained by the fact that patients suffering from vascular disease often display deep lesions, while in commissurotomy patients only the cortex and adjacent white matter is involved (Sparks et al, 1970).

Further supportive evidence for the perceptual model comes from a completely different source: psycholinguistics. Spellacy and Blumstein (1970 b) pointed out that although linguists classify vowels as phonemic, the amount of speech code information conveyed by them is significantly less than consonant phoneme information content. Findings by Shankweiler and Studdert-Kennedy, 1967 (b) and Studdert-Kennedy and Shankweiler, 1970, who reported an REA for stop consonants but not for vowels would tend to be partially explained by this assertion. It was further contended that unequal processing of different classes of phonetic categories and the observed ear advantages in a DL situation may be less due to differential hemispheric processing, but may result from differential susceptibility of the respective phonetic classes to transcallosal degradation. (Shankweiler and Studdert-Kennedy, 1967 b; Studdert-Kennedy and Shankweiler, 1970; Cutting, 1974; Studdert-Kennedy, 1975).

Studdert-Kennedy and Shankweiler (1970) concluded on the basis of their findings that 'the laterality effect then would be due to a loss of auditory information from interhemispheric transfer of the ipsilateral signal to the dominant hemisphere for linguistic processing' (p.593).

The weight of the evidence thus accumulated lead Studdert- Kennedy (1975) to conclude: 'In short, Kimura's model has been widely accepted and makes sense of a good deal of data' (p. 124).

Thus while Kimura's interpretation of her results that observed asymmetries in human perception can be related to known facts about asymmetry of representation of function in the cerebral hemispheres has generally been accepted (i.e. Poeck, 1968; Kinsbourne, 1970; Prohovnik, 1978), prolific research in the area and a variety of new findings, have cast some doubt on the adequacy of the second part of her hypothesis, namely the functional prepotency of the contralateral pathways from the right ear to the left hemisphere as sufficient explanation for DL results (Perl and Haggard, 1975; Studdert-Kennedy, 1975). Alternative explanations for observed asymmetries in DL performance have also been put forth.

Order-Effect Model

Using digits, Broadbent (1954, 1956) showed that subjects tend to report first all the stimuli presented to the right ear, then all the stimuli presented to the left. This so-called 'Broadbent effect' purportedly plays a very central role in the production of the REA observed in DL with verbal material (Inglis, 1960; Inglis and Sanderson, 1961; Inglis, 1962 a,b; Inglis and Caird, 1963; Inglis, 1965; Inglis, 1968).

Broadbent (1957 a,b, 1958) concluded that dichotic recall involves two systems, a perceptual system and a storage system. In this model, the immediate or perceptual channel processes information successively, while the storage channel holds information, which the perceptual system cannot absorb (Inglis, 1968). Accordingly, the observed REA can thus be explained by the fact that the digits reproduced first (according to the Broadbent effect on the right side) are processed directly in the perceptual system, while the material reproduced second (on the left side) is kept in the storage channel and is hence subject to decay and interference (Inglis, 1965).

Inglis (1960) employed this hypothesis, at that time somewhat less elegantly formulated, to predict that senile disorders should affect the memory processes thus postulated to be involved in DL. In a first set of experiments, he examined patients with memory disorders and used brain-damaged patients with no memory disorders as controls. He was able to show consistently that patients with memory disorders made significantly more errors than brain damaged patients with no such memory disorders with sets of verbal DL stimuli, which were reproduced second in the sequence, presumably after having been held in the storage system. Reproduction of stimuli, which, according to the model were still in the perceptual system, showed no group differences (Inglis, 1960; Caird and Inglis, 1961; Inglis and Sanderson, 1961). Caird and Hannah (1964) arrived independently at similar conclusions.

A second set of experiments served to investigate the question in the framework of normal aging (Inglis, 1962 b). While results were not as dramatic as in the case of patients with memory disorders (Inglis, 1962), further studies by Inglis and Caird (1963), Mackay and Inglis (1963), Inglis and Ankus (1965) and Inglis and Tansey, (1967) all showed a progressive age related decrement in the recall of material from the secondary channel, while the primary channel did not show any such impairment. Further independent support of these results came from investigations of Broadbent and Gregory (1965), Caird (1965), and Craik (1965).

While the cited evidence makes an impressive case for the Order-Effect model, one major weakness is inherent in the conclusions, reached on the basis of this hypothesis: The model does not supply any explanation as to why this order effect comes about in the first place. A REA can come about only in this model, as long as the subjects report first material presented to the right ear, i.e. verbal stimuli processed in the perceptual system only. The Inglis model does not supply any answer as to the reasons for this order effect (Mainka and Hoermann, 1971). Inglis (1965) provided the following explanation for the issue: 'If left cerebral dominance for speech simply created a tendency for the material presented to the right ear to be recalled first in sequence, this could create an order effect which then might be misinterpreted as a laterality effect. To control these different possible sources of variance, it is necessary to specify the ear order of recall required from the subject (see Experiment II). When this is done, it appears that errors in reproduction are principally due to order rather than laterality and hence, by Broadbent's hypothesis, due to defects of short-term auditory storage rather than defects of auditory perception' (p.236).

Oxbury, Oxbury and Gardiner (1967) suggested that an attentional bias towards the right ear might be responsible for the observed REA in a free recall procedure, an explanation which Satz (1968) called 'misleading', since he felt that the REA for verbal material is a function of the more efficient connections between right ear and contralateral hemisphere, dominant for language. Oxbury et al (1967) were supported to some degree by Penney (1976), who interpreted her results as indicating that there is an actual division of attention between between competing inputs (in this case a dichotic memory task) and that the Broadbent effect is a reflection of storage format of items (see 'Attentional Model').

In later work (1968), Inglis, himself, contended that determining which of the two outlined factors (laterality or order of report) is the more significant influence upon recall in DL, is not possible, unless precise controls are employed, a position which was supported by Perl (1968) who concluded that on the basis of (then) available evidence, both the perceptual as well as the order-effect model appeared correct.

Inglis' (1968) conclusions constituted a laudable attempt of reconciling some aspects of the perceptual and the order effect model. He emphasized the necessity to consider all possible sources of variance in the DL paradigm, a fact which is often not duly acknowledged in the literature, due to the inadequacies of his order effect model (see eclectic position). Although Inglis (1968) continued to maintain that the order effect has a strong influence on ear accuracy in DL and that ear asymmetry accounts for less of the observed variance, he concluded that ear asymmetry effects may be more important in the their own right than he previously assumed and may be reflective of actual asymmetry of cerebral organization. This type of 'bipartisan approach' to the problem was supported by Wilson, Dirks and Carterette (1968).

While in summary then, Kimura (1961 a,b) conceptualized DL results mainly as a function of perceptual, neurophysiological factors, Inglis (1965) alternatively suggested reproductional mechanisms as the main source of variance.

A more differentiated approach, taking into account more of the available evidence, was provided by Treisman (1969).

Attentional Model

While Treisman agreed with Kimura, that observed laterality effects in DL are mainly a function of a perceptual process, (Treisman 1969), she contended that the phenomenon is not fully discussed if attention, 'the selective aspect of perception and response' (Treisman, 1969, p.283) is not brought into the picture. While admitting that any attentional theory in DL, by virtue of its nature, has to presuppose some general framework on the inherent makeup of the perceptual system (Treisman, 1969) (i.e. a neurophysiological model) she nonetheless presumed a preponderance of attentional factors in the phenomenon.

Treisman (1969) strengthened her theoretical argument by considering two types of attentional variables; a 'divided attention variable', relating to a subject's (S) ability to '(a) attend in parallel to two inputs, (b) use two analyzers at once and (c) test for two targets at once' (Treisman, 1969, p.287) and a 'focused attention variable', which is determined by relative efficiency on tasks which make it more or less necessary that attention be focused on a single input (see Experiment II).

Treisman's (1964 a,b, 1969, 1970) and Treisman's and Rilley's (1969) research employed a novel design, picneered by Cherry (1953) and further used by Moray (1959), the technique of shadowing (discussed in detail in Experiment II). The primary advantage of the design lies with the elimination of storage processes, thus virtually removing from the discussion one of the major points of contention of the Kimura-Inglis debate.

Treisman and Geffen (1968) were able to show with the shadowing technique that ear differences emerged even with more immediate, supposedly largely memory independent DL task sets. They concluded that most of the variance of observed REA in DL is due to 'quantitative differences in distribution of attention to left and right ear inputs reaching left hemisphere areas' (p.139). Efficiency of speech perception in a DL paradigm is thus at least in part a function of attentional variables.

It would appear then that perceptual processes (Kimura, 1961 a,b), possibly memory and storage processes (Inglis, 1965) and attentional variables (Treisman, 1969) all contribute to the variance of observed right-left differences in dichotic listening.

Based on almost two decades of research experience in the area, Bryden (1980) supplied the perhaps most pragmatic and cogent approach to the issue of the DL paradigm by pointing out that we are most likely dealing with a multidimensional phenomenon, with a variety of contributing factors.

Eclectic Position

Perhaps the core of the eclectic position lies with Bryden's (1980) argument that variability associated with perceptual asymmetry measures is only partially associated with hemispheric asymmetry and that other factors, such as attention or memory and response organization make contributions as well.

The background for this model was supplied by Bryden in 1967 in form of his paper on 'Evaluation of some models of laterality effects in Dichotic Listening'. There he critically discussed the then most popular models and concluded at that point 'that right ear superiority in dichotic listening is due to a perceptual factor' (p.595). As discussion basis the following four models were used: (1) order effect model (Inglis, 1965), (2) differentiated storage model (Bryden, 1967), representing an adaptation of the original order effect model in that it assumes 'that input arriving in the dominant hemisphere is less subject to interference or spontaneous decay than is input in the non-dominant hemisphere. In other words, short-term memory processes may be more efficient in the left hemisphere than the right' (Bryden, 1967, p.596); (3) the familiar perceptual model (Kimura, 1961 a,b) and (4) a variation of this model, a perceptual-threshold model (Bryden,1967). The basic assumption of this model is that errors in reproduction occur only when neural activity, which in turn is governed by input processes, falls below a fixed threshold. DL input of a verbal nature then will be more clearly above this 'fixed error threshold' when processed by the language dominant hemisphere than the non-dominant hemisphere. Consequently, it takes longer for stimuli processed in the dominant hemisphere to decay to 'error threshold' levels.

For purposes of model evaluation, Bryden (1967) reanalyzed his own data (Bryden, 1962) and compared it as well as other available evidence with hypothetical predictions reached on the basis of the four mentioned models.

Based on this work the following difficulties emerged with the order effect model: Bryden (1967) showed with his 1962 data that (1) 'lateral asymmetries increased with the amount of material presented, (2) the first number reported was from the right ear in 62.2% of the trials, (3) Analysis of Variance (ANOVA) revealed that this trend was not related to either rate of presentation or amount of material' (Bryden, 1967, p.598).

Bryden (1967) contended that his results did not allow a decision among among all the various models offered; however, it would appear that one can eliminate the order effect model on the basis of the cited evidence. Assuming that the first number reported is indeed independent of the rate of presentation and amount of material, how can the majority of observable variance be attributed to order-effects, if lateral asymmetries vary significantly as a function of difficulty, with 'amount of material' being a significant factor in the difficulty dimension? (see Experiment I).

Bryden (1962) showed that 'increasing the amount of material presented leads to an increase in unsystematic mode of responding' (Bryden, 1962, p.297). Conversely, with a slower rate of presentation, ear order is abandoned in favor of a temporal order of report (Bryden, 1962). Other evidence (see Experiment I) directly supports the notion of increasing lateral asymmetry with increasing task difficulty, a fact which makes it implausible to ascribe the majority of accounted variance in DL to order effects.

Employing a different set of evidence, Bryden (1967) outlined some further difficulties of the order effect model. Satz, Achenbach, Pattishall and Fennell (1965), Bartz, Satz and Fennell (1967) and Bartz, Satz, Fennell and Lally (1967) had consistently shown that in the framework of the primary/secondary channel paradigm, the right ear was better not only as primary channel, but as secondary channel as well, a finding which called into serious question the validity of using the Broadbent effect as discussion basis for observed lateral asymmetries. A further problem source for the order effect model emerged in the form of several studies employing as recall procedure 'ordered report', with subjects reporting the left ear first on 50% of the trials and the right ear first on the other 50% (Bryden, 1967). The result of these investigations were consistent with the earlier finding that 'the superiority of right over left ear was found both for immediate and delayed orders of report' (Borkowski, Spreen and Stutz, 1965, p. 548). Other investigators (i.e. Satz et al, 1965) had also supplied independent evidence supporting this conclusion.

Bryden (1967) thus concluded that while Inglis and Ankus (1965), contrary to other available evidence, failed to obtain consistent lateral asymmetries in their experiment systematically investigating ordered recall, the majority of the literature cannot be interpreted as supporting the order effect model.

The differential storage model (Bryden, 1967) also runs into difficulties. While it's prediction that REA is greater on the storage channel than on the immediate channel is in agreement with the findings of Satz et al (1965), data from the other cited studies do not support this prediction (Bryden, 1967).

While the perceptual model shows some major strengths, a main flaw in the original model (Kimura, 1961 a,b) remains its inability to incorporate memory components, a problem which is elegantly solved by Bryden's adaptation of the paradigm with the 'perceptual threshold model', which takes into account memory processes in form of trace decay time, as previously outlined.

While Bryden (1980) accepted the central relevance of a perceptual model to the DL phenomenon, he stated that 'the laterality effects observed with many dichotic listening techniques are at least as likely to be determined by the subject's strategies and attentional biases as by cerebral organization' (Bryden, 1980, p.5). Even though this 'eclectic position' is more likely to incorporate most of the factors contributing to observed variability than previous models, other evidence may shed further light on the problem of lateral asymmetries and DL.

Other Evidence

While most of the cited factors purportedly contributing to observed variance in the DL paradigm have their basis in neurophysiological or cognitive variables, work by Pizzamiglio and Cecchini (1971), Dawson (1972) and

Pizzamiglio (1974) has added one further source of variance: Individual differences in 'psychological differentiation'.

Briefly, the theory of 'psychological differentiaticn' has one particular dimension of interest here, the field dependence/ independence continuum. This continuum of psychological functioning expresses that particular aspect of the phencmenon in question, which can be called 'the degree of self-nonself segregation' (Oltman, 1980). Witkin, Goodenough and Oltman (1979) contended that under the assumption that 'psychological differentiation' is a broad organismic construct, greater or lesser amcunts of differentiaticn (as measured by the field dependence/independence continuum) may manifest themselves in the psychological as well as neurophysiological domain.

Palmer (1964) described the development cf lateralized functioning, by using the concept of differentiation in much the same way as Witkin and his cowcrkers conceptualized 'psychological differentiation' (Cltman, Ehrlichman and Cox, 1977).

Based on this, a number of workers have investigated the possibility of shared variance between the paradigm of 'psychological differentation' and individual differences in extent of lateralizaticn (Oltman et al, 1977).

Of particular interest in this framework are the findings of the mentioned investigations of Pizzamiglio and Cecchnini (1971), Dawson (1972) and Pizzamiglio (1974), who consistently found a greater REA in DL with verbal stimuli in field independent individuals as compared to field dependent subjects.

These and other findings (Dawson, 1977) lead Witkin et al (1979) to the conclusion that field independent persons display a more definite left hemisphere language representation than field dependent individuals.

Other personality descriptors such as repressor and sensitizer have recently been implicated as well in the framework of lateralization studies, with sensitizers showing more left lateral preference and repressors displaying more right lateral preference (Feldman, Gross and Kravetz, in press).

The question raised in the framework here then deals with the issue whether DL performance is perhaps a function of cognitive style, which in turn then might account for individual differences in perceptual asymmetry, attentional asymmetry and other factors purportedly contributing to differential individual DL performance.

Summary and Research Purpose

In line with the evidence presented here, the only plausible conclusion in terms of a cogent explanation of REA in DL has to be that actual perceptual asymmetry accounts for a significant amount of variance in the DL paradigm. Whether this asymmetry in turn is reflective of psychological differentiation remains to be seen. Attentional variables (Treisman, 1969), subject strategy (Bryden, 1980), psycholinguistic factors (Studdert-Kennedy, 1975), and possibly others (Bryden, 1980) may all make a significant contribution as well. Attempts to relate attribute variables such as age, reading ability or socioeconomic status to lateral preference in DL have been inconclusive (Davidoff, Done and Scully, 1981) and for present purposes these variables will be eliminated from the discussion.

The issues addressed by the present investigations of DL performance thus involve a systematic evaluation of the relevant factors (1) in a context not previously investigated and (2) with a more precise definition and increased control of the independent variables in question.

Accordingly, Experiment I was designed to examine the dimension of task difficulty in terms of response accuracy and laterality. As task set, a 2, 3 and 4 word pair (WP) dichotic tape was used. In order to exercise close control over the task difficulty variable, two equivalent tapes

(French and English) were constructed. Accuracy and laterality preference in repeating 2,3 and 4 WP of dichotic stimuli in English and French of Anglophone and Francophone subjects were tested both in their native language (NL) and non-native language (OL).

Experiment II readdressed the question of order effects but went further and included a cognitive dimension (suggestion: neutral, left ear better, right ear better) and explored the possibility of an interaction between the two factors. Accuracy and laterality of ear preference in repeating words on a 3 WP dichotic stimulation task under the mentioned suggestion and order of recall (free, left ear first, right ear first) were measured.

In Experiment III the question of shared variance between psychological differentiation and DL was closely examined, by investigating the relationship between cognitive style (field independent vs field dependent) and laterality of ear preference on the same dichotic task as Experiment II under the condition of 'no suggestion, left ear better, right ear better', and as a further control group, 'left ear and right ear equally good'.

GENERAL METHOD

At the beginning of each of the experiments all subjects were given the Coren-Porac Sensory Motor Survey II (Porac and Coren, 1981) to insure that only true right-handers participated (Subirana, 1964; Satz et al, 1965; Curry, 1967; Zurif and Bryden, 1969; Bryden, 1975).

All subjects were formally tested for hearing defects with the aid of an audiogram on a Grason-Stadler 1707 audiometer (Grason-Stadler, 1977). Binaural stimulation intensity levels were adjusted on the basis of the audiometric results via a Hewlett-Packard 350 D attenuator set, to insure equal sensation levels for both channels, since interaural intensity differences of only 8-10 db have been reported to yield significant differences in terms of DL performance (Chocolle, 1962; Berlin, Cullen, Hughes, Berlin, Lowe-Bell and Thompson, 1975). The stimulus material was presented on a stereophoni· tape recorder (Sony TC-580) for all but subjects recruiteu from local Victoria High Schools. For reasons of convenient transport, a TEAC A-108 SYNC stereo casette deck was used for the High School Ss group. The stimulus material was delivered via a set of stereophonic head phones (Telephonics MX-41/AR) at an intensity of 70 db SL (Curry and Rutherford, 1967; Spreen et al, 1970; Roeser, Johns and Price, 1972). Intensity levels were calibrated with a Bruel & Kjoer 2203 Precision Scund Level Meter (A Scale).

All stimulus material was recorded for presentaticn at the rate cf 2 pairs per second, with trial separation in intervals of 10 seconds (Bartz, Satz and Fennell, 1966; Pohl, 1979).

To exclude the possibility cf a 'linguistic content effect' either on the left or right side, or effects due to recorder channels cr ear phone characteristics (Shankweiler and Studdert-Kennedy, 1967 a,b; Studdert-Kennedy and Shankweiler, 1970; Studdert-Kennedy, Shankweiler and Schulman, 1970), the designation cf which side of the tape was left and which one was right, was systematically varied across the entire subject population. Only the correct repetition of the target word was counted, approximations were treated as errors.

EXPERIMENT I

Introduction

Background

The attempt to investigate brain lateralization with the dichotic listening technique (DL) has raised issues of recall strategy, order effects and attention span. In recent years several studies have locked at the question of hemispheric specialization with the aid of DL in bilinguals (i.e. Piazza-Gordon and Zatorre, 1981). While a variety of stimulus parameters have been employed, no attempt has been made in this framework to research the dimension of task difficulty in DL qualitatively, by exploring task demand characteristics on stimuli in a non-native versus native language, as well as quantitatively, by systematically varying stimulus list length.

Nachshon and Carmon (1975) however did attempt to investigate part of the qualitative issue raised here by examining the influence of stimulus familiarity on DL performance. They showed with consonant-vowel monosyllables as stimuli that consonants were better identified from the right ear, except when familiar consonants in the left ear were paired with non-familiar consonants in the right ear.

Vowel identification was equal from both ears when both vowels in dichotic pairs were equally familiar or non-familiar. Pairing familiar vowels with non-familiar ones however always led to superior identification of familiar vowels. Nachshon and Carmon (1975) interpreted this result as showing that differential report accuracy from the 2 ears is a function of stimulus familiarity as well as language lateralization. Curry and Rutherford (1967) contended that accuracy of recall in a verbal DL task is a function of the linguistic quality of the target word. Not only did they show that function words (71.4%) were reported more accurately than semantic words (56.5%), which in turn were reported more accurately than nonsense words (19.1%), but that the largest mean difference score between ears was for the nonsense words. This finding can be interpreted as supporting the notion of a direct relationship between stimulus difficulty (the less familiar stimulus will tend to be more difficult) and a Right Ear Advantage (REA) for right-handers. Bryden (1967) independently arrived at the same conclusion.

Bakker (1970) demonstrated that with monaural stimulation the relation between ear asymmetry and task difficulty is not linear. His medium list length (5 digits, 4 sound elements) stimulus set showed the greatest REA as compared to the less difficult 4 digits, 3 sounds and the more difficult 6 digit, 5 sound set.

If we consider OL stimuli difficult and unfamiliar, it would be reasonable to assume that nonsense words and verbal OL stimuli would be equivalent for the completely non-proficient subject. As language familiarity increases, phonemic familiarity and semantic meaningfulness of the stimulus set increases as well, hence results of DI stimulus sets in NL and OL should parallel the Curry and Rutherford (1967) results with nonsense words, semantic words and function words. Expressed more generally, increasing lateralization should occur with increasing task complexity (Nachshon, 1973).

Related Tachistoscopic Studies

When looking at tachistoscopic laterality studies in this framework, right visual field advantages (RVFA) are generally reported as being equal for both languages in adult bilinguals (Barton, Goodglass and Shai, 1965; Kershner and Jeng, 1972; Hamers and Lambert, 1977; Walters and Zatorre, 1978). Since these studies generally involved bilinguals, i.e. persons reasonably proficient in both languages, they add evidence only to the notion that the left hemisphere is primarily (and equally) contributing to language processing of both languages in bilingual persons (Piazza-Gordon and Zatorre, 1981).

Silverberg, Bentin, Gaziel, Obler and Albert (1979) report a right visual field advantage for three groups of

Israeli children with Hebrew words as tachistoscopic stimuli. An observed right visual field advantage for English words in the same children however varied as a function of age and foreign language proficiency, with older and more proficient children displaying a more profound RVFA. An actual left visual field advantage (LVFA) in young, non-proficient children changed to a RVFA in the older, more proficient subjects (Ss).

Bentin (1981) further investigated the issue of perceptual asymmetries and difficulty of pattern recognition in the framework of tachistoscopic studies and found a laterality shift to the RVF with increasing language familiarity in OL as well. He assessed VFAs for Hebrew and English words in Israeli students (age 12-13, all right handers) with a basic knowledge of English (2 years). With 'normal' tachistoscopic presentation he found a RFVA for Hebrew (less difficult) and no preference for English (more difficult) words. However, following recognition training for English stimuli and blurring Hebrew stimuli the VFA pattern changed: no field preference for Hebrew and a RVFA for English words.

Even though it is tempting to use these visual field stimulation results for hypothesis formulation for studies of right versus left advantages in the auditory mode on DL, caution should be exercised. One should be aware that the results in tachistoscopic experimentation may be a function of modality of input. In addition, all of the cited studies employed children as subjects, raising questions of nervous system plasticity and particular developmental stages, and making a non-critical generalization to DL with an NL and OL stimulus set with adult Ss even less desirable.

Dichotic Studies

Carroll (1980) reported differing degrees of REA in English and Spanish bilinguals as a function of age and type of exposure to the second language. When combining ear difference score means for three proficiency levels on English and Spanish dichotic listening tests, he found an increase in ear difference scores as a function of proficiency level in both languages, with beginning and intermediate levels at .12 in English and .15 in Spanish, with an increase to .23 for the advanced Spanish level and .16 for the advanced English level. He also concluded that the second language was reliably more left hemisphere lateralized than the native language across all proficiency levels.

Piazza-Gordon and Zatorre (1981) found clear and equal REAs for English and Spanish in two groups of right-handed Hispanic children (mean age 9:6 and 13:6). Older children scored better than younger ones and showed better performance on Spanish than on English task sets. However, ear differences did not correlate with language proficiency in OL, but there was a positive correlation (r=.58) between degree of asymmetry in the two languages. REA did not interact with performance in OL or NL. Results are difficult to interpret due to the mentioned confounding of developmental and laterality phenomena.

While results on tachistoscopic studies do not uniformly show this purported relationship between task difficulty and laterality preference, underlining the hypothesis that language asymmetry may not be independent of input modality, results of DL studies seem to point in the direction of such a relationship. The evidence is particularly compelling, since it is based on work employing some widely different stimulus sets (familiar and non-familiar vowels and consonants, nonsense words, semantic words and function words). Based on these results, I hypothesized that lateralization as measured by the laterality index (R-L/R+L) (Marshall, Caplan and Holmes, 1975; Birkett, 1977; Stone, 1980) should increase with difficulty (from a 2 WP to a 4 WP condition) and that a difficulty continuum should occur in NL as well as OL. I based this on the notion that as the number of WP increases, the processing capacity is greater for the right ear for input of linguistic content. The interaction of processing capacity and difficulty I reasoned, should result in higher laterality index measures in OL than in NL.

The relationship between language familiarity and REA which should be inverse in line with the Curry and Rutherford (1967) results (the higher the familiarity/proficiency, the less lateralized the performance) was investigated with a measure of the Decrement Ratio (DR) (see Method) between OL and NL laterality index and its relation to a language proficiency score in CI. The DR score was intended as a measure of performance decrement between equivalent DL word sets in OL and NL and constitutes the ratio of the laterality index in OL, divided by the laterality index in NL for the equivalent WP condition.

Method

Subjects

Eighty volunteers, enrolled in an intensive language program at the University of Victoria for English and French respectively, participated in the experiment. The group consisted of 40 francophone students (20 males and 20 females) and 40 anglophone students (20 males and 20 females), all self-professed right-handers, age range 17-41 years, with no previous experience in dichotic listening and no auditory impairments.

Procedure and Materials

The Sensory-Motor Survey II (Porac and Coren, 1981) and audiometric assessment (Grason-Stadler, 1977) were standard as outlined previously. Test forms were available in English and French for the two language groups respectively (see Appendix A). Instructions given in the native language of the subject, asked Ss to recall as many words as possible. English and French DL tapes were designed to be equivalent in linguistic content and level of difficulty, to exclude the possibility of differences in lateralization resulting simply on the basis of stimulus differences (Obler, Zatorre, Galloway and Vaid, 1982). Tapes consisted of 16 trials, all nouns, with a 2 WP, a 3 WP and a 4 WP series respectively in each language (see Appendix A). All subjects had two practice trials with 2 WP stimuli and two with 3 WP stimuli.

The order of tape presentation was varied: half of one language group listened to the NL tape first, the other half to the OL tape first. At the end of the experiment Ss were asked to translate the OL words presented during the OL 2 WP trial. Each word was read out aloud by the examiner, who is fluent in both languages. Ss were allowed 10 seconds per word. The number of words correctly defined constituted the Ss language proficiency score.

The following measures were employed for data analysis: A measure of accuracy, number of words correctly reported with the right ear plus number of words correctly reported with the left ear divided by total number of words possible on each trial series (2 WP, 64 words possible; 3 WP, 96 words possible and 4 WP, 128 words possible).

As an index of laterality the formula R-L/R+L, first proposed by Koch (1933) was used. While the issue of laterality indices has been subject to heated debate for the past decade (i.e. Kuhn, 1973; Marshall, Caplan and Holmes, 1975; Richardson, 1976; Birkett, 1977; Colbourn, 1978; Stone, 1980; Bryden, 1980; Bryden and Sprott, 1981; Eiling, 1981; Hellige, Zatkin and Wong, 1981) criticism of this particular index has centered on confounding between accuracy and laterality. To insure valid use of this index of laterality, mean scores were inspected in each one of analyses undertaken, to insure that accuracy ranged between 25% and 75%.

To allow for the investigation of the variance uniquely attributable to OL in estimation of lateral preference, a decrement ratio (DR) between the laterality index in OL and NL was computed for each condition (LatO2/LatN2, LatO3/LatN3 and LatO4/LatN4).

The data were analyzed with Repeated Measures Analysis of Variance procedures (Anov88 Program, 1975), Newman-Keul's post hoc comparisons, and, where appropriate, with a Pearson Product Moment Correlation Analysis (Nie, Hull, Jenkins, Steinbrenner and Bent, 1975).

Results

Report Accuracy

Table 1 shows overall performance accuracy (R+L/Total) in the six (2,3,4 WP Native and 2,3,4 WP Other) language conditions. While maximum relative accuracy occurred in the 2 WP NL condition with 62.83%, performance dropped only slightly to 59.14% for 3WP NL, with a substantial loss in the 4 WP NL with 48.08%. As expected, relative performance accuracy in OI was considerably lower, with 35.84% in 2 WP, 35.24% in 3 WP and 28.50% in 4 WP (see Fig. 1).

Relative accuracy (A) in the OL 2 WP, OL 3 WP and OL 4 WP condition correlated significantly with 'Verbal Score' (VScore), the measure of language proficiency {O2A with VScore, r= .3490 (p <.001), O3A with VScore, r= .5529 (p <.0001) and O4A with VScore, r= .5149 (p <.0001)}. A Repeated Measures Analysis of Variance (see Table 2) on the accuracy scores with two within factors, a language factor (native versus other) with 2 levels, and a Word Pair factor (2,3,4 WP) with 3 levels, yielded a highly significant language effect (P< .0000001), a highly significant Word Pair effect (p< .0000001), as well as a highly significant interaction effect between the 2 main effects (p< .0000001) (see Fig.1).

TABLE 1: Means on Selected Variables in Experiment I, N=80

LANGUAGE	Variable	WORD PAIRS 2	WORD PAIRS 3	WORD PAIRS 4
NATIVE	A	0.628	0.591	0.480
	LAT	0.209	0.301	0.316
	REART	24.175	36.587	40.325
	LEART	16.037	20.187	21.225
	D	8.137	16.400	19.100
OTHER	A	0.358	0.352	0.285
	LAT	0.376	0.478	0.503
	REART	15.750	25.050	27.400
	LEART	7.187	8.787	9.087
	D	8.562	16.262	18.312

A = ACCURACY   LAT = LATERALITY

REART = RIGHT TOTAL   LEART = LEFT TOTAL

D = REART - LEART

TABLE 2: Repeated Measures Analysis on Percentage Accuracy Scores N=80

LABELS:

SOURCE	DF	SS	MS	F	P
SUBJ	79	15250.14			
LANGUAGE	1	66129.08	66129.08	729.542	<0.000001
ERROR	79	7160.92	90.64		
WORD PAIR	2	10956.62	5478.31	165.923	<0.000001
ERROR	158	5216.72	33.02		
LANGUAGE BY WORD PAIR	2	1079.45	539.72	27.398	<0.000001
ERROR	158	3112.55	19.70		

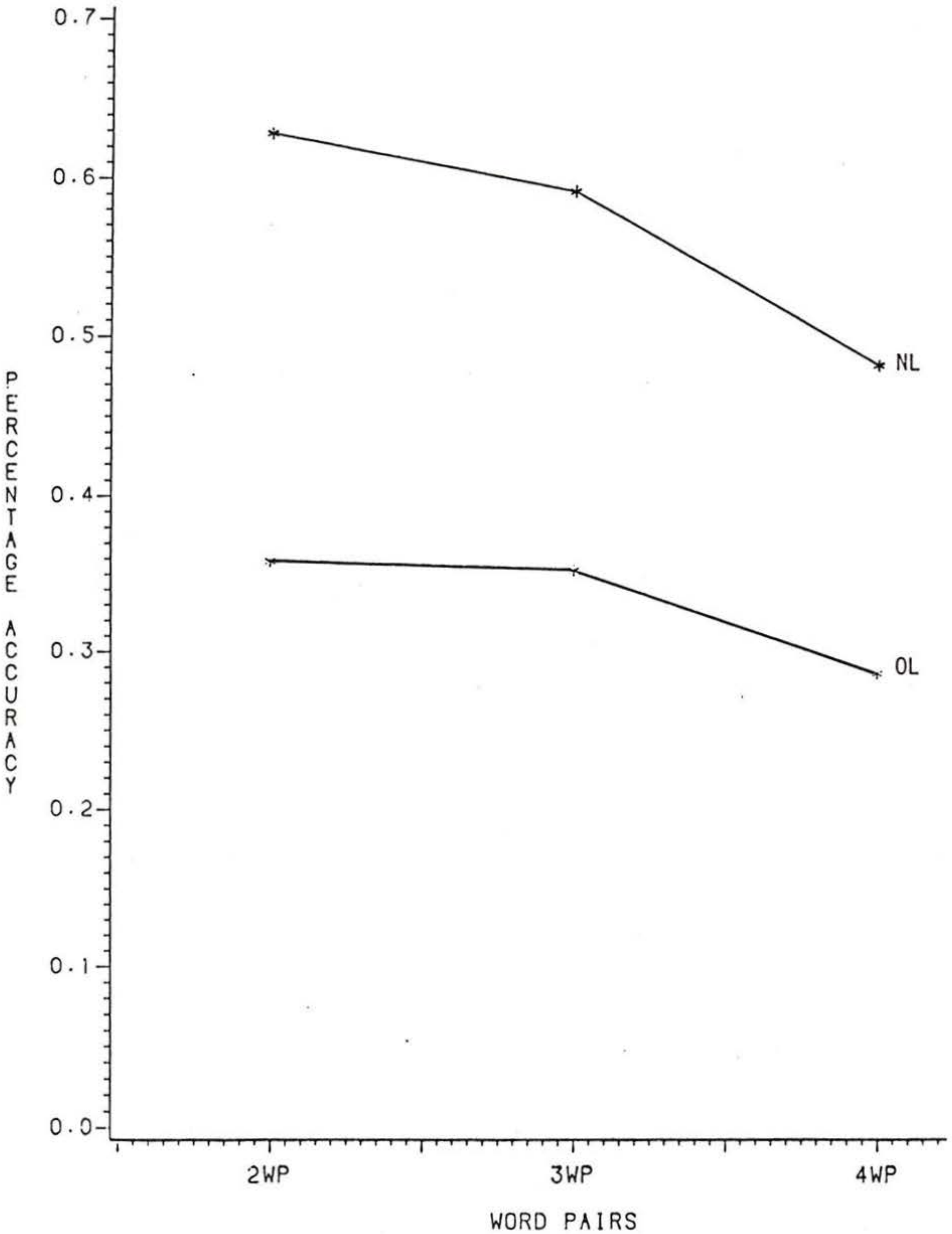

FIGURE 1 :PERCENTAGE ACCURACY AS A FUNCTION OF LANGUAGE AND

Individual post-hoc comparisons between cells using Newman-Keul's procedure (see Table 3) were in the expected direction and showed significant differences between all cells with the exception of 2 WP CL with 3 WP CL.

TABLE 3: Post-hoc Tests on Accuracy Scores (A), Experiment I

		NL 2	NL 3	NL 4	OL 2	OL 3	OL 4
NL	2						
	3	.05					
	4	.05	.05				
OL	2	.05	.05	.05			
	3	.05	.05	.05	NS		
	4	.05	.05	.05	.05	.05	

Lateral Preference Index

Significant correlations between accuracy and laterality indices raise the possibility of distcrtion of results of lateral preference measures (i.e. Stone, 1980, Hiscock, personal communication, 1982).

When computing collapsed means across all three native language conditions, mean accuracy and laterality yielded a Pearson r= -.3146 (p< .002), which means that approximately 9% of the variance is actually shared. In the case of the other language, mean accuracy and laterality did not show any significant correlation (r= .0375, p> .3).

Table 1 shows the means of laterality indices in all 6 conditions, with the smallest index of LatN2= .209, increasing to LatN3= .301, and LatN4= .316. The laterality indices increase dramatically in the other language, with LatO2= .376, LatO3= .478 and LatO4= .503 (see Fig. 2).

When looking at individual subjects, the overall percentages of right lateral preference (a laterality index of >0 to +1.0) the N2 condition showed 96% right preference, N3= 91%, N4= 89%, O2= 93%, O3= 95% and O4=94%, a very profound REA for all subjects across all conditions.

A Repeated Measures Analysis of Variance (see Table 4)

TABLE 4: Repeated Measures Analysis on Laterality Scores N=80

LABELS:

SOURCE	DF	SS	MS	F	P
SUBJ	79	135282.39			
LANGUAGE	1	37594.80	37594.80	52.053	< 0.000001
ERROR	79	57056.53	722.23		
WORD PAIR	2	12432.60	6216.30	19.484	< 0.000001
ERROR	158	50408.40	319.04		
LANGUAGE BY WORD PAIR	2	87.24	43.62	0.142	< 0.867394
ERROR	158	48390.43	306.27		

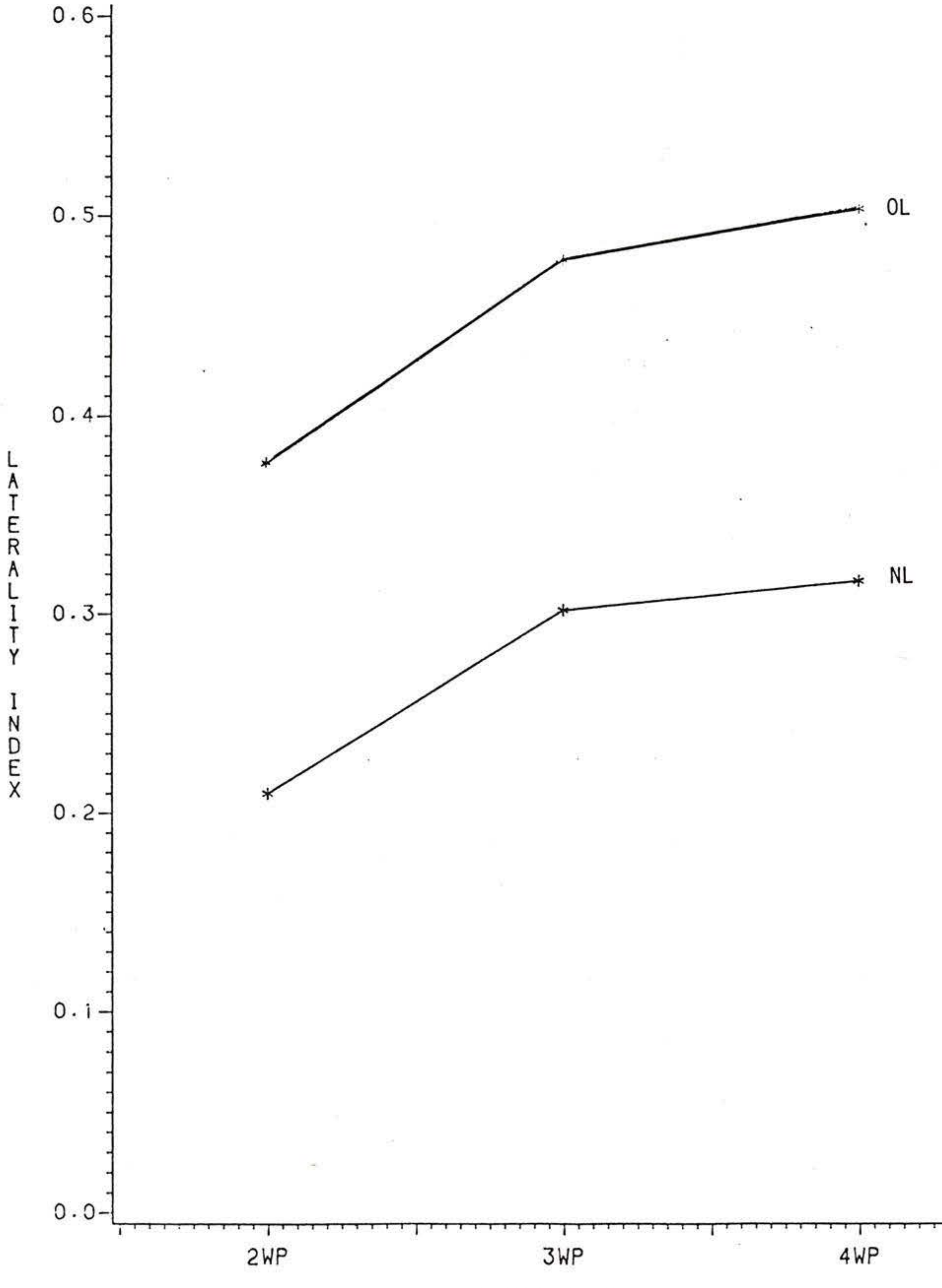

FIGURE 2 : LATERALITY INDEX AS A FUNCTION OF LANGUAGE AND W

on the laterality scores with the same design as in the case of the accuracy scores (2X3 within, with alpha level set at .05=(1-(1-alpha')*2=0.0225, since this constituted a second analysis of variance procedure on the same data, yielded a highly significant result for language ($p < .0000001$) and for Word Pair ($p < .0000001$). No interaction effect was ascertainable.

Individual post-hoc comparisons between cells employing Newman-Keul's procedure (see Table 5) showed significant differences between the majority of cells on the laterality indices, with the exception of LatN3 with LatN4, LatN3 with LatO2, LatN4 with LatO2, and LatO3 with LatO4.

TABLE 5: Post-hoc Tests on Laterality Scores (LAT), Experiment I

		NL			OL		
		2	3	4	2	3	4
	2						
NL	3	.05					
	4	.05	NS				
	2	.05	NS	NS			
OL	3	.05	.05	.05	.05		
	4	.05	.05	.05	.05	NS	

Laterality and Language Proficiency

Fig. 3 shows laterality scores in 2,3 and 4 WP of the other language as a function of language proficiency (VScore), arbitrarily divided at the 50th percentile into low (less proficient) and high (more proficient), to allow a comparison of results obtained here with the Carroll (1980) findings. While no significant effect (ANOVA) was found, the trend towards lower laterality scores as a function of higher proficiency in the 3 and 4 WP condition is clearly visible in Fig. 3. No such difference appears to exist in the 2 WP condition.

When looking only at the variance in laterality scores uniquely attributable to the other language condition, by dividing the laterality scores of the 'other' 2,3 and 4 WP condition respectively by the laterality score of the 'native' 2,3 and 4 WP (LatO2/LatN2, LatO3/LatN3 and LatO4/LatN4), the resultant decrement ratio (DR) score presents the mentioned trend towards lower laterality scores as a function of higher proficiency much more drastically (ANOVA, VScore, high/low, $p < .008$). The effect is particularly marked in the case of the 3 WP (see Fig. 4).

The more appropriate correlational analysis of this data yielded as expected negative correlations between DR score and VScore (the higher the decrement score between other and native language, the lower the language proficiency in the other language), with the correlation of the DR score in the 2 WP condition almost reaching significance ($r = -.1725$, $p < .06$) and a highly significant result in the case of 3 WP ($r = -.3466$, $p < .001$) and a result of 'no significance' with 4 WP ($r = -.08$, $p > .2$).

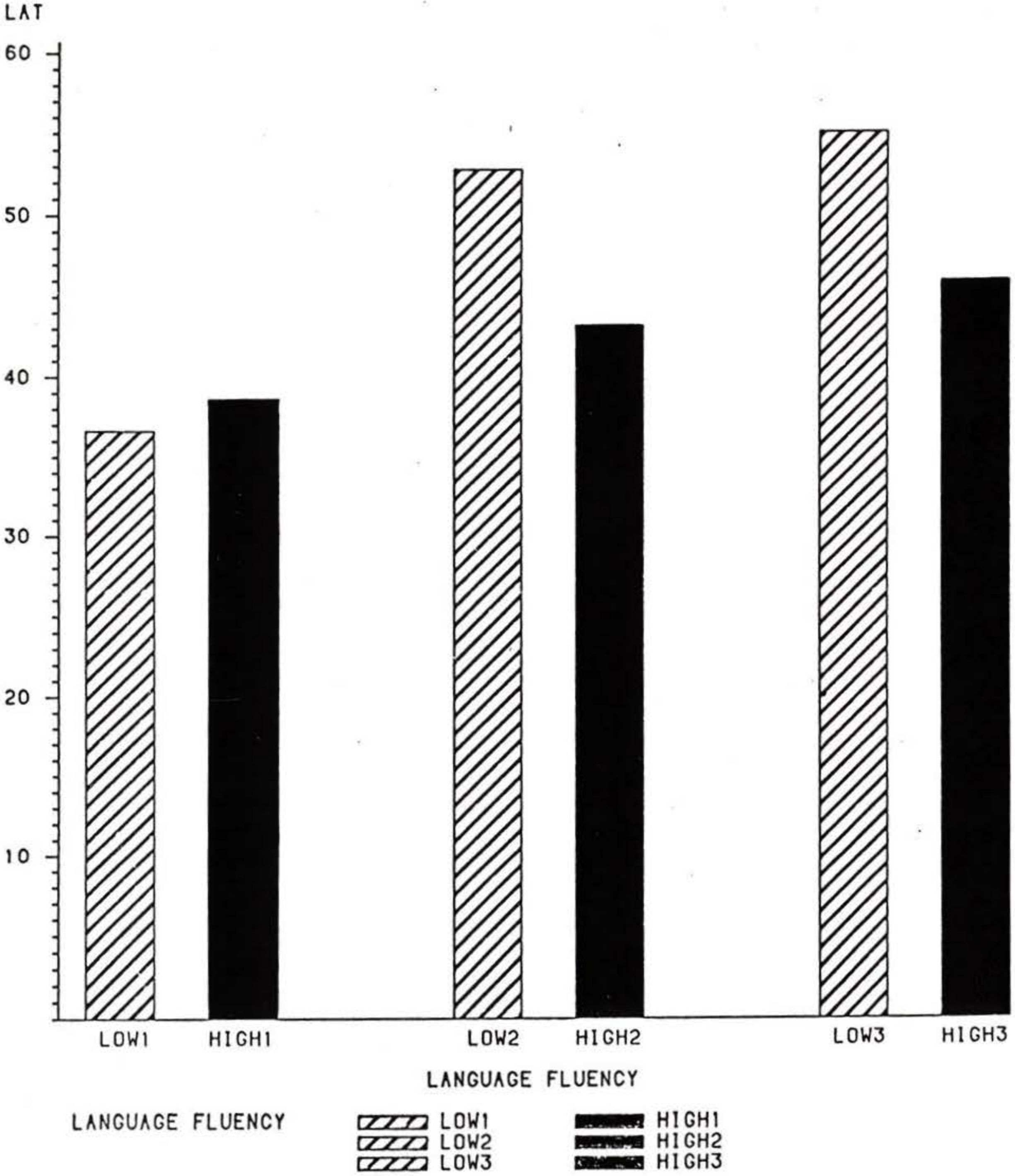

FIGURE 3: LATERALITY SCORES OF OL 2WP(1), 3WP(2), AND 4WP(3) AS A FUNCTION OF LANGUAGE FLUENCY

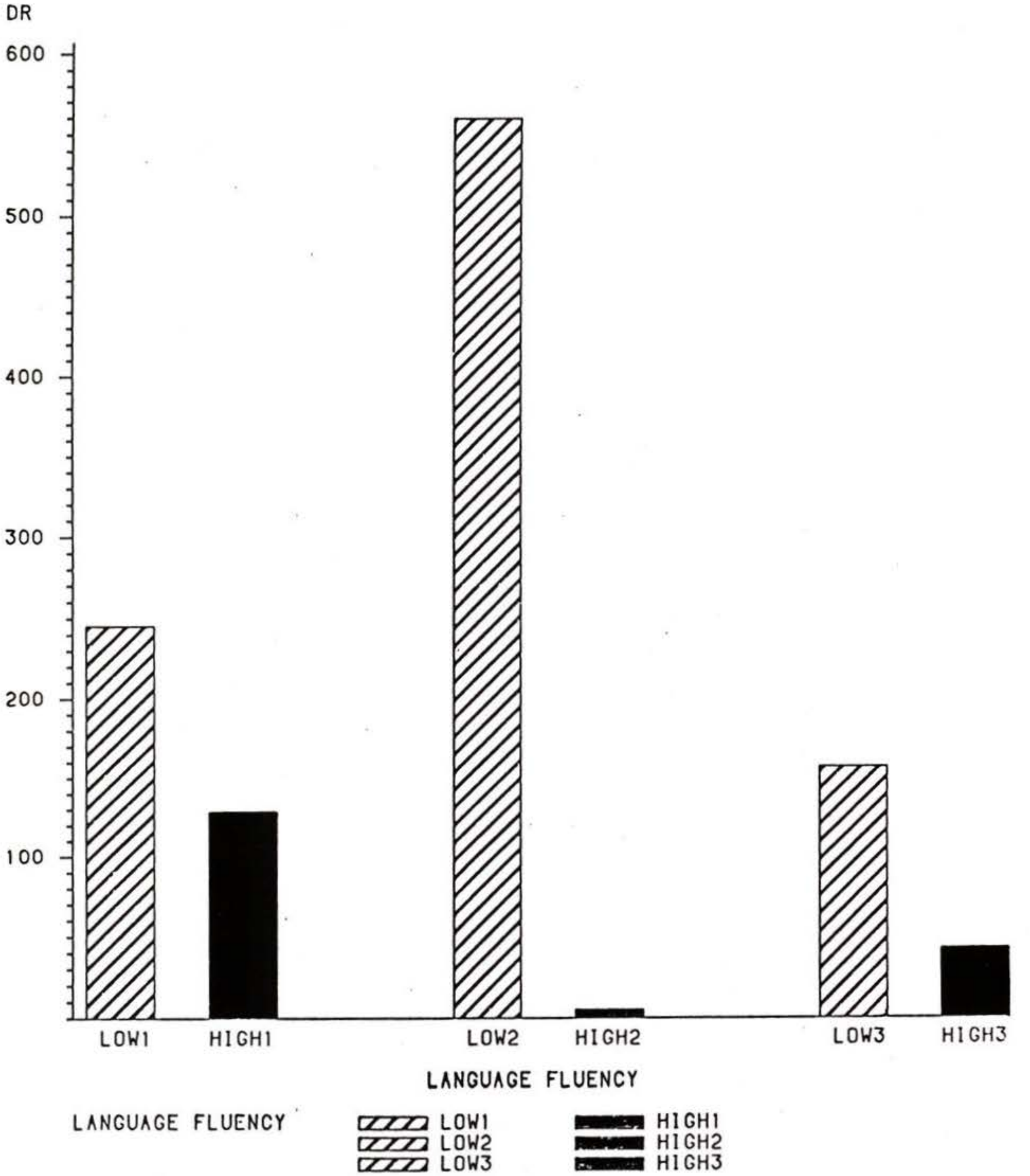

FIGURE 4: DECREMENT RATIO SCORES (LATO/LATN) OF 2WP(1), 3WP(2) AND 4WP(3) AS A FUNCTION OF LANGUAGE FLUENCY

Discussion

The results of the Repeated Measures Analysis of Variance on the accuracy scores are very clear, as the analysis yielded high significance levels. Decreasing relative accuracy across the 2,3 and 4 WP conditions can be interpreted as being reflective of increasing use or overuse of available processing capacity. Even though the difference between accuracy in the 2 WP and 3 WP native condition is significant, the relatively small drop in percentage points (3.69%) makes the observed significance a likely consequence of the relatively large number of Ss used, while the drop of 10.6% from 3 to 4 WP appears to be a substantial decrease. When examining Fig. 1, it becomes apparent that the decrease in accuracy shows parallel elements in the two languages, the highly significant difference between the two languages is illustrated as well.

The observed interaction effect between language and WP factor is most likely attributable to baseline differences in the 2 WP conditions with 62.83% in the native and 35.84% in the other language. While the drop to 4 WP accuracy is significant in both languages, the comparatively smaller drop in OL from 3 to 4 WP (6.74% as compared to the 10.06% in NL) is likely to be reflective of lower baseline performance in OL and probably explains the observed interaction effect.

The high correlation between accuracy scores in OL and VScore measures underlines the validity of the language proficiency score in this context.

The observed laterality scores are somewhat more difficult to interpret. The small negative correlation between accuracy and laterality scores in the native language raise the possibility of a small distortion of laterality scores in the native condition, i.e. high accuracy could yield lower laterality scores. However, since significance levels of the Repeated Measures Analysis of Variance are quite marked, the possibility of significant contamination, particularly in view of the small amount of variance shared (9%), appears very small. Again, results of the ANOVA procedures are very clear: a very marked language effect and a very profound WP effect. The absence of an interaction effect is reflective of virtual parallel increase in laterality indices in the two language conditions (see Fig.2).

Curry and Rutherford (1967) showed that REA tended to increase as a function of qualitative difficulty, with smallest REAs observed with function words and the largest REA observed with nonsense words. Hiscock and Kinsbourne (1980) and Bryden and Allard (1981) ascertained that the REA in DL increases as well as a function of quantitative difficulty, namely with larger REAs for longer stimulus list lengths. The findings described here would parallel these results with two sources of variance, a source of quantitative difficulty (Word Pair factor from 2 to 4) and a qualitative factor (Language, native versus other). Taken together, these two factors may be reflective of two different modes of processing of linguistic stimuli, a phonemic mode and a semantic mode. Phonemic and semantic decoding should ordinarily be phasic sequential, since semantic processing becomes possible only after a certain degree of phonemic processing is accomplished. Since phonemic decoding would appear to be more exclusively a basic linguistic process, it would not be unreasonable to assume that mainly linguistic processors of the left hemisphere are involved. Semantic decoding, on the other hand, could involve other systems, such as 'emotional tone decoders', processing of linguistic quality etc., conceivably processes which could involve to a larger degree both hemispheres. Assuming then a finite processing capacity of the two ears under dichotic conditions, it would be reasonable to assume that available capacity is used to a larger degree for phonemic processing in the other language as compared to the native language due to phonemic novelty, leaving less 'space' for semantic processing. The relatively greater balance of phonemic activity would involve primarily left hemisphere processes, as reflected by higher laterality indices in the other language. Conversely, when increasing the 'load' quantitatively, more available processing capacity has to be used for phonemic decoding, leaving less room for semantic processing and again yielding increasingly higher laterality indices from 2 WP to 4 WP.

Furthermore, this model would predict a decrease in the magnitude of observed laterality indices with an increase in language proficiency. Fig. 3 and 4 appear to support this contention.

Due to the novelty cf research investigating task demand characteristics in DI quantitatively and qualitatively, the speculative nature of this model has to be emphasized. However, recent findings by Tzavaras, Kaprinis and Gatzcyas (1981), who reported a greater REA in illiterate subjects than educated control subjects for language stimuli in DL, would lend further support to the approach proposed here. It should be mentioned though that the Carroll (1980) results are in direct conflict with my findings, since it was reported that observed REA increased as a functicn of language competence, with the more competent Ss showing larger REAs than the less competent Ss. Inadequate description of employed stimulus material, subject characteristics and data obtained, combined with the use of simple ear difference scores as an index of laterality, which could confound results with accuracy, makes a comparison to the data obtained here difficult. His finding, however, of more left lateralization of the other language as compared to the native one, is in agreement with the results presented here. The increase in lateralization as a function of proficiency was not significant and may well have been confounded by performance accuracy.

The Piazza-Gordon and Zatorre (1981) results of no correlation between language proficiency in OL might be related to the use of children as Ss, where issues of central nervous system immaturity make a comparison to adult performance difficult.

The direct contradiction of findings here and those obtained with the use of tachistoscopes (i.e. Silverberg et al, 1979; Bentin, 1981), where RVFA increased with increasing other language proficiency, might have its causes in the additional step of lexeme decoding, i.e. might be attributable to the processing mode rather than robust laterality phenomena. It is apparent that the issues are far from being resolved; the findings obtained here underline the importance of a multidimensional approach to laterality measures, with particular attention to stimulus characteristics as well as mode of decoding.

While careful replication and more research investigating the variables in question is needed, the assumption of sequential phased phonemic and semantic processing appears to have considerable heuristic value on the basis of the available evidence. Although definite conclusions would be premature at this point, this assumption may have its major utility in providing guidance for further research.

While then the magnitude of observed laterality effects appears to be a function of the demand characteristics of the specific language set employed, modification of task demands in terms of subject strategy may serve to shed further light on the variance involved in DL performance. To undertake a systematic investigation of such strategy effects, Experiment II was designed.

EXPERIMENT II

Introduction

In the study of perceptual asymmetry in general, and DL in particular, we are confronted with a certain amount of unexplained variability. Since we are dealing with a live mechanism, the scurce of this variability cannot be unitary and is likely to involve a whole array of factors (Bryden, 1980).

In this experiment concern was focused on the extent to which such factors as attentional and strategy variables play a role in DL. Research to date addressing this particular question has concentrated on two aspects: (1) Division of attention, and (2) Order of report as determinants of laterality.

One of the early attempts of investigating 'subject attention' was undertaken by Mcray (1959). He employed a technique first introduced by Cherry (1953), which requires a subject to repeat aloud a dichotically presented continuous message, while listening to it. Moray (1959) concluded that when a subject directs his attention to the reception of a message from one ear and does not attend to the other, little of the unattended message is able to penetrate what he called a 'perceptual block'. While this finding has been modified considerably, the attended ear has consistently been shown to be more accurately reported than the unattended one (see subsequent detailed discussion). While this technique of 'shadowing' has been used extensively (i.e. Treisman, 1964 a,b,, 1969), Bookbinder and Osman (1979, p. 512) outlined its difficulties : (1) 'The task requires the subject to distinguish between the inputs, thus forcing the subject to attend to one ear; (2) The subject must give continuous responses to each item presented; (3) Each response is dependent on the specific verbal item presented, with the response being made usually after several other items have been presented'. Particularly the last point is of import, since it may present a possible source of contamination. Bryden (1971) showed that attended items, unlike unattended ones are lost through verbal or processing interference, the very interference being produced by shadowing. In order to keep this interference effect to a minimum in attention-type DL experiments, report after every trial set (i.e. Bartz et al, 1967) would appear to be the method of choice for the investigation of subject strategy with such task demand characteristics.

Using an attentional paradigm, Bookbinder and Osman (1979) concluded from their investigations that task performance is dependent on the amount of processing capacity, or, as they phrased it 'resource allocated to the primary ear'. The implicit assumption here is that there is a central source of limited capacity which is allocatable in a variety of ways, depending on the particular strategy employed by the individual subject. This model of 'capacity sharing' was put forth by Kahneman in 1973 and is applicable to a variety of different mental activities.

It is commonly accepted (e.g. Bryden, 1969) that competition between simultaneously arriving inputs is both necessary and sufficient for the laterality effect to occur. Spellacy and Blumstein (1970 a) felt that in addition to hemispheric specialization, a non-specific subject-attention factor might exist, which would serve to enhance the degree of lateralization to a particular ear.

Abe and Aiba (1976) investigated the processing of attended and unattended verbal materials in DL and found that when each of the two attention conditions is taken separately (i.e. attend to right ear only, left ear unattended; attend to left ear only, unattended right ear), overall recall from the attended ear is better for a 'right ear attend' group, while recall from the unattended ear is better for the 'left ear attend' group. They concluded that the right ear advantage is observable in attended as well as unattended ear. Similar results were obtained by Mainka and Hoerman (1971) when comparing a 'divided attention condition' (free recall) with a focused attention condition ('pay attention only to the right ear vs pay attention only to the left ear'). The REA observed in the divided attention condition was shown tc recccur in the focused attenticn condition; predictably, overall producticn increased, since right side only subjects are compared with left side cnly subjects. The intriguing part cf this particular experiment is the fact that the stimulus material did not ccnsist of the customarily employed digits cr vowels and consonants, but rather of 2 syllable (4-5 letter) German ncun pairs with concrete content, which underscores the robustness of the observed phenomenon. The Ss in question were native German speakers.

If, as Mewhort, Thic and Birkenmayer (1971) stated, the attentional component ought to be considered as an active aspect of central processing rather than a simple switch or filter, then perhaps the role cf voluntary attentional control should be investigated more closely. The question arising from this discussion is to what extent these attention processes could account for some of the observed variance in ear advantage. In the context of this present experiment, could a dichotically naive subject population be susceptible to a suggestion concerning normal ear advantage? 'Encoding material, switching attention and sustaining material all require processing capacity, but the capacity available is limited and must be shared among tasks' (Mewhort et al, 1971, p. 125). The issue is whether such processing capacity allocation can be a voluntary process and be susceptible to examiner supplied suggestion or whether strategy effects of this nature play no role in DL performance.

A second large source of variability is introduced by the so-called 'ear order effect' or Broadbent effect, mentioned in the introduction. Broadbent (1954, 1956) showed that when 2 different sets of three digits are presented simultaneously, Ss tend to report first all the digits heard on the right side, then all the digits heard on the left side.

Though this effect has been replicated numerous times and appears to be robust (i.e. Inglis, 1962 b; Bryden, 1962, 1963; Satz et al 1965; Bartz et al, 1967; Cooper, Achenbach, Satz and Levy, 1967), some conflicting results have been reported. Carr (1969) ascertained that in spite of these earlier findings, he was unable to obtain a statistically significant order effect, and Arenberg, Surwillo, Gelbart and Gold (1972) found that the incidence of the Broadbent effect is high in some subjects and does not occur in others at all.

Actual manipulation of this 'order effect' has yielded the following net result: More responses were correctly recalled per subject from the channel reported first than the channel reported second, regardless of which ear the stimulus material entered (Cooper et al, 1967). Instructions as to which ear to report first were delivered immediately before each trial, stimulus material consisted of digits.

Gerber and Goldman (1971) systematically explored the function of three different report strategies on ear preference for dichotically presented consonant pairs with a free recall condition (subjects reported stimuli in any order), ordered before (subjects were instructed which ear to report first prior to the presentation of stimuli) and ordered after (subjects were instructed which ear to report first after the presentation of stimuli). From their findings they concluded (1) 'that the right ear is equally efficient in all three reporting conditions, (2) that the immediate channel is more accurately reported than is the delayed channel in all three conditions, (3) that the right ear has a greater percentage of correct responses on the immediate channel in all three reporting conditions than does the left ear and (4) that the right ear has a greater percentage of correct responses on the delayed channel in the two ordered conditions' (Gerber and Goldman, 1971, p.1165).

Incorporating attentional strategies and order effect variables into a single experiment, Bryden (1971) instructed subjects to attend to the material in one ear (right/left attention effect) and to either report the attended items first or to give the unattended items first (order effect). Again, the attended ear was found to be more accurately reported than the unattended ear. Furthermore, an interaction effect between Order of Report X Ear Attended was ascertainable with those Ss attending to the left ear being much more accurate using the 'unattended ear first' order than those subjects attending to the right ear. Conversely, Bryden (1971) showed little difference in performance between 'attending to the left ear' group and 'attending to the right ear' group for the 'attended ear first' condition.

Several questions arise from these findings in the literature: (1) Is an 'order of report' effect ascertainable with stimulus set which is optimally close to attention span limits? (2) If the previously reported order effect (Cooper et al, 1967; Gerber and Goldman, 1971; Bryden, 1971) does occur, will the overall accuracy change? (3) Can voluntary attentional strategies account for some of the variance observed in the sense that a dichotically naive subject population is susceptible to the outlined suggestion effect? (4) Is there a possible interaction between Order of Report X Suggestion?

To supply answers to these questions, the following experiment was designed.

Method

Subjects

Two-hundred and sixteen volunteers, (108 males, 108 females) half of them High School students at Mount Douglas High School and Victoria Senior High School in Victoria, B.C. between the ages of 16-19 years, the other half subjects recruited with the help of an advertisement placed in a local newspaper, age range 17-35 years, participated. An age limit was imposed to exclude the possibility of result contamination, since age has previously been shown to account for a significant amount of variance in DL (i.e. Caird, 1965; Craik, 1965). All Ss were self-professed right-handers, with no auditory impairments and no previous experience with DL.

Procedure and Materials

The Sensory-Motor Survey II (Porac and Coren, 1981) and audiometric assessment (Grason-Stadler, 1977) were again standard, as outlined previously. Stimulus material consisted of task set shown in Experiment I to optimize accuracy and number of words recalled and consisted of English nouns, 3-6 letters in length, with 4 practice sets (two 2 WP and two 3 WP) and 16 test sets (see Appendix A).

Tape recorded instructions asked Ss to recall as many words as possible ('you are going to hear some words, which are going to come into both ears. Each time you will hear 3 sets of words. After each word set, I would like ycu to repeat aloud as many words as you can remember'). Recorded instructions then contained one of three possible suggestions: no suggestion made (NS), a left ear suggestion ('research has shown that words presented to the left ear are more easily heard and reported',LES) and a right ear suggestion ('research has shown that words presented to the right ear are more easily heard and reported',RES). The three levels of order of recall factor, which followed general instructions and suggestion, were either (1) no instructions as to order (free recall, FR), (2) 'report first all the words you heard with the left ear, then all the words you heard with the right ear for each trial' (left ear recall, LER), or (3) 'report first all the words you heard with the right ear and then all the words you heard with the left ear for each trial' (right ear recall, RER). Subjects participated in one of the 9 (3X3) conditions only, N=24 in each group.

The data were analyzed with a 3X3 Multivariate Analysis of Variance (Clyde, 1969; Harris, 1975) with accuracy (A, Right+Left/Total) and the previously outlined index of laterality (LAT, Right-Left/Right+Left) as dependent variables.

Results

Table 6 shows mean scores for the 216 Ss on accuracy, laterality and the mean raw data for right ear total, left ear total and a difference score of R-L. Accuracy ranged from a low of 52.1% in the Neutral Suggestion Right Ear Order group to a high of 56.8% in the Left Suggestion Neutral Ear Order group, a total range of only 4.7 percentage points. Laterality indices in turn ranged from a high of 0.361 in the Neutral Suggestion Right Ear Order Condition to a low of -0.181 in the Neutral Suggestion Left Ear Order Condition (range =0.542, in a theoretically possible range of 2.0).

A multivariate analysis of variance with 2 factors (a suggestion factor with 3 levels and an order factor with 3 levels), with accuracy and laterality as dependent variables, yielded a significant result for the order factor ($p <.01$) and a result of 'no significance' either for the suggestion or the suggestion-by-order interaction factor (see Table 7).

The univariate tests on the order factor showed a highly significant result for laterality ($p <.0001$) and 'no significance' ($p >.5$) for accuracy. Percentage variance accounted for by the laterality index under the order factor was 36.76%.

TABLE 6: Means on Selected Variables in Experiment II, N=216 (24/cell)

SUGGESTIONS		ORDER: FR	LER	RER
NS	A	0.534	0.524	0.521
	LAT	0.128	-0.181	0.361
	REART	28.625	21.167	33.625
	LEART	22.667	29.167	16.375
	D	5.958	-8.000	17.250
LES	A	0.568	0.535	0.549
	LAT	0.087	-0.098	0.284
	REART	29.542	22.708	33.708
	LEART	24.958	28.667	19.042
	D	4.583	-5.958	14.667
RES	A	0.538	0.538	0.529
	LAT	0.082	-0.106	0.309
	REART	28.208	23.125	33.000
	LEART	23.417	28.542	17.792
	D	4.792	-5.417	15.208

A ACCURACY
LAT LATERALITY
REART RIGHT TOTAL
LEART LEFT TOTAL
D REART - LEART

TABLE 7: Multivariate Analysis of Variance (3x3), Experiment II, N=216

I. EFFECTS..ORDER

MUTIVARIATE TESTS OF SIGNIFICANCE

TEST NAME	VALUE	APPROX F.	HYPOTH.DF	ERROR DF	P
WILKS	.62574	27.20921	4.00	412.00	<0.01

UNIVARIATE F-TESTS WITH (2,207) D.F.

VARIABLE	HYPOTH.SS	ERROR SS	HYPOTH.MS	ERROR MS	F	P
LAT	7.16572	12.32569	3.58286	.05954	60.17122	<.001
A	.00908	1.38925	.00454	.00671	.67642	<510

II. EFFECTS..SUGGESTION

MULTIVARIATE TESTS OF SIGNIFICANCE

TEST NAME	VALUE	APPROX.F	HYPOTH.DF	ERROR DF	P
WILKS	.98439	.81320	4.00	412.00	<.517

UNIVARIATE F-TESTS WITH (2,207) D.F.

VARIABLE	HYPOTH.SS	ERROR SS	HYPOTH.MS	ERROR MS	F	P
LAT	.00488	12.32569	.00244	.05954	.04095	<960
A	.2190	1.38925	.01095	.00671	1.63121	<198

III. EFFECTS..SUGGESTION BY ORDER

MULTIVARIATE TESTS OF SIGNIFICANCE

TEST NAME	VALUE	APPROX.F	HYPOTH.DF	ERROR DF	P
WILKS	.97932	.54095	8.00	412.00	<.826

UNIVARIATE F-TESTS WITH (4,207) D.F.

VARIABLE	HYPOTH.SS	ERROR SS	HYPOTH.MS	ERROR MS	F	P
LAT	.19839	12.32569	.04960	.05954	.83294	<.506
A	.00731	1.38925	.00183	.00671	.27223	<.896

Tests for a possible sex effect (Male/Female) and age effect (High School versus General Population) yielded a 'no difference' result; for the purposes of the MANOVA, groups were hence collapsed across sex and age.

To test for possible distortion due to accuracy and laterality confounding, a Pearson r correlation was performed. Accuracy and laterality showed a small, non-significant correlation ($r=-0.0787$, $p >.12$), with only 0.6% of the variance shared.

When comparing right ear performance with left ear performance as a function of order of report (collapsed across the three suggestion conditions, see Fig. 5), the right ear performance in the FR condition is similar to the left ear performance in the LER condition, and left ear performance in the FR condition is not significantly different from right ear performance in the LER condition.

The statistical post-hoc comparison between FR and RER yields a significantly better result ($p <.005$) for the right ear in the RER, while the left ear is significantly worse compared to the FR condition ($p <.005$). In other words, while performance increment in the right ear is at the expense of the left ear, overall accuracy is not significantly different from the FR condition.

The comparison of ear performance between LER and RER is in the expected direction: While the right ear of the RER is significantly better than the left ear of the LER ($p < .005$), the left ear of the RER is significantly worse than the right ear of the LER ($p < .005$), as graphically demonstrated in Fig. 5.

Thus although accuracy is maintained at the same level in all three conditions, relative ear performance changes as a function of ordered recall.

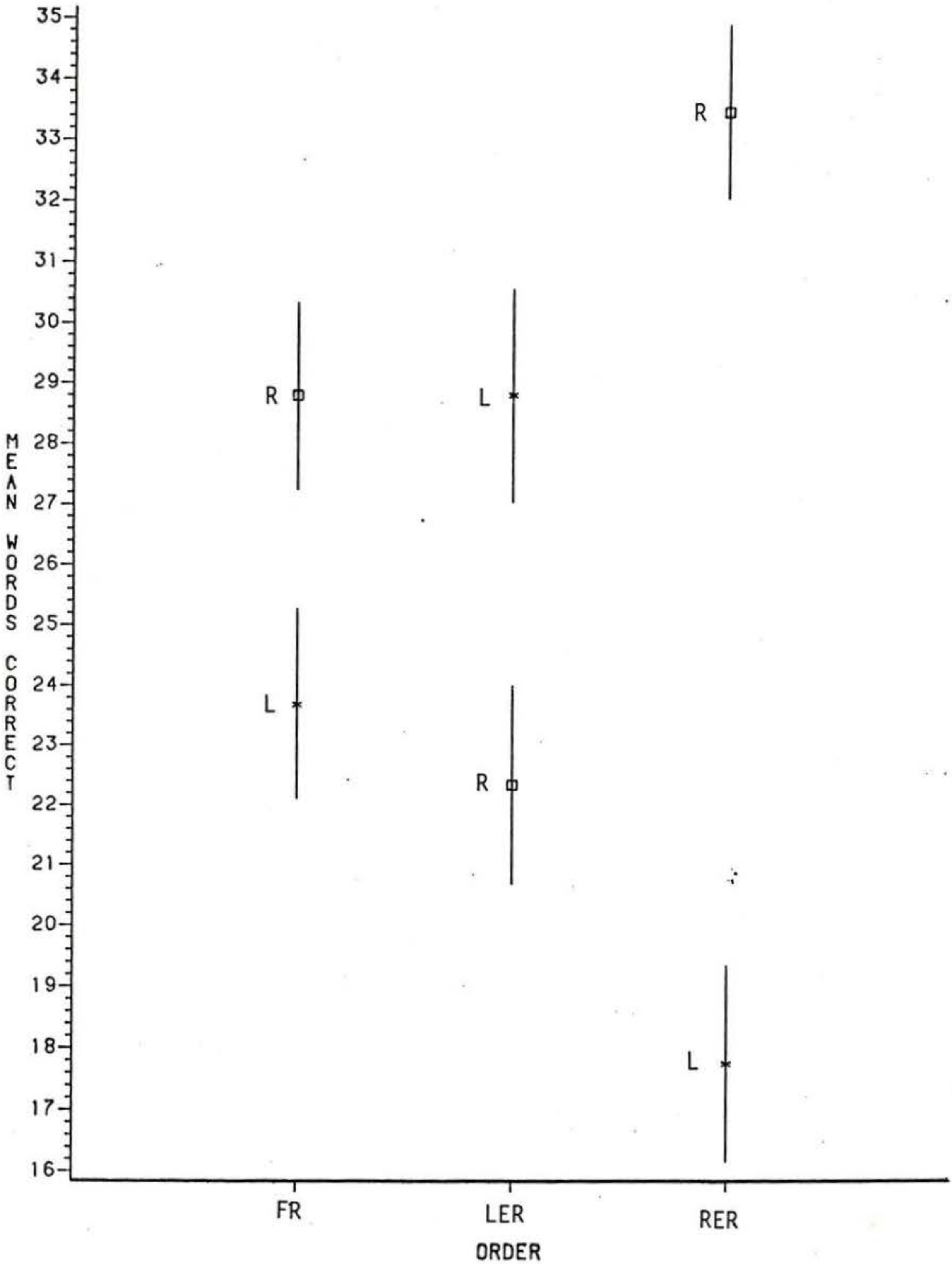

FIGURE 5: RIGHT AND LEFT EAR MEAN ACCURACY SCORES COLLAPSED ACROSS THE 3 LEVELS OF THE SUGGESTION FACTOR (CONFIDENCE INTERVALS DISPLAYED)

Discussion

Results of the multivariate analysis of variance were clear; while there was a marked difference on laterality scores as a function of order of report, no difference for the suggestion factor or interaction factor was ascertainable.

The significant result on the 'Order of Report' condition replicates earlier work (i.e. Satz et al, 1965; Cooper et al, 1967; Bartz et al, 1967) and gives further credence to the assertion that memory and attentional factors are involved in DL performance, particularly in light of the fact that performance accuracy was not significantly different across the three order of report conditions.

It would appear then that we are dealing with a finite amount of processing capacity for the two ears combined, which is allocatable as a function of strategy, in this case by the examiner-induced order of report strategy.

The assertion that there is a finite amount of processing capacity becomes particularly apparent when comparing raw scores of right and left ear performance in the three order conditions (see Fig. 5). Since multiple post-hoc comparisons were performed on raw right ear and left ear scores, true significance levels may be lower than reported here; however, since marked differences emerged for all groups ($p < .005$ in each case), alpha level inflation would appear to be of little concern. Though performance accuracy remained stable, the resource allocated to the individual ear varied considerably and significantly. Particularly intriguing is the inverse identical performance of right and left ear in the FR and the left and right ear in the LER condition. Apparently subjects are able to reverse the ordinarily observed right ear advantage simply by reversing 'natural strategy', i.e. the condition in which the examiner induced no strategy.

On the other hand, in the RER condition, the right ear performance was significantly better than the right ear performance in FR or the left ear in LER, but this performance increment took place at the expense of the left ear.

Satz et al (1965) reported findings of a similar nature, however their results reached significance only for the comparison of the two 'immediate ears' (left ear in LER and right ear in RER) but failed to show significance for the two 'delayed ears' (right ear in LER and left ear in RER). Direct comparison runs into further difficulty, since Satz et al (1965) did not employ a control group (no order of report instructions) and for purposes of ear performance comparison percent error scores were used.

The implications of my findings for clinical use of the DL technige may indeed be considerable, since subject determined strategy may significantly alter results and may render findings invalid for the original purpose, mainly to test for presence or absence of pathognomonic signs and to determine language lateralization.

On the basis of results obtained here, it might be advisable to reconsider the clinical use of DL in its present form. A more profitable approach may be to measure patient performance on DL with three different task sets (FR, LER, RER) and to compare performance of the right ear (RER) with the left ear (LER). The FR condition would serve as practice and control condition. A systematic investigation of this procedure is presently in progress (Mohr and Costa, in preparation).

Results on the suggestion factor were very surprising in light of these findings, since subject strategy appears to play such a major role in the framework of the order variable. Two plausible explanations for the absence of significant differences emerge:

(1) The suggestion was not strong enough and hence was largely ignored. While a cogent argument could be made to support this point of view, it is difficult to adequately strengthen the suggestion effect, without virtually demanding ordered recall, or by using an attentional model,

a project already aptly undertaken by Bryden (1971), Hiscock and Bergstrom (1982) and others.

While this line of argument does not refute the lack of strength hypothesis, it does allow for consideration of an alternative explanation:

(2) The suggestion effect was cancelled on the basis of equal group participation of subjects susceptible to the effect in one direction and a second group in the opposite direction, effectively cancelling each other out.

A likely discriminator for such group membership might be field dependence/independence, since FD's are known to lateralize less than their FID counterparts in a neutral DL condition (Pizzamiglio and Cecchini, 1971; Dawson, 1972; Pizzamiglio, 1974) and may be more susceptible to suggestion on the basis of relatively higher dependence on environmental cues.

In order to test this hypothesis, which would supply at least a partial explanation as to why a result of 'no difference' was found for the suggestion factor, Experiment III was designed.

EXPERIMENT III

Introduction

In recent years many studies investigated individual difference variables which may contribute to the ability to predict cerebral lateralization. Among those most extensively considered, one finds the variable of 'psychological differentiation'. Efforts have concentrated on determining whether any variance in an individual's response to lateralized stimulation such as DL could be accounted for by the subject's 'cognitive style' (Pizzamiglio, 1974; Zoccolotti and Oltman, 1978; Zoccolotti, Passafiume and Pizzamiglio, 1979; Pizzamiglio and Zoccolotti, in press).

This construct of 'psychological differentiation' serves basically to conceptualize a particular dimension of individual functioning (Witkin, Oltman, Raskin and Karp, 1971), namely the cognitive style dimension of field-dependence/independence (FD/FID) (Oltman, Semple and Goldstein, 1979). First proposed by Witkin (Witkin and Asch, 1948; Witkin, 1950) and based on the original work by Gottschaldt (1926) 'Ueber den Einfluss der Erfahrung auf die Wahrnehmung von Figuren - about the influence of experience on the perception of figures' the FD/FID dimension can be measured by the Embedded Figures Test (EFT) (Witkin, 1950), and the Rod-and Frame Test (RFT) (Witkin and Asch, 1948). The EFT is a perceptual test, in which the subject is asked to locate a previously seen simple figure within a larger, more complex figure, organized in such a fashion, as to embed or obscure the simple figure (Witkin et al, 1971). The RFT is a procedure, where the subject, seated in a totally darkened room, has to adjust to the upright a tilted, luminous rod, which itself is centered in a tilted luminous frame, with the frame remaining in its original position.

FD/FID, which also has been called 'cognitive control of field articulation' (DeFazio and Moroney, 1969) thus relates to the question of the individual's ability 'to overcome competing cues so as to perceive or extract an item from the perceptual field in which it appears with greater or lesser dependence on the field' (DeFazio and Moroney, 1969, p.77). While FD/FID performance was thought originally to be mainly a function of selective attention to the relevant parts of a complex figure (Gardner and Long, 1961), more recently the explanation has been broadened.

The field independent cognitive style in this modern view can be characterized by the preponderance of autonomy from external referents. Thus field-independence would involve a highly developed spatial restructuring ability as well as relative autonomy in the interpersonal realm (Witkin et al, 1979; Oltman et al, 1979). A field dependent cognitive style in turn, involves, according to this point of view, greater reliance on external referents and a somewhat less developed spatial restructuring ability, coupled with a comparatively more interpersonal orientation (Witkin et al, 1979; Oltman et al, 1979). The previously mentioned term of 'psychological differentiation' was proposed by Witkin, Faterson, Goodenough and Karp, 1974, Witkin and Goodenough, 1977 and Witkin et al, 1979, as an overall term which contains the concept of FD/FID. In this more general sense, FID is thought to be reflective of greater psychological differentiation, including perceptual, intellectual, social-interpersonal, learning-memory and personality-defensive processes (Goodenough, 1970), while FD is thought to show a lesser degree of psychological differentiation.

While the entire construct has been subject to some debate, with issues like reliability and validity being raised by critics, particularly when EFT results are extended beyond the 'simple perceptual realm' (Dana and Goocher, 1959), proponents claim that such problems are mainly related to failure to adhere to original rating procedures (Witkin, 1960). Frequently undertaken replication work with the original Witkin test (i.e. Young, 1959) has strengthened the position of the proponents.

In terms of actual measurement of FD/FID, words of caution have been added by such workers as Arbuthnot (1972), who noted that various tests commonly employed individually as measures of FD/FID like the EFT, RFT, Koh's Block Design subtest of the Wechsler Intelligence Scale for Children and the Draw-a-Person Test, generally do show some shared variance but lack common form validity. Literature purporting to have properly used the FD/FID paradigm in terms of measurement, may, due to the wide array of tests utilized, not deal with FD/FID alone, but rather with some 'varying continued combination of field independence and other abilities or characteristics, tangentially related to the construct' (Arbuthnot, 1972, p.486). Walsh's (1978) findings that the EFT (Witkin et al, 1971) and the Portable RFT (Oltman, 1968) did not measure the same underlying construct in a varimax rotated factor matrix, underlines the necessity for caution in the interpretation of research employing a FD/FID paradigm. However, the FD/FID dimension has been related to EEG coherence measures (O'Connor and Shaw, 1978), fluctuation over time in integrated EEG amplitudes recorded from the left and right hemisphere (Oltman et al, 1979), differing ability of FDs and FIDs to withstand sensory deprivation (Murphy, 1966), differing ability of the two groups to withstand distraction (Bloomberg, 1965), differing performance on a Signal Detection task (DeFazio and Moroney, 1969) and unequal hypnotic susceptibility (DeWitt and Averill, 1976).

While some of the experiments relating FD/FID to cognitive variables such as sensory deprivation effects, susceptibility to distraction and hypnotic susceptibility showed mixed results (FDs were more susceptible to sensory deprivation effects than FIDs, Murphy, 1966; susceptibility to distraction did not relate linearly to the FD/FID continuum, Bloomberg, 1965; and hypnotic susceptibility was found to possibly relate to FD/FID via a not yet specified right hemisphere process underlying both, DeWitt and Averill, 1976) the findings involving actual laterality measures were much more clear.

O'Connor and Shaw (1978) suggested that 'individual differences in processing information may reflect characteristic systems of neuronal functional organization in the cortex that can be monitored by the EEG' (p.107). Specifically, dextral individuals were presumed to have a more specific system of functional units in the cortex, while sinistrals showed more diffuseness. O'Connor and Shaw (1978) concluded that field-dependence (as a measure of psychological differentiation), EEG coherence measure (as a measure of neuronal differentiation) and lateral preference (as a measure of functional differentiation) showed a stable and significant association.

Oltman et al (1979) reported that 'fluctuations over time in integrated EEG amplitudes recorded from the left and right hemispheres were more similar to each other (i.e. less differentiated) in individuals with a field-dependent cognitive style, than in those whc were field-independent' (p. 699).

While Garrick (1978) in his theoretical review of the question of field-dependence and hemispheric specialization favored the notion of a continuum of lateralization underlying the field-dependence independence continuum, actual behavioral research has lent further support tc this purported association between psychological differentiation and measures of lateralized cerebral function. Cltman et al, (1977) and Zoccolotti and Cltman (1978) reported a LVF (right hemisphere) superiority for face discrimination and a RFV (left hemisphere) advantage for letter discrimination in FIDs, while FD subjects showed no such lateralized pattern. Pizzamiglio and Zoccolotti (in press) confirmed these reports by finding more pronounced lateralization effects for both face and letter recognition in visual hemifield studies of FIDs than FDs.

Zoccolotti et al, (1979) broadened the investigation to include a tactile test and found FIDs perceived a line orientation task significantly more accurately with their left hand than with their right hand, while FDs did not show any significant lateral differences.

Since left hemisphere mediation of language and the REA on dichotic listening tasks, as outlined in the General Introduction are well documented (i.e. Hecaen and Albert, 1978), DL lends itself readily to the investigation of the hypothesis that variations along the continuum of the FD/FID dimension correlate with hemispheric lateralization, as purportedly measured by DL. When investigating this question, Pizzamiglio and Cecchini (1971), Dawson (1972), Pizzamiglio (1974) and Waber (1976) all reported a greater REA in DL for FID subjects than for FD subjects.

If all of the discussed results are taken together, support for the association between purported cerebral laterality measures and psychological differentiation assessed with the FD/FID paradigm, emerges in the visual realm (Oltman et al, 1977; Zoccolotti and Oltman, 1978; Pizzamiglio and Zoccolotti, in press), the tactile realm (Zoccolotti, Passafiume and Pizzamiglio, 1979) and for the purposes of this investigation most importantly in the auditory realm (Pizzamiglio and Cecchini, 1971; Dawson, 1972; Pizzamiglio, 1974; Waber, 1976).

The research results relating DL and FD/FID, raise several relevant questions for the purposes of this investigation. Specifically, (1) can a more pronounced REA in FIDs as compared to FDs be replicated (under neutral suggestion, NS) and (2) will a specific suggestion (LES versus RES versus left and right ear suggestion (BES), (see Procedure Experiment III) change the performance of the 2 groups.

I hypothesized that FD Ss, on the basis of their dependence on external referents, will lateralize in the direction given by the suggestion and hence show an LEA for LES, an REA for RES and no preference for BES. FID Ss I hypothesized, on the other hand will not be susceptible to suggestion effects due to their relative independence from external cues and will show no performance change from the NS to the LES, RES or BES condition.

In order to address these issues, Experiment III was designed.

Method

Subjects

One hundred and twenty volunteers (Male/Female), 72 of whom already took part in Experiment II and 48 student volunteers from the University of Victoria (age range 17-35) participated. All Ss again were self-professed right-handers with no auditory impairments and no previous experience in DL.

Procedure and Materials

As in the previous two experiments, the Sensory-Motor Survey II (Porac and Coren, 1981) and formal audiometric assessment (Grason-Stadler, 1977) were standard.

As a measure of Field Dependence/Independence the Embedded Figures (EF) subtest of the Comprehensive Ability Battery (CAB) developed by Hakstian and Cattell (1976) was used. This EF test (see Appendix A) is a measure of spatial ability in form of a multiple choice embedded figures test, which presents a set of five simple figures and requires subjects to indicate which one of the five is hidden in a more complex design (Porac and Coren, 1981).

The designation of FD vs FID was arbitrarily defined as EFT performance under the 50th percentile (score 1-7, FD) and above the 50th percentile (score 8-12, FID), based on norms of Porac and Coren (1981). The criterion of the 50th percentile as cut-off point was utilized by Pizzamiglio and

Zoccolotti (in press) and was used for reasons of comparability with their results.

DL task set was identical to the one employed in Experiment II. Instructions as to the nature of the task were again recorded and were of the familiar content. Instructions contained one of four possible suggestions: no suggestion (NS), a left ear suggestion (LES) a right ear suggestion (RES), and as a 'suggestion control group' a 'both' suggestion condition (BES): 'research has shown that the right ear and the left ear are equally well heard and reported'. No instructions as to order of recall were supplied, hence all Ss followed a FR strategy. Subjects participated in one of 8 (2X4) conditions only, N=15 in each group.

The data were analyzed with a 2X4 Analysis of Variance (Winer, 1971; Nie, Hull, Jenkins, Steinbrenner and Bent, 1975) with the previously outlined index of laterality (IAT, Right-Left/Right+Left) as dependent variable. Where appropriate, post-hoc ANOVA procedures were employed, again with Lat as dependent variable (Nie et al, 1975).

Results

Table 8 shows the mean scores for accuracy and laterality in the 8 cells of the present 2X4 design. Maximal accuracy occured in the field independent (high EF), BES group with 58.7%, while high EF, NS yielded the lowest score with 53%, a total spread of 5.7 percentage points, virtually identical to the accuracy spread observed in Experiment II (4.7 percentage points). Laterality scores on the other hand showed some wide discrepancy, with a low of 0.021 in the high EF, LES group and a high of 0.194 in the high EF, NS group.

Analysis of Variance with an EF factor (2 levels, low and high), and a suggestion factor (4 levels, NS, LES, RES and BES, see Table 9) and the familiar laterality coefficient R-L/R+L as dependent variable, yielded no significant main effects, but showed an interaction effect approaching significance ($p < .070$), an effect of only minimal magnitude however (percentage variance accounted for, Eta*2 = 6%). Fig. 6 presents results graphically and shows that we are dealing with a classic interaction pattern, with main effects virtually cancelling each other.

TABLE 8: Means on Selected Variables in Experiment III, N=120 (15/cell)

		SUGGESTION							
		NS		LES		RES		BES	
E LOW	A	0.549	A	0.553	A	0.542	A	0.533
	LAT	0.077	LAT	0.135	LAT	0.149	LAT	0.151
	REART	28.133	REART	30.067	REART	30.200	REART	29.667
	LEART	24.600	LEART	23.000	LEART	21.867	LEART	21.533
	D	3.533	D	7.067	D	8.333	D	8.133
F HIGH	A	0.530	A	0.575	A	0.565	A	0.587
	LAT	0.194	LAT	0.021	LAT	0.039	LAT	0.052
	REART	30.133	REART	28.133	REART	28.467	REART	29.867
	LEART	20.733	LEART	27.067	LEART	25.800	LEART	26.467
	D	9.400	D	1.067	D	2.667	D	3.400

A = ACCURACY LAT = LATERALITY
REART = RIGHT TOTAL LEART = LEFT TOTAL
D = REART - LEART

TABLE 9: Analysis of Variance (2x4) Experiment III, N=120

SOURCE OF VARIATION	SS	DF	MS	F	P
SUGGESTION	0.053	3	0.018	0.450	< 0.718
FIELD DEPENDENCE	0.079	1	0.079	2.027	< 0.157
SUGGESTION-BY-FIELD DEPENDENCE	0.284	3	0.095	2.417	< 0.070
ERROR	4.380	112	0.039		
TOTAL	4.796	119	0.040		

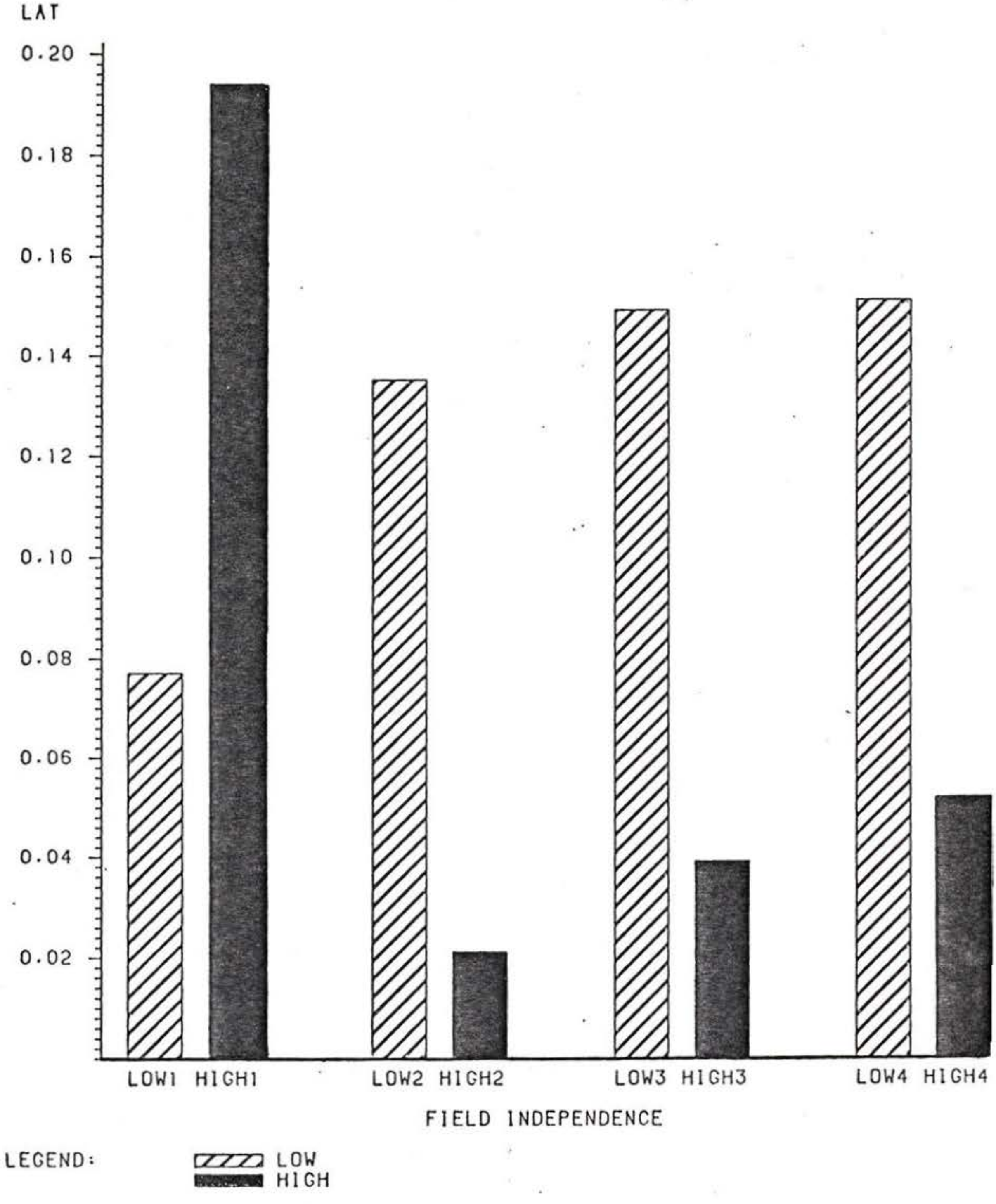

FIGURE 6: LATERALITY SCORES OF NS(1), LES (2), RES(3) AND BES(4) AS A FUNCTION OF FIELD INDEPENDENCE (LOW/HIGH)

For the purpose of post-hoc testing of simple effects, the overall analysis was partitioned into 2 separate parts, a oneway ANOVA (2 levels, low and high EF), comparing the NS condition, and a 2X3 ANOVA (EF factor, 2 levels, high/low and suggestion factor, 3 levels, LES, RES and BES).

The oneway comparison between the two NS cells testing for a difference on the laterality index as a function of low versus high EF, was suggestive of the possibility of a significant difference, but did not reach actual significance ($p < .09$).

The 2X3 ANOVA (EF, high/low, Suggestion, LES, RES, BES) yielded a significant main effect of field dependence/ independence ($p < .017$), while the suggestion and the interaction effect showed a result of no significant difference between groups. Field independent Ss then scored significantly lower on the laterality index than did field dependent Ss under any of the three suggestion (LES, RES and BES) conditions.

Since performance in the three suggestion conditions (LES, RES and BES) yielded no significant differences, there is a possibility that the significance level of the interaction in the overall ANOVA was masked by the relatively homogenous performance of the two groups respectively (FD/FID) under the three suggestion conditions (see Table 8).

To test for this possibility, the three levels of suggestion were collapsed and the data were reanalyzed as an unequal N 2X2 Analysis with an EF factor (high/low) and a Suggestion factor (NS or suggestion present, SP). No main effects were ascertainable, but the EF-by-Suggestion interaction showed a highly significant result ($p < .007$).

To test again for the possibility of confounding between accuracy and the index of laterality employed here, a Pearson correlation between accuracy and laterality across all 8 cells was performed: $r=0.0068$, $p > .47$, hence virtually no variance is shared.

Discussion

While results of Experiment III initially appear difficult to interpret, since statistical significance in the ANOVA emerged only as a trend, post-hoc analyses served to provide a much clearer pattern of findings.

The hypothesis of lateral preference change of FD Ss on the basis of suggestion, with no such change for FID Ss, was not supported by the data. Instead, an unexpected pattern of results emerged.

Differences in DL performance appear to exist as a function of psychological differentiation. The fact that the ANOVA did not yield any significant main effects, reflects performance reversal as a function of presence or absence of suggestion (FDs low REA in the NS condition and increased REA in any of the three suggestion conditions with FIDs high REA in the NS condition and decreased REA in any of the three suggestion conditions).

The failure of the interaction effect to reach actual significance, might be due to a masking effect of the relatively similar performance of Ss in the three suggestion conditions. Statistically the three suggestion conditions may simply be a replication of each other (suggestion presence), hence lowering the power of the statistical test employed. The marked increase in significance level (from $p < .07$ to $p < .007$) when collapsing across LES, RES and BES indeed reflects such an effect.

The uniform change of FDs and FIDs respectively from the NS condition to any of the suggestion conditions, regardless of suggestion content, is intriguing. While caution should be exercised in the interpretation of post-hoc test significance levels, since several analyses were performed on the same data which were arbitrarily divided on the basis of post-hoc questions posed, and were analyzed in one case with markedly unequal N's (2X2 post-hoc analysis), results can still be taken as indicative of trends in the variance accounted for by the various effects.

The pattern which emerges from these findings is that suggestion content was largely immaterial as far as DL performance is concerned, but that suggestion presence versus absence markedly affected observed lateral preference. It is tempting to speculate that such a performance pattern may be due to subject sensitization to strategy. Conceivably the presence of a suggestion may induce subjects to employ a self-determined strategy, leading to the curious performance reversal from the NS condition to the three suggestion conditions for the 2 groups (FD/FID).

While I was unable to replicate previous work (Pizzamiglio, 1974) showing significant differences between FD and FID Ss in a NS condition on the basis of lateral preference in DL (FDs less lateralized than FIDs), results obtained here are suggestive of a trend in this direction ($p < .09$ in the post-hoc oneway ANOVA). Since the measure of psychological differentiation employed here did successfully discriminate between groups in the second post-hoc ANOVA (EF, high/low, Suggestion, LES, RES and BES) with a main effect of FD/FID at the $p < .017$ level, the measure itself is an unlikely source of difficulty. A more likely source might be the pretrial selection employed by Pizzamiglio (1974), using only subgroups with extreme right and mixed ear preference. Such pretrial selection might increase chances to obtain significant differences between groups, a fact which may have lead Pizzamiglio (1974) to call his results 'only preliminary'.

The fact then that psychological differentiation can account for some of the variance in DL performance, however modest this contribution may be, underlines the previously mentioned assertion that valid clinical use of DL necessitates stringent control procedures, making performance largely independent of self-induced strategy effects.

GENERAL DISCUSSION AND SUMMARY

General Discussion

Experiment I showed that lateral preference is closely tied to stimulus quality as well as quantity. While multilingual research of this nature is only in its infancy, further investigation may elucidate the value of the proposed phasic phonemic-semantic processing sequence explanation. The necessity for further work is underlined by the presence of conflicting results (i.e. Carroll, 1980, who claimed an increase in right lateral preference with an increase in language proficiency in a second language) and by the virtual absence of pretrial equalization of sensation levels on the basis of audiometric assessment in the literature at this point, which makes comparisons to findings obtained here difficult. The comparatively high results of right lateral preference (89%-96%) in right-handers shown here might be related to the careful use of audiometric screening techniques and certainly warrant a replication study. If these results were indeed robust, the generally voiced criticism of 'too much noise' (on the basis of 'only' 75% right lateral preference in DL commonly reported in the literature, even though lateralization for language is purported to be on the left in 94% of the population) in the use of the technique (i.e. Teng, 1981), might indeed be muted.

The dramatic order effects of Experiment II might serve to sensitize the critical user of this technique for clinical purposes to the dangers of possible contamination due to subject determined strategy choices. These findings may also point the way to further research systematically evaluating the possibility of actual clinical use of examiner induced recall strategies in DL administration, with the purpose of reducing subject determined strategies.

Experiment III further underlined the contention that present administration techniques may very well be subject to extraneous contamination due to subject determined strategies. The issue of psychological differentiation and lateralization deserves further careful evaluation with alternative instruments, possibly assessing more accurately the field dependence/independence dimension, to insure that the variance accounted for by psychological differentiation in DL performance is indeed as small as results obtained here suggest.

Results of the three experiments provide support for an eclectic position concerning ear advantage in DL, as formulated by Bryden (1980). The REA shown consistently in all conditions in Experiment I and all neutral (strategy-free) cells of Experiment II and III, again lend support to that part of Kimura's (i.e. 1967) perceptual asymmetry model, which contends that observed right lateral preference in DL with stimuli of linguistic content is a function of left lateralization of language in rt-handed Ss.

Manipulation of Ss strategy and stimulus characteristics show that other factors, such as an order factor, attentional factors (investigated elsewhere, i.e. Bryden, 1971; Mainka and Hoerman, 1971) and to some degree psychological differentiation, all contribute to observed variance in DL. While other sources of variance in the DL paradigm may yet emerge, perceptual asymmetry and allocation of processing capacity (which includes subject or examiner induced strategies such as 'order of report' and attentional variables) are likely to account for a sizable amount of variance in the multifactorial DL paradigm thus proposed.

As a consequence, the answer to the main question posed by this dissertation, 'does the concept of lateralization sufficiently explain dichotic listening performance', is a clear and unequivocal -no-. The extent of this 'no' can only be established, once the spectrum of possible contributing variables has been more adequately investigated.

Summary

Four performance dimensions in DL were investigated. (1) Stimulus characteristics, (2) Order effects, (3) Susceptibility to suggestion effects and (4) Psycholcgical differentiation and lateral performance in DL.

It was ascertained that stimulus quantity (2,3 and 4 WP) significantly altered performance. Increasing loads on processing capacity increased right lateral preference. The investigation of stimulus quality (native language versus other language) revealed that REA decreases as a function of language familiarity, with the largest REA displayed by non-proficient Ss in OL and the relatively smallest right preference by native-speakers in NL. As an interpretation of these results, a phased sequential explanation of phonemic-semantic processing was introduced.

Order effects in turn were shown to account for a significant amount of variance in the phenomenon; with no accuracy changes across three order conditions (FR, LER, RER) the notion of finite processing capacity, allocatable on the basis of subject or examiner induced strategy, gained substantial support. Results were taken to suggest that caution should be exercised with present clinical administration techniques, since an unknown amount of contamination of results might be present on the basis of subject self-induced strategy. Suggestions for research further invstigating this issue were supplied.

No suggestion effects as such were ascertainable. The absence of a significant effect was interpreted as having one or both of the following causes: (1) Suggestion was too weak, (2) Different susceptibility to suggestion effects in the subject population might cancel any effect.

However, in Experiment III an effect in terms of presence or absence of a suggestion was shown, while suggestion content appeared to be immaterial. This effect emerged as a function of field dependence/independence, with performance reversal from a neutral (NS) condition to any one of three suggestion present (LES, RES, BES) conditions. It was concluded that in the case of both groups (FD/FID), examiner supplied suggestions were not reflected in specific changes in pattern of performance across groups, but that their presence resulted in overall differences in ear advantage.

It was speculated that the effect of suggestion presence versus absence was due to subject sensitization to strategy options which led to the observed performance reversal from the NS to any of the SP conditions for the two Ss groups (FD/FID).

Results of the entire set of experiments were interpreted as providing clear support for an 'eclectic position' concerning the nature of ear advantage in DL, with several main contributors to observed variance. While perceptual asymmetry was identified again as a main source of variance in DL, as claimed by Kimura (i.e. 1967), and reflected by Ss performance in any of the 'neutral' conditions, linguistic stimulus characteristics, processing capacity allocation and to a lesser extent personality variables such as field dependence/ independence are all thought to make contributions to size and extent of lateral preference in DL.

Research implications were seen mainly in the necessity of careful evaluation and possible control of the different sources of variance, in the clinical use of DL, to insure valid and reliable results.

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Appendix A

TESTING MATERIAL

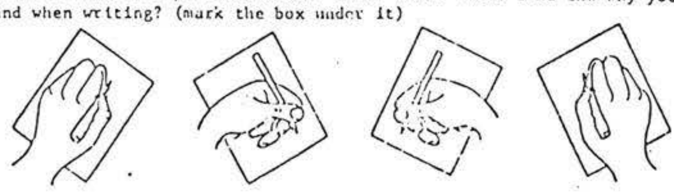
PPRA:Sensory-Motor Survey II

Name		
Sex female☐ male☐		
Date of birth	Height	Weight

COORDINATION-PREFERENCE INFORMATION (Check the response that describes you best)

1. Most people carry their heads with a slight tilt. How do you usually hold your head?	left☐	right☐	middle☐
2. With which hand do you use an eraser on paper?	left☐	right☐	both☐
3. Which eye would you use to peep through a keyhole?	left☐	right☐	both☐
4. With which foot would you kick a ball?	left☐	right☐	both☐
5. If you had to look into a dark bottle to see how full it was, which eye would you use?	left☐	right☐	both☐
6. Into which ear would you place the earphone of a transister radio?	left☐	right☐	both☐
7. With which hand do you remove the top card when dealing	left☐	right☐	both☐
8. Which eye would you use to sight down a rifle?	left☐	right☐	both☐
9. If you had to step up onto a chair, which foot would you place on the chair first?	left☐	right☐	both☐
10. If you wanted to listen in on a conversation going on behind a closed door, which ear would you place against the door?	left☐	right☐	both☐
11. With which hand would you throw a ball to hit a target?	left☐	right☐	both☐
12. With which hand do you draw?	left☐	right☐	both☐
13. If you wanted to pick up a pebble with your toes, which foot would you use?	left☐	right☐	both☐
14. If you wanted to hear someone's heart beat, which ear would you place against their chest?	left☐	right☐	both☐
15. Which eye would you use to sight down a telescope?	left☐	right☐	both☐

16. Consider the four pictures below. Which looks most like the way you hold your hand when writing? (mark the box under it)



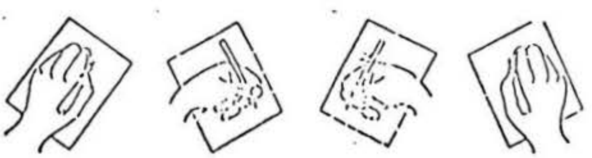
☐ ☐ ☐ ☐

NOM	
SEXE FEMME	HOMME

DATTE DE NAISSANCE	GRANDEUR	POIDS

L'INFORMATION SUR COORDINATION DE PRÉFÉRENCE. (COCHEZ LA RÉSPONSE QUI VOUS DÉCRIT LE MIEUX.)

1. La plupart des gens penchent legerement la tête. Comment est-ce que vous penchez la vôtre? — à gauche ☐ à droi ☐ pas du tout ☐
2. Quand vous effacez une erreur sur la page, quelle main employez-vous? — à gauche ☐ droit ☐ les deux ☐
3. Quel oeil est-ce que vous, regarderiez dans un trou de serrure? — à gauche ☐ à droit ☐ les deux ☐
4. Avec quel pied donneriez-vous un coup de pied à une balle? — à gauche ☐ à droit ☐ les deux ☐
5. Avec quel oeil est-ce que vous regarderiez dans une bouteille obscure pour déterminer le niveau de liquide la dedans? — à gauche ☐ à droit ☐ les deux ☐
6. Contre quelle oreille est-ce que vous placeriez l'écouteur d'une radio? — à gauche ☐ à droit ☐ les deux ☐
7. Avec quelle main enleveriez-vous la première carte quand vous commencer a faire la donnee? — à gauche ☐ à droit ☐ les deux ☐
8. Avec quel oeil est-ce que vous visez un fusil? — à gauche ☐ à droit ☐ les deux ☐
9. Quand vous montez sur une chaise, quel pied mettez-vous d'abord? — à gauche ☐ à droit ☐ les deux ☐
10. Si vous vouliez ecouter une conversation qui se passait derrière une porte fermme, quelle oreille placeriez-vous contre la porte? — à gauche ☐ à droit ☐ les deux ☐
11. Pour atteindre un but, avec quelle main lanceriez-vous une boule? — à gauche ☐ à droit ☐ les deux ☐
12. Quelle main employez-vous pour dessiner? — à gauche ☐ à droit ☐ les deux ☐
13. Pour rammaser une pierre avec les orteils, quel pieds employez-vous? — à gauche ☐ à droit ☐ les deux ☐
14. Pour entendre le battement du coeur quel oreille placeriez-vous contre la poitrine? — à gauche ☐ à droit ☐ les deux ☐
15. Avec quel oeil est-ce que vous regardez dans un télescope? — à gauche ☐ à droit ☐ les deux ☐
16. Regardez ces quatre images. Laquelle rassemble plus à votre facon d'écrire?



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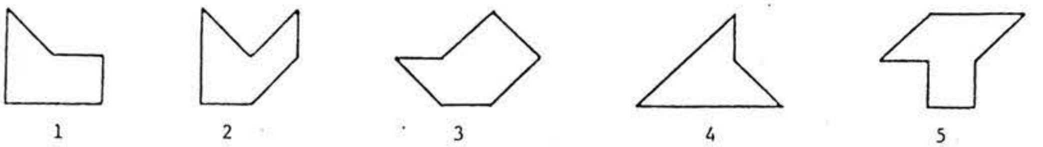
.------------------ . In this test, you are to try to find a simple figure when it is hidden in a more complex design.

At the top of the test page you will see a row of *five simple figures*, labeled 1,2,3,4,5. Below them are 12 complex designs. In each of these designs *one of the five* simple figures is hidden. Only one of the five figures will be hidden in each complex design, and that one figure will be the *same size* and *in the same position* as it is at the top of the page.

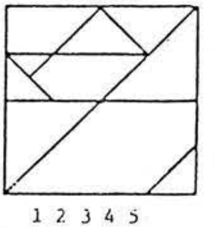
The five simple figures you are to look for are:



1 2 3 4 5

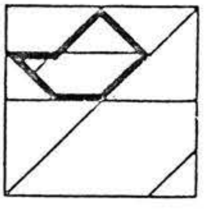
EXAMPLE X: Now try an example. Look for one of these simple figures in the complex design given to the right. Mark your answer on the Answer Sheet in column 1.

Example X



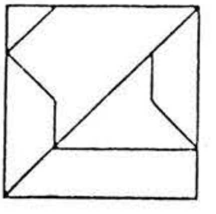
1 2 3 4 5

Figure 3 is the one that is hidden in the design, so you should have filled in the 3 slot on your Answer Sheet for column 1. You can see this more clearly in the design to the right, where Figure is outlined with a heavy line.



EXAMPLE Y: Now try another example. Mark your answer on the Answer Sheet in column 2

Example Y



In EXAMPLE Y, Figure 4 is hidden, so you should have filled in the 4 slot for this example.

1 2 3 4 5

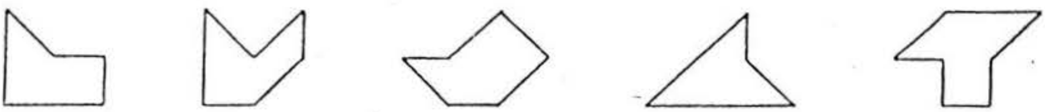
The same simple figures are on the next page. Starting with the first (col 3), find which one of these simple figures is hidden in each design. Then mark your Answer Sheet. *Work quickly* to finish as many as you can. You will have *5 minutes* for the test. If you are not sure of the right answer for an item, mark the choice that is your best guess. If you finish before time is called, please *STOP*. Do *not* turn the page.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

Dans ce test vous allez essayer de trouver une simple figure geometrique dans un dessein plus complexe.

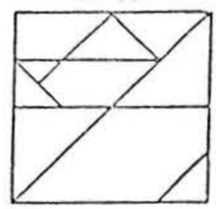
Au haut de la page vous verrez une rangee de figures simples numerotees 1 2 3 4 5. Au dessous d'eux il y a 12 desseins complexes. Cachee dans chacun de ce dessein, il y a une figure simple. Une seule figure est cachee dans chaque dessein et cette figure est de la meme grandeur et dans la meme position que celle du haut de la page.

Les cinq figures que vous devez recherch r sont:



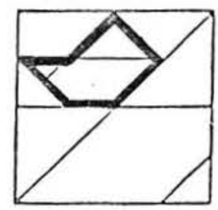
1 2 3 4 5

Example X



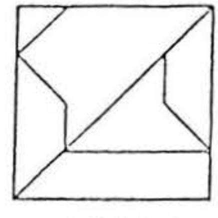
EXEMPLE X: Maintenant faites un premier esai. Recherchez une des figures simples dans le dessein complexe qui se trouve a droite. Indiquez votre reponse dans la 1° colonne sur la feuille de reponses.

1 2 3 4 5



La figure no 3 est celle qui est cachee dans le dessein: alors vous auriez du noircir la troisieme espace sur votre feuille de reponses pour la colonne 1. Vous pouvez constater ceci en regardant le dessein a droite ou la figure simple numero 3 a ete contournee au crayon gras.

Example Y

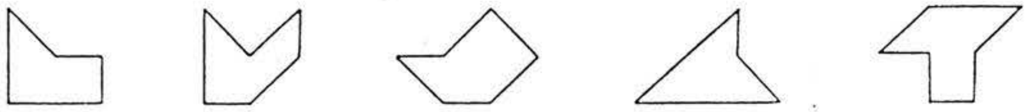


EXEMPLE Y: Essayez encore un fois. Indiquez votre reponse dans la deuxieme colonne sur la feuille de reponse.

Dans l'exemple y la figure numero 4 est cache. Vous auriez du noicir le quatrieme espace.

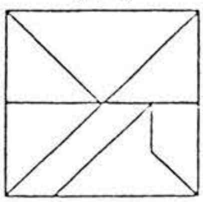
1 2 3 4 5

Les memes figures sont sur la prochaine page en commencant par le premier (troisieme' colonne) essayez de deviner quelle figure simple est cachee dans cheque dessein. Indiquez la resulte sur votre fuille de reponses. Faites le rapidement pour en finir le possible. Vous aurez cinq minutes pour faire le test. Si vous n'etes pas sur de la reponse indiquez ce qui vous parait le plus vraisemblable. Si vous terminez avant le temps, arretez.



1 2 3 4 5

col 3



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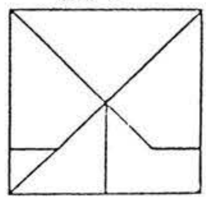
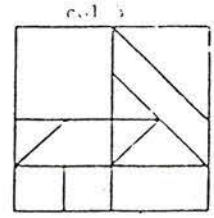
col 4



1 2 3 4 5

col 5



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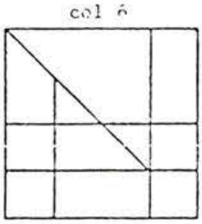
col 6



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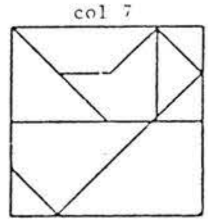
col 7



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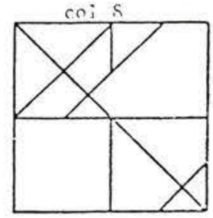
col 8



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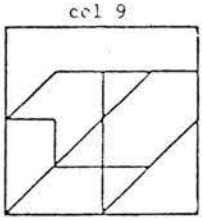
col 9



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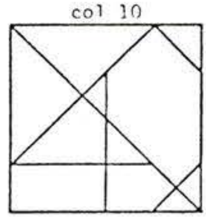
col 10



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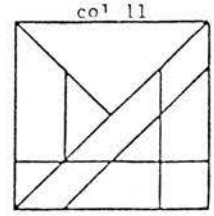
col 11



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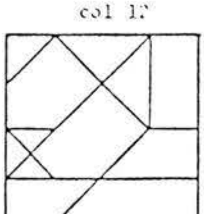
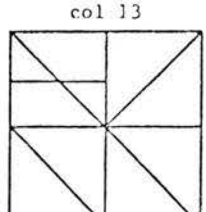
col 12



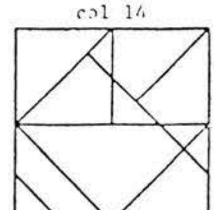
1 2 3 4 5

col 13



1 2 3 4 5

col 14



1 2 3 4 5

STOP. PUT YOUR PENCIL DOWN.

S#____________________

NAME______________________________ Date__________ Age_____ Examiner______________

UNIVERSITY OF VICTORIA NEUROPSYCHOLOGY LABORATORY FEATURE BALANCED DICHOTIC LISTENING TEST

	Left			Right		
1.	bed	lamp		chair	desk	
2.	rug	inch		hill	tree	
3.	lock	smile	book	sea	stool	club
4.	ball	gun	top	doll	game	bet
5.	bear	hat		rain	cart	
6.	boat	jeep		car	cart	
7.	hair	wall		roach	bowl	
8.	paw	skirt		spoon	snow	
9.	storm	leg		tick	truck	
10.	storm	pail		bog	wind	
11.	aunt	moth		flea	grat	
12.	fork	plate		pot	stove	
13.	shirt	tie		coat	shoes	
14.	tan	sheep		shoes	wood	
15.	dog	cat		horse	deer	
16.	pot	worm		bike	rat	
17.	wall	roof		steps	floor	
18.	moth	eye		bog	car	
19.	deer	pants		pan	roof	
20.	hair	toe		arm	head	

1.	plate	ant	coat	door	wind	bus
2.	jet	train	bike	truck	bus	ship
3.	cat	brick	cup	nose	skirt	fly
4.	hail	stair	jeep	foot	horse	blouse
5.	cloud	sleep	cold	sun	snow	rain
6.	fly	wasp	roach	worm	tick	bee
7.	bowl	dish	cup	spoon	pan	knife
8.	arm	floor	dog	gnat	train	fork
9.	ship	dress	wasp	cold	head	dish
10.	truck	pants	dress	hat	skirt	blouse
11.	mouse	rat	sheep	cow	pig	bear
12.	sleep	mouse	tie	bee	boat	cloud
13.	room	wood	hall	brick	stair	door
14.	toe	fork	knife	cow	jet	steps
15.	eye	hand	foot	leg	nose	ear
16.	room	sun	stove	ear	pig	flee

1.	car	jet	bike	ship	bus	train	jeep	truck
2.	gnat	snow	fork	shirt	truck	foot	pig	hall
3.	hail	sun	cloud	wind	snow	fog	rain	sleet
4.	floor	cow	leg	bike	knife	storm	hat	worm
5.	moth	flee	roach	fly	ant	gnat	tick	wasp
6.	cup	plate	pan	dish	stove	fork	bowl	pot
7.	jeep	bowl	skirt	hand	fog	stair	wasp	mouse
8.	flee	spoon	cold	boat	brick	deer	pants	hair
9.	shoes	roof	arm	bee	hair	ship	dog	pot
10.	coat	sock	blouse	tie	shirt	dress	shoes	hat
11.	cat	horse	bear	dog	sheep	pig	cow	mouse
12.	brick	door	wall	wood	roof	steps	room	stair
13.	tick	cloud	head	cat	skirt	dish	wall	train
14.	sun	toe	ant	pan	cart	rat	door	coat
15.	blouse	rain	stove	wood	ear	horse	roach	bus
16.	head	eye	nose	foot	arm	hand	toe	leg

S# ____________________

NAME ____________________ Date __________ Age ___ Examiner __________

UNIVERSITY OF VICTORIA NEUROPSYCHOLOGY LABORATORY FEATURE BALANCED DICHOTIC LISTENING TEST

1.	lit	lampe		chaise	bureau	
2.	tapis	pouce		cote	arbre	
3.	cerrure	sourire	livre	mer	banc	club
4.	balle	fusil	haut	poupee	geu	enjeu
5.	ours	chapeau		pluie	brouette	
6.	bateau	jeep		auto	brouette	
7.	cheveux	mur		punaise	bol	
8.	patte	juppe		cuillère	neige	
9.	tempète	jambe		tique	camion	
10.	tempète	seau		tourbe	vent	
11.	tante	mite		puce	puceron	
12.	fourchette	assiette		pot	four	
13.	chemise	cravate		manteau	souliers	
14.	teint	mouton		souliers	bois	
15.	chien	chat		cheval	renne	
16.	pot	ver		biciclette	rat	
17.	mur	toit		marche	plancher	
18.	mite	oeil		tourbe	auto	
19.	renne	pantalon		poelon	toit	
20.	cheveux	orteil		bras	tête	

1.	assiette	tante	manteau	porte	vent	autobus
2.	avion	train	bicicle	camion	autobus	bateau
3.	chat	brique	tasse	nez	juppe	mouche
4.	giboulee	marche	jeep	pied	cheval	blouse
5.	nuage	sommeil	froid	soleil	neige	pluie
6.	mouche	guêpe	punaise	ver	tique	abeille
7.	bol	assiette	coupe	cuillere	poelon	couteau
8.	bras	plancher	chien	puceron	train	fourchette
9.	bateau	robe	guepe	froid	tête	assiette
10.	camion	pantalon	robe	chapeau	juppe	blouse
11.	souris	rat	mouton	vache	cochon	ours
12.	sommeil	souris	cravate	abeille	bateau	nuage
13.	chambre	bois	corridors	brique	marche	porte
14.	orteil	fourchette	couteau	varche	avion	marche
15.	oeil	boite	pied	jambe	nez	oreille
16.	chambre	soleil	four	oreille	cochon	puce

1.	auto	avion	bicicle	bateau	autobus	train	jeep	camion
2.	moucheron	neige	fourchette	chemise	camion	pied	cochon	corridor
3.	giboulée	soleil	nuage	vent	neige	brume	pluie	grêle
4.	plancher	vache	jambe	bicicle	couteau	tempete	chapeau	ver
5.	mite	puce	puceron	mouche	tante	puceron	tique	guêpe
6.	coupe	assiette	poelon	bol	four	fourchette	bol	pot
7.	jeep	bol	juppe	main	brume	marche	guepe	souris
8.	puce	cuillere	froid	bateau	brique	renne	pantalon	cheveux
9.	souliers	toit	bras	abeille	grèle	bateau	chien	pot
10.	manteau	bas	blouse	cravate	chemise	robe	souliers	chapeau
11.	chat	cheval	ours	chien	mouton	cochon	vache	souris
12.	brique	porte	mur	bois	toit	marche	chambre	escalier
13.	tique	nuage	tete	chat	juppe	assiette	mur	train
14.	soleil	orteil	tante	poelon	brouette	rat	porte	manteau
15.	blouse	pluie	four	bois	oreille	cheval	puceron	autobus
16.	tête	oeil	nez	pied	bras	main	orteil	jambe

Appendix B

RAW SCORES

```
//MOHR JOB (S9007,221,,COSTA),CLASS=C
//* USERID=CORNETT
// EXEC SPSS,VERSION=9A
RUN NAME COSTA/MOHR STUDY
VARIABLE LIST   LEVEL,SEX,AGE,VSCORE,EF,ORDER,N2L,N2R,N3L,N3R,N4L,N4R,
                O2L,O2R,O3L,O3R,O4L,O4R,EARL,EARR,TH,LANG
INPUT FORMAT    FIXED(T9,F1.0,1X,F1.0,1X,F2.0,1X,F2.0,1X,F2.0,1X,F1.0,2X,
                      2F2.0,3X,2F2.0,3X,2F2.0,3X,2F2.0,3X,2F2.0,3X,2F2.0,
                      3X,2F2.0,F5.2,T80,F1.0)
VAR LABELS      LEVEL LANG PROFICIENCY,6BEST,1WORST/
VAR LABELS      SEX,1=FEMALE,2=MALE/
VAR LABELS      AGE CHRONOLOGICAL AGE OF SUBJECT/
VAR LABELS      VSCORE VERBAL SCORE ON OTHER LANGUAGE/
VAR LABELS      EF EMBEDDED FIGURE SCORE, 1-12/
VAR LABELS      ORDER ORDER OF PRESENTATION,1=ENG,2=FRENCH/
VAR LABELS      N2L 2WORD PAIRS,NATIVELANG,LEFTSIDE/
VAR LABELS      N2R 2WORD PAIRS,NATIVELANG,RIGHTSIDE/
VAR LABELS      N3L 3WORD PAIRS,NATIVELANG,LEFTSIDE/
VAR LABELS      N3R 3WORD PAIRS,NATIVELANG,RIGHTSIDE/
VAR LABELS      N4L 4WORD PAIRS,NATIVELANG,LEFTSIDE/
VAR LABELS      N4R 4WORD PAIRS,NATIVELANG,RIGHTSIDE/
VAR LABELS      O2L 2WORD PAIRS,OTHER LANG,LEFTSIDE/
VAR LABELS      O2R 2WORD PAIRS,OTHER LANG,RIGHTSIDE/
VAR LABELS      O3L 3WORD PAIRS,OTHER LANG,LEFTSIDE/
VAR LABELS      O3R 3WORD PAIRS,OTHER LANG,RIGHTSIDE/
VAR LABELS      O4L 4WORD PAIRS,OTHER LANG,LEFTSIDE/
VAR LABELS      O4R 4WORD PAIRS,OTHER LANG,RIGHTSIDE/
VAR LABELS      EARL EAR ATTENUATION ON THE LEFT SIDE IN DB/
VAR LABELS      EARR EAR ATTENUATION ON THE RIGHTSIDE IN DB/
VAR LABELS      TH THRESHOLD FOR BETTER EAR/
VAR LABELS      LANG NATIVE LANGUAGE OF SUBJECT/
PRINT FORMATS   LEVEL,SEX,AGE,VSCORE,EF,ORDER,N2L,N2R,N3L,N3R,N4L,N4R,
                O2L,O2R,O3L,O3R,O4L,O4R,LANG(2),EARL,EARR,TH(4),
                N2D TO SUMLATO(4)
READ INPUT DATA
        6 2 18 48 10 2  2328  2643  2251  1424  2229  1245  -60007.50  2
        6 2 21 52 09 2  1522  0835  1238  1119  1724  1828  00-615.00  2
        6 2 19 54 09 2  1321  2041  1840  1024  1828  1932  00-105.00  2
        6 2 20 48 11 1  1628  1042  1538  0821  1325  1129  00-907.50  2
        5 2 18 40 09 1  0827  0840  1344  0312  1223  1128  00-401.25  2
        5 2 24 55 11 1  1223  1337  1443  0820  1027  0934  00-606.25  2
        5 2 19 43 11 1  1721  2029  2938  0811  1411  2130  000008.75  2
        5 2 30 51 12 1  1928  3325  2540  1216  1922  1727  -40008.75  2
        4 2 19 41 08 1  1128  1443  0650  0514  1524  0727  00-106.25  2
        4 2 21 51 12 2  1625  1835  2340  1417  1928  1224  00-405.00  2
        3 2 20 46 12 1  1523  1637  2231  0312  1117  1620  00-511.50  2
        3 2 23 40 03 2  2727  2742  2543  1618  1726  1130  00-212.50  2
        3 2 26 48 12 2  1925  2437  3032  0521  1925  1428  -50007.50  2
        3 2 18 37 06 1  1826  1541  2438  0722  1225  0727  00-600.00  2
        3 2 21 38 12 1  1118  2127  2737  0513  1214  0724  00-403.75  2
        1 2 20 44 04 1  1223  1944  1330  0515  1225  0924  00-102.50  2
        1 2 22 39 07 1  2027  1637  1940  0518  1324  0727  000008.75  2
        1 2 20 33 08 2  2531  1846  1450  1016  1322  0923  00-606.25  2
        1 2 18 42 12 2  0326  0441  0249  0223  0327  0923  00-411.25  2
        1 2 22 35 06 2  1123  1143  0655  0612  0818  0429  -10005.00  2
        6 1 19 48 12 2  2029  1643  1452  0819  1432  2128  00-102.50  2
        6 1 21 46 12 2  1623  1643  1553  0720  0731  0939  -90002.50  2
        6 1 20 49 12 2  2726  2431  2436  1023  1724  1330  00-105.00  2
        6 1 41 41 08 2  1524  1643  2539  0620  0628  2318  000015.00  2
        6 1 18 41 12 2  1518  1738  2230  1016  1431  2023  00-400.00  2
        5 1 19 41 12 2  1926  1741  1648  0819  0733  0643  -60002.50  2
        4 1 18 41 11 2  1727  1545  2043  0517  0726  0629  000010.00  2
        4 1 21 42 11 1  1424  2038  2237  0817  1230  1732  000013.70  2
        4 1 18 37 02 2  2026  2428  2427  0818  0724  1819  -40000.00  2
```

```
4 1 20 42 05 1   2024   2140   1542   1017   0721   0430   00-506.20   2
3 1 18 40 06 2   1325   2434   2541   0914   1921   1522   00-206.20   2
3 1 19 41 05 1   1321   1239   1147   0614   0028   0033   00-107.50   2
3 1 19 40 11 1   1927   1744   1457   1022   0734   1132   -20010.00   2
3 1 22 42 06 2   1827   2940   3839   1114   1718   2424   -20005.00   2
3 1 18 36 11 1   1130   1436   0651   0715   1317   0926   00-901.20   2
3 1 19 32 06 1   1218   1340   1239   0312   0512   0522   -40006.20   2
3 1 20 33 11 1   1424   0641   1645   0516   0523   0527   00-206.20   2
1 1 18 36 05 1   1028   0942   0951   0616   1515   0728   -50006.20   2
1 1 31 26 04 1   1722   1135   0738   0511   0813   1014   -10007.50   2
1 1 19 15 05 1   2023   2424   2530   0613   1804   1313   00-106.20   2
6 1 19 43 05 2   1723   1527   1645   0521   0635   0335   00-610.00   1
6 1 21 44 12 2   1114   1924   3414   0504   0715   0919   00-106.25   1
6 1 21 51 09 2   1521   1339   0950   1419   0641   0247   -20006.25   1
5 1 24 44 12 1   1826   1744   1550   0722   0236   0050   -10002.50   1
5 1 21 42 12 1   1428   2041   2136   0518   0731   0721   00-111.25   1
4 1 19 39 08 2   1729   2045   1551   0415   0136   1043   00-412.50   1
4 1 17 34 11 1   1927   2335   2351   1120   0730   0930   00-107.50   1
4 1 18 32 11 2   1625   2431   4427   0817   0730   0638   00-303.75   1
4 1 19 36 07 1   1525   1241   1737   0615   0724   0626   00-403.75   1
4 1 21 37 09 1   1921   2829   2738   0320   0528   0534   -30008.75   1
3 1 19 41 12 2   1423   3029   2734   0408   1316   1621   00-421.25   1
3 1 20 36 12 1   1925   1743   1149   0421   0435   0635   00-606.25   1
3 1 21 30 12 2   2123   3245   2546   0413   0525   0632   00-502.50   1
3 1 20 31 12 2   1826   2935   3535   1416   0234   0436   00-308.75   1
2 1 20 32 10 1   1525   1538   .1833  0420   0530   0622   000008.75   1
2 1 17 23 12 2   1420   1434   1944   0410   0423   0823   -10013.75   1
2 1 18 30 07 1   1622   2728   3132   0710   0625   0525   000010.00   1
2 1 19 19 04 2   1625   3235   3642   1311   1116   1018   -50008.75   1
1 1 25 14 06 2   1926   3138   3729   0516   0525   0426   00-415.00   1
1 1 23 15 08 1   1622   2033   2048   0613   0428   0225   00-110.00   1
6 2 30 58 12 1   1620   3137   3236   1012   1326   1223   000010.00   1
6 2 28 54 05 1   1118   0529   1532   0520   0928   1027   -20008.75   1
5 2 21 45 12 2   2123   3936   4039   1116   0829   1533   00-507.50   1
5 2 20 45 12 2   1423   2142   1855   0215   0035   0336   -20006.25   1
4 2 18 46 12 2   1524   2536   2239   0516   0630   0726   -20007.50   1
4 2 21 49 08 1   1228   1341   0947   0321   0339   0444   00-607.50   1
4 2 18 32 11 2   1924   3228   1842   1208   0822   0211   00-406.25   1
4 2 20 18 12 1   1622   2433   2343   0710   0315   0213   00-210.00   1
4 2 21 36 12 2   1321   2428   2232   0612   0220   0220   -10008.75   1
4 2 21 31 10 1   1218   1633   1930   0221   0531   0135   00-616.25   1
2 2 24 21 12 2   1923   2938   3051   0612   0427   0918   00-210.00   1
2 2 19 23 11 1   1125   2332   2433   0914   0428   0629   00-308.75   1
2 2 28 29 12 2   1628   1636   1153   0115   0025   0027   00-710.00   1
2 2 20 44 12 1   1828   3130   3832   0812   1029   0426   00-705.00   1
2 2 19 38 10 2   1623   3335   2343   0706   0421   0923   00-506.25   1
2 2 18 39 12 1   1922   3333   3144   1511   0720   1916   -40008.75   1
2 2 26 33 07 2   1527   1841   2043   0119   0137   0345   00-210.00   1
1 2 21 36 12 2   2125   3337   3130   0912   0529   0823   -10006.25   1
1 2 22 13 12 1   2018   2627   3325   0908   0413   0710   00-706.25   1
1 2 19 08 12 1   0919   1923   4014   0910   0908   1410   000013.75   1
END INPUT DATA
FINISH
//
```

```
//MOHR JOB (S9007,221,,COSTA),CLASS=C
//* USERID=CORNETT
// EXEC SPSS,VERSION=9A
//FT09F001 DD SYSOUT=(B,MOHR)
RUN NAME        DISS MOHR
VARIABLE LIST   SNUM,SEX,INST,ORDER,AGE,SEQ,EF,LEART,REART,OILI,OIL2,OIL3,
                OIRI,OIR2,OIR3,O2LI,O2L2,O2L3,O2RI,O2R2,O2R3,O3LI,O3L2,
                O3L3,O3RI,O3R2,O3R3,O4LI,O4L2,O4L3,O4RI,O4R2,O4R3,O5LI,
                O5L2,O5L3,O5RI,O5R2,O5R3,O6LI,O6L2,O6L3,O6RI,O6R2,O6R3,
                O7LI,O7L2,O7L3,O7RI,O7R2,O7R3,O8LI,O8L2,O8L3,O8RI,O8R2,
                O8R3,O9LI,O9L2,O9L3,O9RI,O9R2,O9R3,IOLI,IOL2,IOL3,IORI,
                IOR2,IOR3,IILI,IIL2,IIL3,IIRI,IIR2,IIR3,I2LI,I2L2,I2L3,
                I2RI,I2R2,I2R3,I3LI,I3L2,I3L3,I3RI,I3R2,I3R3,I4LI,I4L2,
                I4L3,I4RI,I4R2,I4R3,I5LI,I5L2,I5L3,I5RI,I5R2,I5R3,I6LI,
                I6L2,I6L3,I6RI,I6R2,I6R3
INPUT FORMAT    FIXED(F3.0,1X,3F1.0,F2.0,F1.0,1X,F2.0,1X,F2.0,1X,F2.0,3X,
                     8(6F1.0,1X),/T23,8(6F1.0,1X))
PRINT FORMAT    SNUM,SEX,INST,ORDER,AGE,SEQ(2),EF,LEART,REART TO I6R3(4)
RAW OUTPUT UNIT      9
READ INPUT DATA
001 211192 10 16 33   120003 143020 100002 001002 230100 004123 400123 020103
001                   000321 002001 004123 000120 000123 000102 054123 000123
002 211231 12 20 29   000123 040123 000120 001002 000102 045123 020143 001023
002                   102000 010023 123000 020001 003120 100002 423156 012300
003 211192 12 21 22   100002 030120 230100 010000 001000 103020 134020 023100
003                   003120 002010 000123 120300 000123 000102 234001 030102
004 211221 03 18 36   405123 020143 300120 100234 200134 000000 023104 002010
004                   200143 000123 001203 120003 400123 003012 004123 012403
005 211212 11 22 29   000120 004123 120003 010002 143200 000120 103024 001200
005                   200301 123000 123504 002100 040123 002103 040123 040123
006 211301 04 13 32   000123 020103 000010 013020 100423 100002 000132 002010
006                   200031 000123 003124 100002 002010 000012 013245 010320
007 111201 07 23 22   000123 024103 000010 001032 103002 023001 032104 102000
007                   200301 020013 341002 321000 000021 002001 000012 123000
008 111182 04 21 28   130204 000123 000100 000012 020100 012000 104023 030102
008                   200130 125034 020103 012034 120403 003102 134205 000010
009 111191 11 23 27   200130 123000 300120 000012 400123 000321 021304 100020
009                   123000 000012 123504 021003 120030 001230 000123 123400
010 111272 06 34 32   120003 035241 120430 123004 123400 034120 154023 000132
010                   400123 023014 123504 040123 020103 123004 123456 123400
011 111201 06 20 24   000123 020103 003120 001000 100023 000012 013002 201034
011                   120000 000012 123504 020010 020001 002001 004123 123000
012 111202 08 22 33   120304 040123 010002 000010 024103 003412 103024 020103
012                   003120 024013 234516 000123 210000 030102 123504 000123
013 212251 09 35 25   012034 001203 102340 012300 102034 120034 012304 102000
013                   123000 012034 123405 120000 123450 002010 123456 123045
014 212212 10 27 05   120000 003120 120000 010000 012000 001000 123000 010002
014                   001000 021000 010000 312000 123000 001000 123000 000102
015 212221 10 18 29   004123 010203 003120 020001 120000 010000 040123 023010
015                   023410 010023 040123 100023 001020 004123 000123 001020
016 212192 06 44 34   123405 123405 120345 123000 123456 123456 123045 010203
016                   012345 123045 123405 123045 123450 123004 123456 123450
017 212181 05 34 29   003124 421035 123540 012003 120003 053124 023154 000010
017                   123004 020134 132405 142003 120300 103024 103042 123040
018 212172 12 33 18   120003 023140 120300 123004 123400 012000 130524 012003
018                   100200 120003 123004 010000 001000 023104 143020 023104
019 112222 08 41 02   120000 023100 123000 123000 123000 123000 123000 010000
019                   123000 123000 123000 123000 020010 123000 123000 012000
020 112261 04 13 31   003012 020103 000120 000123 000001 000123 023104 003120
020                   000123 010423 312000 300021 200100 001002 000123 010200
021 112172 07 31 20   123004 023140 120300 120000 123004 100002 143020 012003
021                   102000 123045 100023 014230 000010 012003 123004 000123
022 112171 05 35 14   012003 012304 012300 012030 123000 000000 123405 100020
022                   123004 032100 123504 123000 123040 103020 102000 120000
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023	112212	07	27	16	123000	012030	123004	210000	123004	002001	103020	020100
023					100230	023010	103024	000000	020010	003200	123400	000012
024	112181	12	27	26	002310	010000	100320	002100	010023	023154	023104	102430
024					123000	020143	132054	123000	120003	002103	002134	102030
025	213222	11	22	30	120000	000123	000123	000012	012000	045123	204013	040123
025					000120	002013	453102	020103	020001	123000	456213	030012
026	213171	09	11	42	004123	000123	020100	020100	000123	004123	040123	000123
026					400123	003124	000123	000123	100234	003012	004123	100023
027	213182	12	10	37	300102	002013	000120	000021	000132	000010	100023	000102
027					004132	020001	004123	004123	040123	003102	004123	000123
028	213281	10	15	36	000120	020103	003120	020103	400123	000120	034102	000123
028					400123	000123	345102	001000	450123	203001	000123	000123
029	213182	11	16	22	021000	003012	120000	010000	120030	000010	123040	000001
029					000312	020010	000201	000312	030120	002001	023100	000123
030	213241	10	13	35	003120	000001	000120	020100	003124	045123	004123	002010
030					000001	000123	004123	000123	020001	003102	003124	045123
031	113251	04	13	33	003120	024103	000120	000012	003012	025134	020103	000001
031					003102	000012	054123	000012	000012	003012	004123	002010
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158	232161	08	22	22	100002	023001	123405	003124	420130	003120	000123	102000
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166	132172	08	27	22	120003	201030	123000	123400	003124	123004	401230	010200
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197	222171	03	20	29	000123	010002	000123	001000	120300	123045	012304	001020
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198	222172	04	27	18	120000	103020	210000	123000	012300	000123	123000	000132
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205	223162	12	09	37	100002	000123	004123	000012	003102	004123	003012	000102
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207	223172	04	24	26	100302	104023	034102	123000	000012	000123	104023	000123
207					000123	123000	000102	000123	210000	123004	123004	123000
208	223171	11	18	33	000123	020103	000120	030102	004123	304012	000102	000123
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209	223182	06	19	38	030210	000000	405123	004123	400123	040123	405123	000123
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210	223161	09	24	31	004123	024103	040123	000012	105423	435120	034102	102000
210					320100	003012	234105	120003	000120	000102	015423	002100
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212	123162	05	21	30	312000	004123	003120	000001	003102	004123	103020	023100
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213	123161	06	24	43	450123	040123	340120	003120	400123	450123	045123	300120
213					000123	004123	456123	004123	023100	004123	045123	450123
214	123172	07	22	23	130002	030120	324001	000012	003021	000000	103020	030201
214					123000	000012	200103	020103	120304	002001	123400	030012

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215 123161 08 13 33   000120 024103 000120 000120 020103 003120 000123 003120
215                   100000 000123 004123 300012 003120 003120 004123 120030
216 123172 03 15 32   000102 003124 420103 030012 000120 000000 104023 020103
216                   003120 034012 003124 000120 010000 020103 045123 000123
END INPUT DATA
FINISH
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//* USERID=CORNETT
// EXEC SPSS
//FT09F001 DD SYSOUT=(B,MOHR)
RUN NAME         DISS MOHR
VARIABLE LIST    SNUM,SEX,INST,ORDER,AGE,SEQ,EF,LEART,REART,OILI,OIL2,OIL3,
                 OIRI,OIR2,OIR3,O2LI,O2L2,O2L3,O2RI,O2R2,O2R3,O3LI,O3L2,
                 O3L3,O3RI,O3R2,O3R3,O4LI,O4L2,O4L3,O4RI,O4R2,O4R3,O5LI,
                 O5L2,O5L3,O5RI,O5R2,O5R3,O6LI,O6L2,O6L3,O6RI,O6R2,O6R3,
                 O7LI,O7L2,O7L3,O7RI,O7R2,O7R3,O8LI,O8L2,O8L3,O8RI,O8R2,
                 O8R3,O9LI,O9L2,O9L3,O9RI,O9R2,O9R3,IOLI,IOL2,IOL3,IORI,
                 IOR2,IOR3,IILI,IIL2,IIL3,IIRI,IIR2,IIR3,I2LI,I2L2,I2L3,
                 I2RI,I2R2,I2R3,I3LI,I3L2,I3L3,I3RI,I3R2,I3R3,I4LI,I4L2,
                 I4L3,I4RI,I4R2,I4R3,I5LI,I5L2,I5L3,I5RI,I5R2,I5R3,I6LI,
                 I6L2,I6L3,I6RI,I6R2,I6R3
INPUT FORMAT     FIXED(F3.0,1X,3F1.0,F2.0,F1.0,1X,F2.0,1X,F2.0,1X,F2.0,3X,
                     8(6F1.0,1X),/T23,8(6F1.0,1X))
PRINT FORMAT     SNUM,SEX,INST,ORDER,AGE,SEQ(2),EF,LEART,REART TO I6R3(4)
READ INPUT DATA
  1 211192 10 16 33    120003 143020 100002 001002 230100 004123 400123 020103
                       000321 002001 004123 000120 000123 000102 054123 000123
  2 211231 12 20 29    000123 040123 000120 001002 000102 045123 020143 001023
                       102000 010023 123000 020001 003120 100002 423156 012300
  3 211192 12 21 22    100002 030120 230100 010000 001000 103020 134020 023100
                       003120 002010 000123 120300 000123 000102 234001 030102
  4 211221  3 18 36    405123 020143 300120 100234 200134 000000 023104 002010
                       200143 000123 001203 120003 400123 003012 004123 012403
  5 211212 11 22 29    000120 004123 120003 010002 143200 000120 103024 001200
                       200301 123000 123504 002100 040123 002103 040123 040123
  6 211301  4 13 32    000123 020103 000010 013020 100423 100002 000132 002010
                       200031 000123 003124 100002 002010 000012 013245 010320
  7 111201  7 23 22    000123 024103 000010 001032 103002 023001 032104 102000
                       200301 020013 341002 321000 000021 002001 000012 123000
  8 111182  4 21 28    130204 000123 000100 000012 020100 012000 104023 030102
                       200130 125034 020103 012034 120403 003102 134205 000010
  9 111191 11 23 27    200130 123000 300'20 000012 400123 000321 021304 100020
                       123000 000012 123504 021003 120030 001230 000123 123400
 10 111272  6 34 32    120003 035241 120430 123004 123400 034120 154023 000132
                       400123 023014 123504 040123 020103 123004 123456 123400
 11 111201  6 20 24    000123 020103 003120 001000 100023 000012 013002 201034
                       120000 000012 123504 020010 020001 002001 004123 123000
 12 111202  8 22 33    120304 040123 010002 000010 024103 003412 103024 020103
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 37 231221  7 23 34    000123 020134 300120 023104 100023 205134 024103 102030
                       200103 030012 104023 002013 200130 102003 010234 245130
 38 231172 10 25 21    123004 130020 120003 020013 000010 023001 201000 021300
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 39 231181  8 23 34    004123 020134 020100 002001 030102 004123 301200 000132
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 40 231172 11 31 28    123004 103020 123000 001002 030120 023154 124035 142003
                       000213 012043 132004 020143 304120 020103 123004 040123
 41 231231  6 23 33    400231 020413 040123 021300 103024 504123 020103 143020
                       230104 003124 401302 000100 002310 002001 004132 103020
 42 231182 11 24 31    124003 043125 210030 000120 002100 023010 103024 123004
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 43 131282  5 25 30    120403 030120 124300 000012 032100 000120 405123 020143
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 44 131211  8 24 37    405123 045123 405123 021003 102003 004123 125403 003120
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 45 131192  5 22 17    002100 002010 000010 010020 023100 023100 123000 002001
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 46 131201  7 28 32    504123 001020 230100 010000 300102 045123 546123 102030
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 47 131232  4 14 44    000123 004123 000120 000123 004123 004123 405123 000123
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74	221181	7	20	32	000123	023104	000123	000120	000102	040123	020103	002010
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75	221192	7	24	25	124003	013200	124003	100000	134200	000123	103200	020103
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76	221191	10	30	18	200100	023104	123040	000102	100020	120003	003102	102000
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77	221182	12	40	26	450123	012034	125340	123040	523104	001002	123456	023104
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84	121172	12	32	38	243100	003124	450123	123045	023100	045123	264531	540123
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112	211171	12	26	30	002341	000123	100200	032100	100203	012345	043102	001320
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VITA

Surname:	MOHR	Given Name:	ERICH
Place of Birth:	Tuebingen, Germany	Date of Birth:	7 November 1954

Educational Institutions Attended,
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University of the Pacific, Stockton, Calif., USA	1975-1978
University of Victoria, Victoria, B.C., Canada	1978-1982

Degrees, Diplomas, Etc., Awarded,
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B.Sc.	(Chemistry/Biology)	1977	University of the Pacific
B.A.	(Psychology)	1978	University of the Pacific
M.Sc.	(Psychology)	1980	University of Victoria

Honors and Awards:

Dean's List for Outstanding Academic Achievement, University of the Pacific, Stockton, Calif., USA	1977
Dean's List for Outstanding Academic Achievement, University of the Pacific, Stockton, Calif., USA	1978
Graduation with Honors for Outstanding Academic Achievement, University of the Pacific, Stockton, Calif., USA	1978
Fellowship, University of Victoria, Victoria, B.C.	1978/79
Fellowship, University of Victoria, Victoria, B.C.	1979/80
Fellowship, University of Victoria, Victoria, B.C.	1980/81
Fellowship, University of Victoria, Victoria, B.C.	1981/82

PUBLICATIONS

1. Mohr, E. and Corcoran, M.E. Depletion of Noradrenaline and Amygdaloid Kindling. _Experimental Neurology_, 1981, _72_, 507-511.

2. Mohr, E. and Costa, L. Right versus left performance on dichotic stimulation tasks which increase in difficulty. _Paper presented at the Fourth European Meeting of the International Neuropsychological Society_, Bergen, Norway, June 1981.

3. Mohr, E. and Costa, L. Suggestion and order of recall effects on dichotic stimulation tasks. _Paper presented at the Tenth Annual Meeting of the International Neuropsychological Society_, Pittsburgh, Penn., U.S.A., February 1982.