THE USE OF A VERBAL REACTION TIME TO ASSESS EAR ASYMMETRY IN A MONAURAL LISTENING PARADIGM

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THE USE OF A VERBAL REACTION TIME TO ASSESS EAR ASYMMETRY IN A MONAURAL LISTENING PARADIGM

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PREFACE

This experiment is concerned with the study of cerebral dominance from the view point of an interference model. The primary object is to use reaction time as the dependent variable, and in a situation of monaural auditory stimulation, demonstrate that there is a definite cerebral dominance effect although there is no interference between auditory pathways in such a situation.

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CHAPTER I

INTRODUCTION

Recent studies on dichotic listening (Kimura, 1967; Treisman, 1967; Simon, 1967), have all seemed primarily interested in the use of memory measures, a tapping response or auditory reaction time (RT) as the prime dependent variable in measuring cerebral dominance and interference effects. Broadbent's (1954) famous Split-Span experiment led the way by having Ss try to recall in a specified way or by free recall during the intertrial interval, as many as possible of three digits pairs dichotically presented at different rates. Although Broadbent's (1954) study was concerned basically with the study of switching rates, its form of dichotic presentation of stimulus elements was adopted as one of the basic models for future cerebral asymmetry experiments (Kimura, 1961; Sparks & Geschwind, 1967).

Another widely used model was the shadowing situation developed by Cherry (1953). In this type of task the S shadows either a message or a list of digits or letters presented dichotically. The dependent variable in such a problem could either be a tapping response to key targets or the correctness of the Ss shadowing (Treisman & Geffen,

1967).

Under these dichotic conditions, Ss whose left hemisphere was dominant for speech have consistently shown superior recall for verbal information presented to the right ear (Kimura, 1961). It was postulated that this superior right ear recall is brought about by the more efficient connections which exist between the speech areas in the left temporal lobe and the contralateral ear (Kimura, 1967). In Ss whose right hemisphere was dominant for speech, the recognition of verbal material arriving at the left ear was more efficient (Kimura, 1961).

Moray (1969) pointed out however, that a problem arose in the many different ways used to score errors which would make it difficult to form any concrete relationships concerning cerebral dominance. "There is no doubt that one source of difficulty in comparing experiments lies in the different methods of scoring which are used by different workers." For example, errors might be scored by counting the number of lists totally correct (Broadbent, 1954), or by scoring errors item by item (Moray & Barnett, 1965). One possible way of overcoming this problem was to use a dependent variable that would lend itself more readily to interexperimental comparisons. Kristofferson (1967) and Simon (1967) used reaction time (RT) as a variable which seems to solve this problem by eliminating some of the arbitrary scoring found in other studies, and at the same time increased experimental prevision. Simon (1967)

reported an experiment which was concerned with the effect of ear (s) stimulated, age, handedness and responding member on simple auditory reaction time (RT). Kristofferson's (1967) study was basically concerned with studying switching time relationships in a choice reaction time setting.

The present study extends the use of reaction time (RT) as a dependent variable while also looking at the interference explanation of ear asymmetry. According to the interference theory, the ear asymmetry found in dichotic situations is due to a conflict between messages (Kimura, 1967). Presumably the contralateral pathways are capable of occluding, because of the greater quantity of fibers, the impulses arriving along the overlapping ipsilateral pathways (Bocca, Calearo & Migliavacca, 1955; Sinha, 1959; Kimura, 1967). In the monaural situations however, no ear asymmetry effect is found because there is no competition between the messages arriving over the overlapping auditory pathways. Hence the right ear effect will be demonstratable only in situations where there is a competition or interference between auditory inputs.

The main difficulty in totally accepting the interference theory for noncompetitional situations, however, lies in the fact that it may be explained only as a failure to adequately measure with precision the monaural conditions. For example, by using a different dependent variable such as reaction time (RT), it may be possible to discover that there is a right ear effect in the monaural situation. Simon (1967)

used RT in a cerebral asymmetry experiment and found that there was a difference between ears in the monaural situation but only when the S did not know in advance which ear would be stimulated. In Simon's study, however, the dependent variable, reaction time, depended on the finger manipulation of a recording timer, which means that a whole complex of cerebral and efferent pathways was necessary to translate the auditory stimulus into a finger reflex. It would seem to be possible, although highly conjectural, that a verbal response would be more revealing, since it would not require the translation of an auditory stimulus into a finger reflex. A vocalization would seem to have a shorter if not more direct connection with the verbal left hemisphere. This then was the whole idea behind this experiment--a verbal reaction time was used to look for a possible difference between ears in a monaural situation. Also included was the standard comparison between dichotic situations in which the usual right ear effect was expected.

CHAPTER II

METHODOLOGY

SUBJECTS

The Ss were 24 right-handed and right-eyed (Appendix A) student volunteers at Oklahoma State University. There were 17 females and 7 males between the ages of 17 and 41 (average age 23.4). The use of 24 Ss allowed one S to be placed in each of the 24 possible random orders of the four experimental conditions (4! = 24), while the requirement of right handedness and right eyedness helped assure that all Ss were left hemisphere dominant. Each S was run both in a randomized order of experimental conditions and tape sequences.

All Ss passed, at a predetermined 25 decibel (dB) hearing level (HL), an audiometric screening test in which pure tones of 500, 1,000, and 2,000 hz were presented to each ear separately while the intensity was varied according to the method of limits, until the lowest possible HL was reached. The use of a 25 dB level was arrived at because of its common use in audiometric screening tests.

APPARATUS

The basic equipment was as follows: a Sony 650 stereo tape deck and capacitor microphone, Dynaco 120 stereo amplifier and PAS-3X preamplifier, a Lafayette voice relay with clock timer, Koss Pro-4 headphones, a practice tape consisting of 20 pairs of random letter names, and a dichotic listening tape consisting of 16 pairs of digits in four different random order sequences for a total of 64 digit pairs. The dichotic tape was prepared using a new technique developed by Carr (1970). This new method uses two tape recorders, with the spacing between the record and playback heads equal, thereby allowing Recorder A to trigger the start of Recorder B so that both messages are recorded simultaneously. The greatest error within any digit pair was 52 milleseconds (ms) (Carr, 1970).

The tape consisted of digits 1-4 arranged in random order on channel A and 6-9 on channel B. This selection of digits was arrived at by giving consideration to possible future applications of the tape. Channels A and B were counterbalanced in the experiment by having the playback channels reversed for left and right ears, with 12 of the 24 Ss receiving channel A right ear--channel B left ear and the other 12 Ss receiving channel A left ear--channel B right ear.

PROCEDURE

Two conditions involved monaural digit presentation (Appendix B). In the right-ear-alone (RA) and left-ear-alone

(LA) conditions, the S heard a list of digits presented monaurally, through headphones, either to the right or to the left ear. At the onset of the stimulus item, a clock started and continued until the S made his verbal response. The S had approximately ten seconds to make a vocal naming response, after which the next digit was automatically presented. The dependent variable was the time from the onset of the digit to the onset of the vocalized digit name (reaction time, RT).

Two other conditions were right-ear-dichotic (RD) and left-ear-dichotic (LD). In these situations, the S heard a pair of dichotically presented digits through headphones. The S was required to respond either with the digit presented to the right ear (RD) or the left ear (LD). Again (RT) was recorded.

Upon entering the experimental situation, each S received practice on each of the four within-Ss conditions, using a practice tape composed of 20 random pairs of letter names, until a criterion of 100% correct responses was attained. This helped insure that incorrect responses would be held to a minimum and that the emphasis would remain on the reaction times. A rest pause of about 60 seconds was then given while tapes were changed, after which the testing situation began. Data were collected for each of the four conditions, each condition consisting of 16 trials.

In summary, the over-all design was a 2X2 factorial, with either Alone or Dichotic presentation by Left or Right ear responding.

CHAPTER III

RESULTS

Mean RTs were computed for each of the four conditions. These means were obtained by averaging across the 24 Ss' 16 trials for each condition, and are summarized in Table I. An overall analysis of variance, Table II, revealed a significant Alone-Dichotic effect, $F(1,92) = 36.66$, $p<.01$, and a significant Left-Right ear effect, $F(1,92) = 5.65$, $p<.05$, while a significant interaction effect was not indicated, $F(1,92) = 3.61$, $p>.05$. Even though both the Left-Right and the Alone-Dichotic factors reached significance, it was of prime importance to test the comparison of RA versus LA. A t-test for correlated observations was used and indicated that this comparison did not reach significance, $t(23) = 0.70$, $p>.05$, showing that there is no difference between the means for the right and left ears in the Alone condition. It is also apparent, however, that this lack of significance between levels RA and LA indicates that the significance for the Ear factor is predominately due to the ear difference in the dichotic situation. In fact RD versus LD was significant, $t(23) = 4.46$, $p<.01$.

Performance changes as a function of Trial Blocks are

TABLE I

OVERALL MEAN RT AS A FUNCTION OF PRESENTATION AND EAR STIMULATED MEASURED IN 1/100 SECONDS

	Presentation		
	Alone	Dichotic	
Ear Stimulated	0.53	0.63	Right
	0.55	0.73	Left

TABLE II

OVERALL ANALYSIS OF VARIANCE

Source	df	SS	MS	F	p
Between	3	60.93			
Presentation (Alone-Dich)	1	48.64	48.64	36.66	$<.01$
Ear Stim. (R or L)	1	7.49	7.49	5.65	<05
Pres. X Ear Stimulated	1	4.79	4.79	3.61	≥ 05
Within	92	122.07	1.33		
Total	95	182.99			

shown in Figure 1. RT in 1/100 seconds is the dependent variable, and conditions incurred by S during the various states of the experiment serve as the parameters. The parenthetical entries at the right of each function indicate the mean and standard error of the mean (SE_m) for each condition when averaged over the 16 trials. Each point in the graph corresponds to the mean of 96 observations (24Ss X 4 trials).

Finally, it is also interesting to note that although correctness of response was not stressed to the Ss, errors were held to a minimum with only the LD situation showing any appreciable error percentage, Table III. Out of a possible 384 trials per condition (24Ss X 16 trials), the LD condition exhibited 21 errors due to the vocal naming of the wrong digit (WD) during the dichotic situation, two errors due to the S not answering (NA) in the 10 second intertrial interval and two errors due to a machine malfunction (MM) which caused no RT to be recorded for that trial.

In cases where there was a machine malfunction (MM) or no answer (NA) given, the trials were not retaken but the denominator was changed when the average for that block of 16 trials was calculated. RTs for naming the wrong digit (WD) were used just as if the S had not made a wrong vocal naming, and did not appear to vary from those RTs that went with correct responses. All errors are summarized in Table III along with the percentage of errors for each

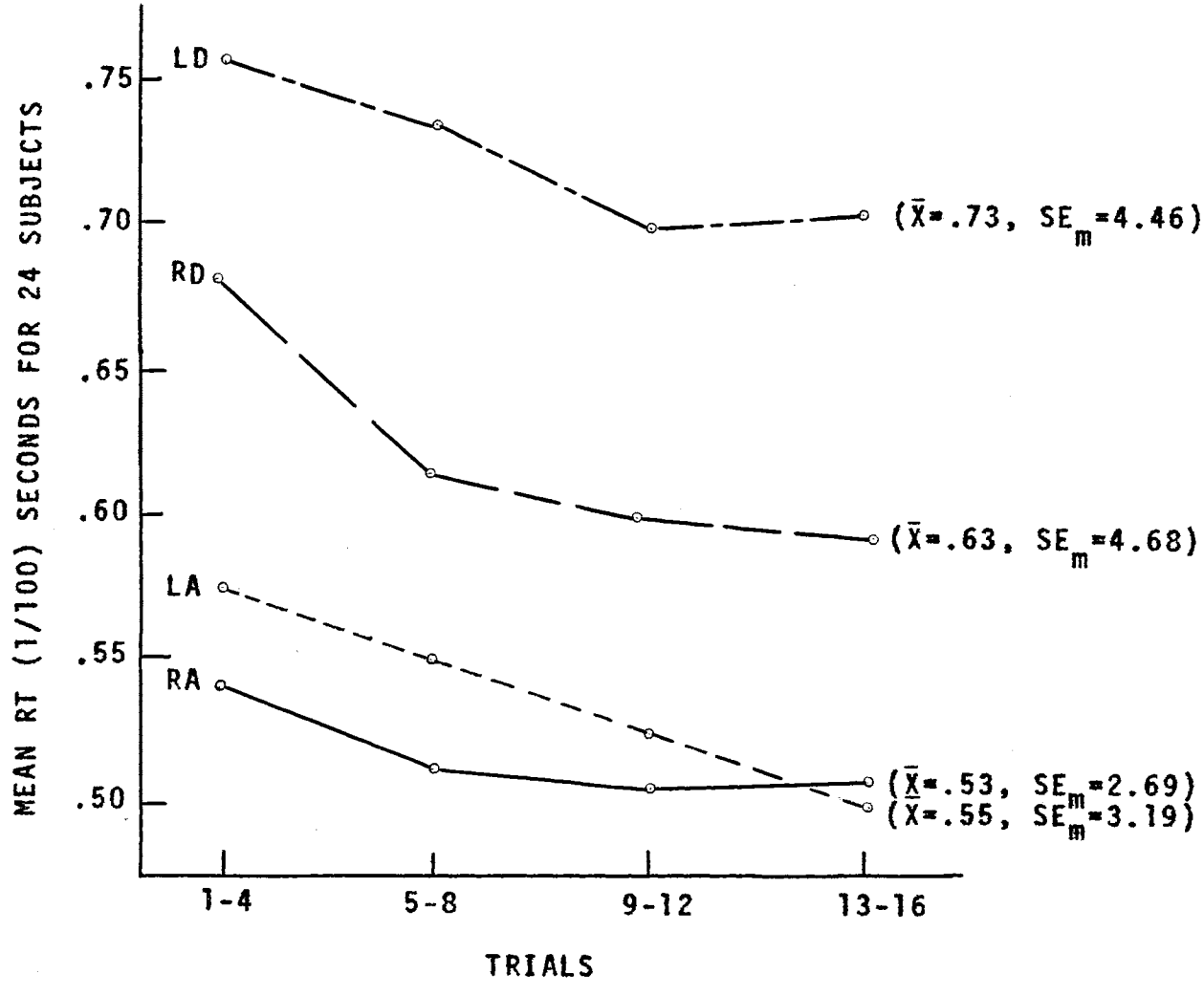

Figure 1. RT as a Function of Practice, with Presentation and Ear Responded to as the Parameters.

TABLE III

TOTAL ERRORS PER CONDITION
AND PERCENTAGE ERRORS
FOR SUBJECTS

	MM[1]	NA	WD	TOTAL	% S ERRORS (NA & WD)
RA	6	--	--	6	--
LA	3	--	2	5	0.52
RD	4	1	4	9	1.31
LD	4	1	20	25	5.52

[1]Note.--MM= Machine Malfunction

NA= No Answer

WD= Wrong Digit

condition for S errors only (NA and WD). If a machine error occured in a condition, the denominator was changed for the condition when calculating S error percentages.

A finding that was curious at first was that Ss twice named the wrong digit in the LA condition. It was discovered later however that these errors occured as a result of a flaw in the dichotic tape which caused a digit pair to become slightly distorted because the first few milliseconds of reproduction were cut off when the tape was originally edited. Although this condition was known about before the testing situation started, it was not deemed significant enough to be justification for the re-editing of the tape. Judging from the number of errors occurring because of this situation, this decision seemed to be justified and these errors were treated as a S naming error (WD) in the calculations. This clipped digit pair accounted for both errors in the LA condition, occurred twice out of a possible five errors in the RD condition, and only five times out of a possible 21 times in the LD condition--it occurred one time in the LD condition causing the S to give no answer (NA) at all.

From the above data, two results are apparent: First, a right ear effect is not found in the alone conditions, a finding that is supported by previous RT studies when the S knows in advance what condition will be presented (Simon, 1967); and secondly, a pronounced difference was found

between ears in the dichotic conditions, indicating the well documented right ear effect holds also for a RT measure.

CHAPTER IV

DISCUSSION

The results of this experiment failed to demonstrate a difference between ears in the monaural situation (RA and LA), while the dichotic situation (LD and RD) exhibited a strong right ear effect. Both results are in complete accord with the previous findings in this field (Kimura, 1964; Treisman, 1967).

Although the hoped for result that there would be a significant difference between the right and left ears in the monaural situation because of the greater efficiency of the crossed pathways was not found, it was not totally unexpected. This study was conducted under the hypothesis that one reason a monaural right-ear effect has not been found has been due to a lack of precision in the measurement of the dependent variable. And while this hypothesis was not upheld in this experiment, current experimental evidence indicates that auditory asymmetry occurs only under conditions of competition between the two auditory pathways and that the nature of the auditory stimulus determines which ear is dominant (Kimura, 1964; Calearo & Antonelli, 1963). A study by Simon (1967) indicated, however, that under conditions of uncertainty as to which ear

would be stimulated, auditory asymmetry may occur under monaural situations. This was explained in terms of set and expectancy. "When uncertain as to which ear will be stimulated, Ss tend to tune in with their right ear and therefore react faster on the trials where the stimulus source corresponds to their expectancy. The importance of observer set and uncertainty has been demonstrated repeatedly in the signal detection literature" (Simon, 1967, p. 54). This line of argument, however, seems to leave the realm of a strict reaction-time study.

It therefore seems possible to conclude that either the ear-asymmetry effect is improbable in monaural conditions, which is suggested by the present experimental literature, or a method for detecting a right-ear effect in a monaural situation has not yet been discovered. Moreover, the answers to such detection problems may lie in the psychophysiological study of the different uses and interactions of the ipsilateral and contralateral auditory pathways.

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APPENDIX A

CRITERIA FOR THE DELINEATION OF RIGHT-HANDED AND RIGHT-EYED SUBJECTS

To determine whether a S was right-or left-handed, each S was asked five questions. These were: (1) Which hand do you write with? (2) If you were to throw an object, which hand would you use? (3) Which hand would you use to hold a toothbrush? (4) Are any of your immediate relatives left-handed? (5) Do you ever do anything in which your dominant hand would be the left? If the responses to questions 1-3 were "right hand", and the answers to questions four and five were "No", then the S was classified as being right handed.

To delineate as to whether a person was right-eyed, the S was required to point, with the arm fully extended and with both eyes open, at a spot on the wall using the index finger. When the S indicated that he was aligned, he was instructed to close or cover his left eye and to designate whether or not his finger had moved off target. If it was reported that his finger did <u>not</u> shift off the target, he was classified as being right-eyed.

APPENDIX B

INSTRUCTIONS GIVEN TO SUBJECTS AFTER THE DELINEATION OF RIGHT HANDEDNESS AND RIGHT EYEDNESS

"In this experiment we are going to be dealing with a dichotic listening situation. Do you have any idea what that is? No? Well perhaps you are familiar with a recent popular recording by the James Gang--Funk 48? I have part of it recorded here and I would like you to listen to it, but pay close attention to the beginning part when they are talking. That beginning situation was close to the type you will be hearing in this experiment, only instead of words we will be using digit pairs presented simultaneously--1/2 of ear pair to each ear. Any questions so far?

Okay. You will hear four sets of 16 digits either in pairs or alone. In one set, called left-ear-alone, you will hear only one digit at a time presented to the left ear, and will be asked to respond by repeating that digit as soon as you hear it and as quickly as possible. In another set, right-ear-alone, you will be asked to respond to only the digit presented to the right ear. In the third and fourth sets, right-ear-dichotic and left-ear-

dichotic, you will hear a digit pair and will be asked to repeat the digit that you heard in either the right or left ear depending on what is asked for. Before each set, I will tell you what I want you to do for that entire set. For instance, if I said right-ear-alone, you would hear only a single digit presented to the right ear and should repeat that digit as soon as you hear it and as fast as you can. Or, if I said left-ear-dichotic, you would hear a pair of digits--one digit presented to each ear--and should respond by repeating as fast as possible the digit heard in the left ear. Any questions?

Now first I will present to you a practice tape consisting of letters and not digits. This will be used to thoroughly familiarize you with the different situations. Now remember that as soon as you hear the letter or letters you are to respond as quickly as possible with the proper letter. Any questions? Okay, the first set will be _____. Ready?

Now that you know what to do we will begin the testing situation. Remember to respond as fast as you can, and remember also that now we will be using the digits instead of the letters."

APPENDIX C

RAW DATA: MEASURED IN 1/100 SECONDS FOR EACH OF THE FOUR CONDITIONS

RIGHT ALONE (Continued)

SUBJECTS

RF	MP	ZW	LP	JC	LC	MB	CC	DB	CF	MM	JV
.57	.71	.68	.70	.62	.60	.60	.46	.62	.36	.51	.41
.46	.42	.69	.61	.52	.45	1.30	.56	.52	.38	.48	.38
.42	.56	.77	.52	.60	.52	.90	.39	.42	.40	.56	.40
.65	.57	.62	.58	.53	.65	.75	.42	.43	.40	.50	.39
.79	.60	1.04	.52	.50	.52	.65	.40	.51	.34	.47	.44
.50	.59	.70	.72	.46	.40	.65	.46	.68	.37	.43	.40
.67	.65	.72	.65	.52	.55	.60	.45	.42	.38	.52	.45
.56	.62	.65	.60	.49	.43	.50	.48	.67	.43	.51	.41
.50	.65	.73	.52	.45	.48	.50	.45	.48	.35	.48	.35
.32	.65	.56	.53	.38	.48	.55	.47	.52	.36	.35	.38
.30	.52	.80	.52	.48	.48	.70	.47	.40	.25	.41	.38
.45	.60	1.10	.58	.33	.47	.58	.43	.40	.37	.37	.42
.32	.55	.71	.62	.38	.45	.64	.47	.58	.38	.24	.42
.47	.50	.52	.54	.51	.55	.45	.48	.52	.47	.42	.48
.56	.52	.57	.63	.45	.40	.47	.45	.55	.36	.37	.47
.51	.60	.60	.65	.44	.46	.56	.50	.58	.32	.45	.31

TRIALS

RIGHT ALONE (Continued)

SUBJECTS

TRIALS	SS	JS	JM	JP	CG	MM	BB	PP	MS	HR	SC	DS
	.73	.78	.62	.60	.42	.46	.80	.51	.53	.54	.61	.47
	.45	.80	.66	.40	.47	.57	.72	.48	.45	.41	.49	.44
	.60	.90	.62	.48	.42	.44	.73	.54	.48	MM	.56	.36
	.72	.75	.60	MM[1]	.51	.49	.60	.53	.65	.52	.39	.47
	.65	.92	.77	.67	.47	.64	.78	.48	.65	.50	.54	.59
	.58	.88	.63	.47	.44	.40	MM	.62	.53	.41	MM	.45
	.56	.72	.55	.38	.62	.40	MM	.51	.44	.45	.52	.42
	.32	.80	.50	.58	.48	.49	MM	.49	.59	.38	.37	.43
	.47	.75	.59	.58	.40	.49	.65	.43	.65	.50	.60	.51
	.51	.90	.58	.47	.43	.42	.70	.52	.62	.36	.46	.41
	.62	1.05	.60	.56	.58	.56	.71	.45	.59	.52	.56	.48
	.44	.75	.50	.48	.56	.47	.63	.55	.58	.42	.43	.39
	.47	.92	.60	.58	.47	.35	.65	.49	.56	.47	.58	.46
	.57	.98	.49	.65	.45	.36	.71	.60	.62	.48	.39	.40
	.33	.81	.57	.51	.40	.48	.49	.60	.61	.50	.47	.49
	.50	.82	.59	.62	.52	.38	.60	.46	.62	.49	.35	.44

RIGHT ALONE

SUBJECTS

RF	MP	ZW	LP	JC	LC	MB	CC	DB	CF	MM	JV	
8.05	9.31	11.46	9.49	7.66	7.89	10.40	7.34	8.30	5.92	7.07	6.49	ΣX
.50	.58	.72	.59	.48	.49	.65	.46	.52	.37	.44	.41	$\bar{X}$

SS	JS	JM	JP	CG	MM	BB	PP	MS	HR	SC	DS	
8.52	13.53	9.47	8.03	7.64	7.40	8.77	8.26	9.17	6.95	7.32	7.21	ΣX
.53	.85	.59	.54	.48	.46	.67	.52	.57	.46	.49	.45	$\bar{X}$

MM[1] = Machine Malfunction

◯[3] = WD = S responded with the wrong digit

NA[2] = No Answer

LEFT ALONE (Continued)

SUBJECTS

TRIALS	RF	MP	ZW	LP	JC	LC	MB	CC	DB	CF	MM	JV
	.69	.80	.68	.70	.58	.56	.55	.74	.78	1.07	.58	.57
	.50	.70	.72	.78	.55	.54	.60	.75	.60	.62	.52	.41
	.41	.75	.74	.65	.62	.60	.60	.65	.52	.54	.53	.55
	.48	.59	.71	.65	.48	.58	.64	.52	.55	.50	.47	.42
	.81	.74	.86	.72	.48	.56	.52	.58	.64	.56	.55	.48
	.51	.57	.75	.62	.52	.79	.70	.55	.58	.49	.52	.36
	.39	1.05	.68	.57	.50	.53	.73	.58	1.35	.78	.55	.44
	.41	.79	.72	.63	.52	.48	.59	.60	.58	.51	.46	.44
	.51	.70	.92	.75	.48	.54	.60	.56	.52	.62	.47	.44
	.76	.56	.75	.64	.54	.52	.63	.60	.52	.44	.39	.52
	.56	.68	.72	.70	.51	.55	.60	.62	.61	.49	.47	.49
	.46	.50	.60	.63	.51	.44	.59	.52	.81	.47	.36	.49
	.55	.68	.73	.70	.50	.59	.60	.58	.66	.46	.52	.47
	.42	.59	.79	.52	.53	.54	.56	.55	.52	.42	.41	.46
	.48	.56	.78	.64	.50	.50	.59	.52	.30	.42	.50	.43
	.58	.60	.89	.61	.72	.38	.77	.57	.52	.43	.38	.57

LEFT ALONE (Continued)

SUBJECTS

TRIALS	SS	JS	JM	JP	CG	MM	BB	PP	MS	HR	SC	DS
	.54	.86	.73	.46	.58	.50	.67	.53	.58	.52	.48	.42
	.52	.69	.58	.65	.43	.46	.56	.60	.47	.43	.48	.33
	.57	.84	.55	.52	.34	.55	.74	.46	.58	.47	.34	.40
	.65	.85	.59	.54	.40	.43	.53	.33	.49	.45	.42	.33
	.62	.75	.64	.55	.30	.38	.57	.38	.73	.48	.38	.28
	.62	.75	.48	.51	.44	.50	.50	.40	.55	.53	.31	.32
	.47	.90	(58)	.52	.43	.48	.58	.36	.60	.46	.33	.28
	.57	.94	.55	.50	.48	.30	.57	.41	.54	.45	.36	.30
	.58	.84	.52	.48	.47	.45	.55	.50	.54	.42	.37	.33
	.55	.77	.44	.52	.39	.38	.51	.42	.61	.46	.35	.34
	.75	.91	.51	.53	.33	.36	.58	.52	.53	.46	.38	.44
	.56	.83	.49	.48	.28	.44	.55	.45	.65	.44	.27	.33
	.62	.84	.47	MM	.32	.50	.53	.35	.57	.36	.46	MM
	.47	.72	.60	.55	.40	.45	MM	.30	.55	.48	.25	.44
	.59	.74	.57	.55	.42	.42	.62	.48	.50	.39	.37	.40
	.57	.92	.51	.58	.40	.46	.54	.42	.54	.35	.26	.40

LEFT ALONE

SUBJECTS

RF	MP	ZW	LP	JC	LC	MB	CC	DB	CF	MM	JV	
8.52	10.86	12.04	10.51	8.54	8.70	9.87	9.49	9.95	8.82	7.68	7.54	ΣX
.53	.68	.75	.66	.53	.54	.62	.59	.62	.55	.48	.47	$\bar{X}$

SS	JS	JM	JP	CG	MM	BB	PP	MS	HR	SC	DS	
9.25	13.15	8.81	7.94	6.41	7.06	8.60	6.91	9.03	7.15	5.81	5.34	ΣX
.58	.82	.55	.52	.40	.44	.57	.43	.56	.45	.36	.36	$\bar{X}$

[3]= WD = S responded with the wrong digit

RIGHT DICHOTIC (Continued)

SUBJECTS

TRIALS	RF	MP	ZW	LP	JC	LC	MB	CC	DB	CF	MM	JV
	1.00	.85	.95	.75	.85	.52	.59	.54	.75	.58	.70	.89
	.82	.85	.75	.75	.90	.47	.63	.67	.50	.54	.77	.60
	.70	.78	.88	.94	.64	.42	.50	.55	.79	.47	.76	.44
	.49	.70	.82	.92	.50	.48	.58	.60	.82	.42	.76	.45
	.60	.60	.90	.92	.61	.50	.71	.49	.62	.31	.72	.32
	.72	.58	.68	.64	.60	.46	.52	.48	.64	.41	.57	.43
	.47	.58	.76	.85	.44	.49	.58	.58	.62	.40	.82	.50
	.56	.50	.80	.71	.46	.39	.75	.57	.61	.40	.66	.53
	.59	.55	1.00	.73	.50	.48	.65	.64	.92	.44	.54	.58
	.45	.52	.95	.68	.44	.52	.54	.62	.70	.38	.58	.52
	.55	.61	.98	.68	.57	.33	.61	.60	.80	.35	.68	.40
	.84	.53	.78	.64	.45	.48	.58	.48	.50	.39	.49	.50
	.57	.60	.98	.81	.48	.47	.55	.48	.67	.39	.73	.55
	.37	.50	.94	.70	.44	.39	.58	.50	.62	.44	.61	.53
	.72	.55	.89	.63	.58	.23	1.05	.84	.82	.36	.55	.54
	.38	.53	(.85)	.70	.60	.44	.60	.57	.65	(.42)	.68	.45

RIGHT DICHOTIC (Continued)

SUBJECTS

TRIALS	SS	JS	JM	JP	CG	MM	BB	PP	MS	HR	SC	DS
	.87	1.01	.82	1.02	.68	.75	.82	.78	.86	.56	.44	.64
	.80	.90	.95	.77	.55	.78	.57	.41	.70	.40	.64	.47
	.65	.92	.72	.78	.60	.94	.85	.55	.63	.64	.38	.58
	.67	.89	.78	.71	.58	.67	.68	.43	.97	.64	.62	.49
	.57	.95	MM	.62	.64	.64	.66	.75	1.12	.64	.50	.56
	.70	1.42	MM	.62	.65	.56	.63	.39	.74	NA[2]	.39	MM
	.82	.94	.68	.94	.58	1.36	.73	.45	.65	.58	.33	.58
	.55	.88	.64	.71	.50	.65	.63	.48	.69	.54	.47	.38
	.57	.82	.75	.61	.61	.86	.68	.43	.81	.71	.40	.56
	.55	.90	.60	.65	.51	.58	.62	.60	.76	.55	.51	.41
	.55	.90	.72	.77	.53	.59	.68	.57	.79	.92	.49	.36
	.58	.86	.70	.42	.61	.59	.57	.52	.65	.55	.49	.53
	.68	.99	.68	.62	.45	.49	.63	.50	.81	.56	.38	.54
	.40	.78	.62	.68	.73	.43	MM	.50	.62	.58	.33	.58
	.59	.88	.65	.49	.61	.49	.76	.35	.78	.96	.31	.47
	.77	.81	.72	.70	.63	.47	.74	.42	.80	.78	.56	.45

RIGHT DICHOTIC

SUBJECTS

RF	MP	ZW	LP	JC	LC	MB	CC	DB	CF	MM	JV	
9.83	9.83	13.91	12.05	9.06	7.07	10.02	9.21	11.03	6.70	10.62	8.23	ΣX
.61	.61	.87	.75	.57	.44	.63	.58	.69	.42	.66	.51	$\bar{X}$

SS	JS	JM	JP	CG	MM	BB	PP	MS	HR	SC	DS	
10.32	14.85	10.03	11.11	9.46	10.85	10.25	8.13	12.38	9.61	7.24	7.60	ΣX
.65	.93	.72	.69	.59	.68	.68	.51	.77	.64	.45	.51	$\bar{X}$

NA^2= No Answer

LEFT DICHOTIC (Continued)

SUBJECTS

TRIALS	RF	MP	ZW	LP	JC	LC	MB	CC	DB	CF	MM	JV
	.88	1.02	1.25	1.30	.60	.52	.82	.65	.78	.79	.44	.61
	.90	.95	1.00	.85	.60	.50	.93	1.45	.98	.57	.57	.78
	.67	.84	.88	.85	.59	.38	.80	.72	.58	.55	.48	.60
	.83	.60	.84	.77	.70	.54	.72	.63	.71	.58	.52	.72
	.60	.60	.90	.80	.85	.53	.65	.67	.62	.65	.56	1.27
	.66	.95	.96	.75	MM	.44	.42	1.10	.42	.60	.51	1.10
	.74	.75	.82	.77	.75	.59	.96	.72	1.62	.53	.48	.51
	.64	.68	.79	.85	.77	.62	.80	.60	.71	.58	.58	1.00
	.69	.60	.89	.79	.75	.66	.75	.63	.63	.53	.73	.75
	.57	.70	.80	.78	NA	.59	1.23	.57	1.10	.60	.68	.74
	.77	.65	.88	.85	.70	.82	.70	.68	.60	.49	.60	.68
	.45	.60	.73	.72	.52	.58	.76	.60	.65	.66	.50	.54
	.66	.95	.91	.78	.67	.53	.58	.54	.73	.58	.53	.60
	1.02	.72	.78	.75	.75	.57	.77	.62	.59	.54	.46	.55
	.80	.69	.86	.98	.62	.75	.75	.54	.58	.66	.58	.81
	1.02	.56	.74	.78	.65	.52	.60	.58	.58	.66	.59	.59

LEFT DICHOTIC (Continued)

SUBJECTS

TRIALS	SS	JS	JM	JP	CG	MM	BB	PP	MS	HR	SC	DS
	.70	.70	.68	1.02	.66	MM	.85	.85	1.00	.85	1.01	.49
	.60	.71	.73	.95	.68	1.02	.76	.69	.60	1.42	.84	.50
	.84	.93	.90	1.01	.68	.58	.63	.73	.96	.82	.82	.42
	.69	.70	.98	.96	.70	.60	.73	.65	.78	.75	.88	.58
	.80	.87	1.05	1.65	.64	.92	.66	.73	.89	.79	.71	.75
	.98	.68	.84	.91	.68	MM	.63	.56	.70	.66	.68	.43
	.73	.78	1.01	.94	.79	.53	.62	.65	.75	.67	.64	.46
	.62	.73	.83	1.03	.68	.87	.58	.71	.79	.74	.62	.46
	.86	.87	.68	.92	.84	.71	.63	.69	.86	.63	.65	.63
	.63	.78	.78	1.49	.61	.73	.75	.60	.70	.77	.70	.48
	.68	.86	.79	.95	.61	.50	.69	.59	.79	.62	.68	.45
	1.37	.73	.52	.82	.60	.68	.63	.59	.65	.52	.62	.46
	.72	.95	.75	.80	.70	.88	.64	.63	.70	.78	.74	.44
	.60	.87	.80	1.64	.53	.56	.67	.52	.72	.67	.65	.53
	.65	.87	.72	.92	.67	.82	.85	.60	.75	.86	.94	.55
	.92	.73	1.02	.79	.70	1.36	MM	.78	.65	.65	.94	.46

LEFT DICHOTIC

SUBJECTS

RF	MP	ZW	LP	JC	LC	MB	CC	DB	CF	MM	JV	
11.90	11.86	14.03	13.37	9.52	9.14	12.24	11.30	11.88	9.57	8.81	11.85	ΣX
.75	.75	.88	.84	.68	.57	.77	.71	.74	.60	.55	.74	$\bar{X}$

SS	JS	JM	JP	CG	MM	BB	PP	MS	HR	SC	DS	
12.39	12.76	13.08	16.80	10.77	10.76	10.32	10.57	12.29	12.20	12.12	8.09	ΣX
.77	.80	.82	1.05	.67	.77	.69	.66	.77	.76	.76	.51	$\bar{X}$

VITA

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