1984

A Signal Detection Theory Analysis of Several Psychophysical Procedures Used in Lateralization Tasks

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20

A SIGNAL DETECTION THEORY ANALYSIS OF SEVERAL PSYCHOPHYSICAL PROCEDURES USED IN LATERALIZATION TASKS

by

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A Thesis Submitted to the Faculty of the Department of Psychology of Loyola University of Chicago in Fulfillment of the Master's Thesis Requirement in Psychology

December

1983

ACKNOWLEDGMENTS

The following thesis is the product of much collaboration, and I would like to express my gratitude, and acknowledge those people who greatly contributed to its completion. First, I would like to thank my committee, Richard R. Fay, Ph.D., and Raymond H. Dye, Jr., Ph.D., for their continued help and suggestions, both in data collection and analysis. I have learned greatly from the experience. I would also like to thank William A. Yost, Ph.D., for his instruction in the area of TSD, and for providing the inspiration that led to this project.

I would also like to express my thanks to all the subjects that participated in these experiments.

VITA

The author, Joseph Norbert Baumann, is the son of Norbert John Baumann and Clare (Brennan) Baumann. He was born February 16, 1961, in Covington, Kentucky.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The Theory of Signal Detectability (TSD) has been used to analyze sensitivity measures for many psychoacoustic tasks, most notably masked signal detection and discrimination. Use of the criterion-free sensitivity measure, d', allows one to compare performance across stimulus-paradigms in order to determine whether different paradigms are analogous. Furthermore, application of TSD can provide insight into the nature of differences between paradigms when they are found. For instance, TSD accurately predicts signal detectability in multiple-interval tasks from that obtained in single-interval tasks (Swets, 1959), and performance in "matching" tasks from detection and discrimination data (Sorkin, 1962). On the other hand, not all differences between paradigms can be accounted for by TSD. Creelman and MacMillan (1979), in a comparison of nine psychophysical procedures, found that models from Signal Detection Theory accounted for differences in frequency discriminability across procedures, but not differences in the effects of monaural phase.

One notable area lacking the rigorous application of TSD is that of lateralization of a sound image. Localization of the source of sound is performed using at least two cues, interaural differences of time (IDTs), and interaural differences of intensity (IDIs). Often in psychoacoustic tasks, stimuli are presented to subjects via headphones, and the term "lateralization" is applied to the task; subjects discriminate between stimuli on the basis of the lateral positions of the intracranial images. Presenting the stimulus via headphones allows for the independent control of interaural time and intensity differences, so that discrimination based upon either cue alone can be measured.

Several varieties of lateralization paradigms are currently used as though they were interchangeable, despite the fact that the few data that exist in the literature suggest that differences between lateralization paradigms cannot be easily accounted for by TSD. Zwislocki and Feldman (1956) noted that observers were more sensitive to interaural phase in paradigms using fixed standards. These fixed standards were intervals containing diotic stimuli to mark the intracranial midline. Theoretically, they convey no information to the observer since they are fixed across trials. Employing pulsed tones, they found that sensitivity to interaural phase was greatest at medium sensation levels (70 dB SL), and that the just noticable difference (jnd) rapidly increased with frequency. Zwislocki and Feldman noted that "the jnd seems to be particularly dependent on the psychophysical method used (to measure sensitivity)."

Yost, Turner and Bergert (1974) measured psychometric functions, utilizing four different lateralization tasks. Procedures included the following: 1) Yes-No (classical single interval); 2) Left-Right (a single interval task); 3) Same-Different; 4) 2-Alternative Forced Choice (2AFC). The stimulus was a 250-Hz tone presented at 70 dB SPL. Two interaural delays were presented; 30 μsec (2.7°) and 85 μsec (7.7°). Results showed that TSD could not account for differences in sensitivity under the various paradigms if lateral position served as the cue for discrimination throughout the study. They suggested that observers use position as a cue in single interval tasks and motion as a cue in two-interval tasks.

One of the beauties of the Theory of Signal Detectability, as pointed out by Green and Swets (1966), is its utility in interpreting changes in experimental conditions as changes in the information provided during a trial. In the current set of experiments, variations in the experimental paradigm can affect the information presented to the observer in at least two ways. One of the changes that might be brought about by moving from single- to multiple-interval lateralization tasks is a change in the decision variable. Yost et al. (1974) argued that the addition of observation intervals converts the observer's judgement from one based on lateral position to one based on lateral motion. For instance, the same-different (SD) task can be considered in two ways; first, as a task in which the observer detects a lateral displacement of the intracranial image during the second interval (with the first interval serving only to mark the midline); second, as a task in which the observer detects the presence of lateral motion. In the latter case, half of the trials present a movement of the lateral image to the left (center-left) and the other half contain no movement (center-center). Assuming that lateral position and lateral motion are different decision variables, with subjects able to use one <u>or</u> the other, sensitivity to one may be superior to the other. As such, a change in the paradigm might provide a greater amount of information by changing the decision variable to one which subjects' sensitivity is more acute (i.e., lateral motion).

Presenting additional intervals might increase information by providing multiple observations upon which decisions are made. The integration model of detection theory assumes that information from individual observations is combined before a decision is made (Green and Swets, 1966). The observations are assumed to be independent, with no loss of information occuring with their combination. If lateral position is the cue, the most elemental task is the single interval, since it provides a single observation (lateral position off midline or not) of the decision variable. The two-alternative forced choice task can be considered as a two-observation variant of the single-interval task, with each of the two intervals providing as much information as is present in each trial of the SI. Similarly, if lateral motion is the cue, then the most elemental task of which multiple observations can be presented is the same-different task (lateral movement or not).

Using TSD, one normally computes d' in a manner that corrects for the number of observation intervals. As such, TSD predicts that the d's measured with different psychophysical procedures should be the same, as long as the decision variable is constant. However, for the purpose of comparing lateralization paradigms, we chose to use an uncorrected version of d', based upon our belief that some of the differences between lateralization paradigms that one finds might be due to changes in the decision variable. For a given decision variable, uncorrected d' should increase as a function of the square root of the number of observation intervals. Note that performance (d') can not be predicted across paradigms when the decision variable changes.

The present study was undertaken to examine possible differences in sensitivity in lateralization tasks when the measures are taken with various, commonly-used, psychophysical procedures: Single Interval (SI), Same-Different (SD), and 2-Alternative Forced Choice (2AFC). In addition two varieties of four-interval tasks were examined: 4-observation 2AFC (4-2AFC) and 4-observation Same-Different (4SD).

METHOD I

Figure 1 shows the possible trials for each condition. Note here that an O represents a diotic stimulus, and a P represents a dichotic stimulus, that is, one that is interaurally phase-shifted. Position information is carried in both intervals in the 2AFC task, intervals 2 and 4 in the 4-2AFC task, the second interval in the same-different condition, and interval 3 in the 4SD task. All other intervals in the multiple-interval paradigms are midline markers and provide no additional position information to the subject. The amount of position information in these paradigms will be compared to the amount contained in the single interval (SI) task, which is treated here as the most basic of the tasks requiring position judgements.

The time between successive intervals was 250 msec, except during 4-observation tasks, in which the time between intervals 2 and 3 was 500 msec. This was done to segregate the first two intervals from the last two.

Subjects were seated in an IAC sound attenuating-chamber for each trial session, which consisted of 100 trials. Stimuli were presented through TDH-49 earphones suspended in Auraldomes. Practice trials were given before each block was started, during which subjects adjusted the headphones so that intracranial images resulting from diotic presentation sounded centered. A trial consisted of one or more signal-intervals, after which the subject responded by pressing one of two response buttons. After a reponse was made, the correct response was indicated via feedback lights. One second after the termination of feedback, the next trial was presented.

Signals were generated with a DEC PDP-11/34 digital computer and digital-to-analog converters whose output rates were 10 kHz per channel. The stimulus to each channel was lowpass filtered at 5000 Hz (Krohn-Hite model 3343R) and then attenuated. The stimulus used throughout the paradigms was a 500-Hz tone presented at 70 dB SPL. The phase delays tested were 12, 8, and 4 degrees, corresponding to an interaural delay of 66.6, 44.4, and 22.2 μsec respectively. Note that this was an ongoing phase delay, as the signals were gated on at both ears simultaneously. The duration of the tone was 250 msec, with a 10 msec rise/decay time.

The subjects who participated in this experiment were undergraduates at Loyola University of Chicago, and were paid an hourly wage for their participation. Subjects had no known hearing loss, and had not previously participated in psychoacoustic experiments. Subjects received at least 1000 trials in each of the paradigms before data were recorded.

FIGURE 1. CONDITIONS AND POSSIBLE STIMULUS CONFIGURATIONS

SINGLE INTERVAL	O or P
2AFC	O-P or P-O
4 OBSERVATION 2AFC	O-O O-P or O-P O-O
SAME DIFFERENT (SD)	O-O or O-P
4 OBSERVATION SD	O-O O-O or O-O P-O

RESULTS I

Psychometric functions for two subjects, JP and KC, are seen in figures 2 and 3, respectively, where uncorrected d' is plotted as a function of the interaural phase shift. Each point represents data from 400 trials per subject.

Two problems impede making general conclusions based upon the data from these two subjects. First, the intersubject differences are quite large, as has often been reported for lateralization (Hafter and Carrier, 1972; McFadden, Jeffress, and Russell, 1973). Secondly, one of the subjects, JP, performed so well with phase shifts of 12° that approximately 97-100% correct was reached for all of the paradigms except Single Interval. Since small changes in percent correct are accompanied by wide swings in d' for percentages in this range, the determination of differences between the paradigms is impossible given that each point is based upon only 400 trials. To make matters worse, the data from subject JP for a phase shift of 4° converge for all paradigms except the 4-2AFC. Since the only data from JP that reliably differentiate between paradigms are those at

8^{o}, we will tend to emphasize these data when drawing general conclusions. The psychometric functions for subject KC (figure 3) are somewhat more orderly, with the relative position of a function for a given paradigm remaining roughly constant over the range of interaural phase delays that were tested.

In general, the psychometric functions from the four-interval paradigms are elevated relative to the others, with best performance obtained with the 4-2AFC, and worst performance obtained with the SI. In order to facilitate a comparison of the paradigms, figure 4 presents psychometric functions based on data averaged across these two subjects. The averaged data show performance in the 4-SD task to be second best, with the psychometric functions from the 2AFC and SD falling between those from the 4-SD and the SI tasks.

FIGURE 2. d' VERSUS INTERAURAL PHASE : SUBJECT JP

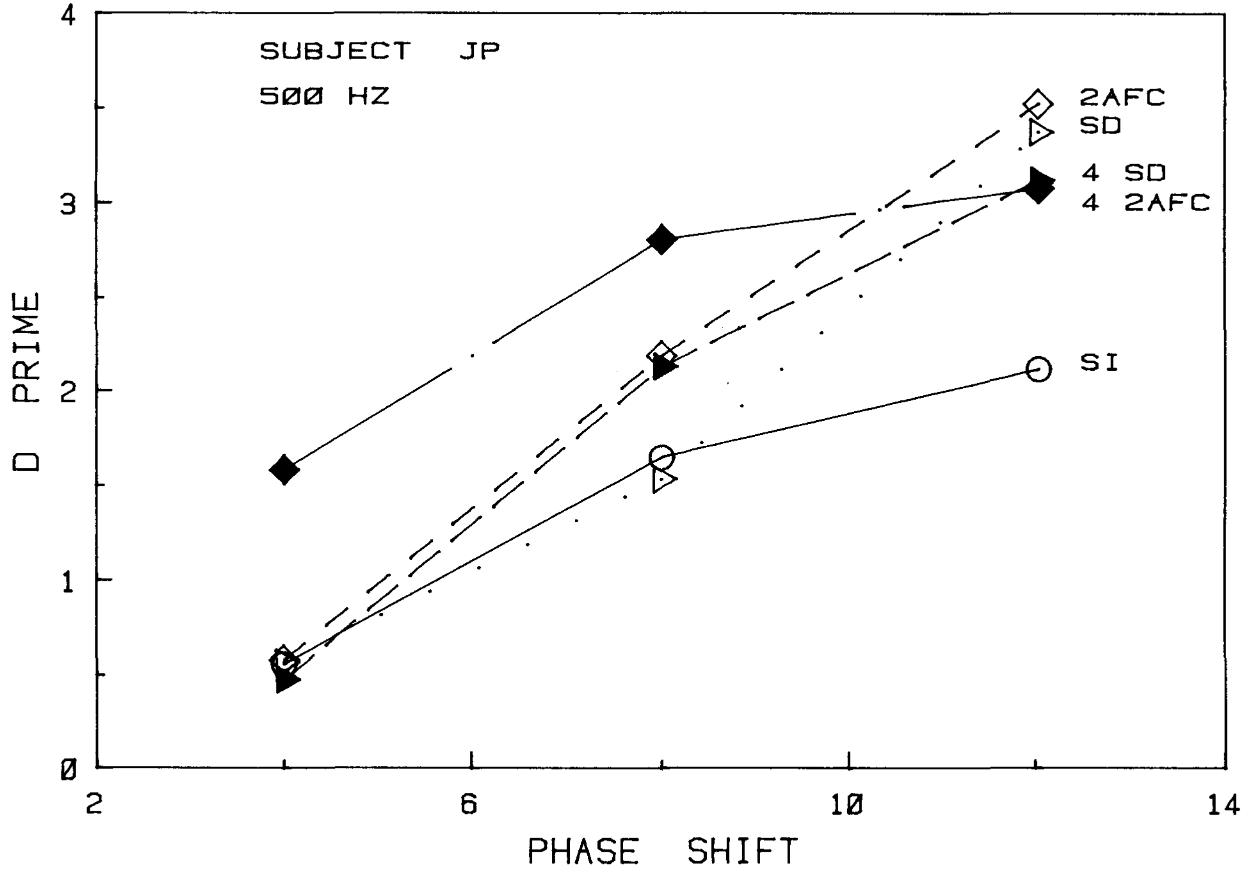


FIGURE 3. d' VERSUS INTERAURAL PHASE : SUBJECT KC

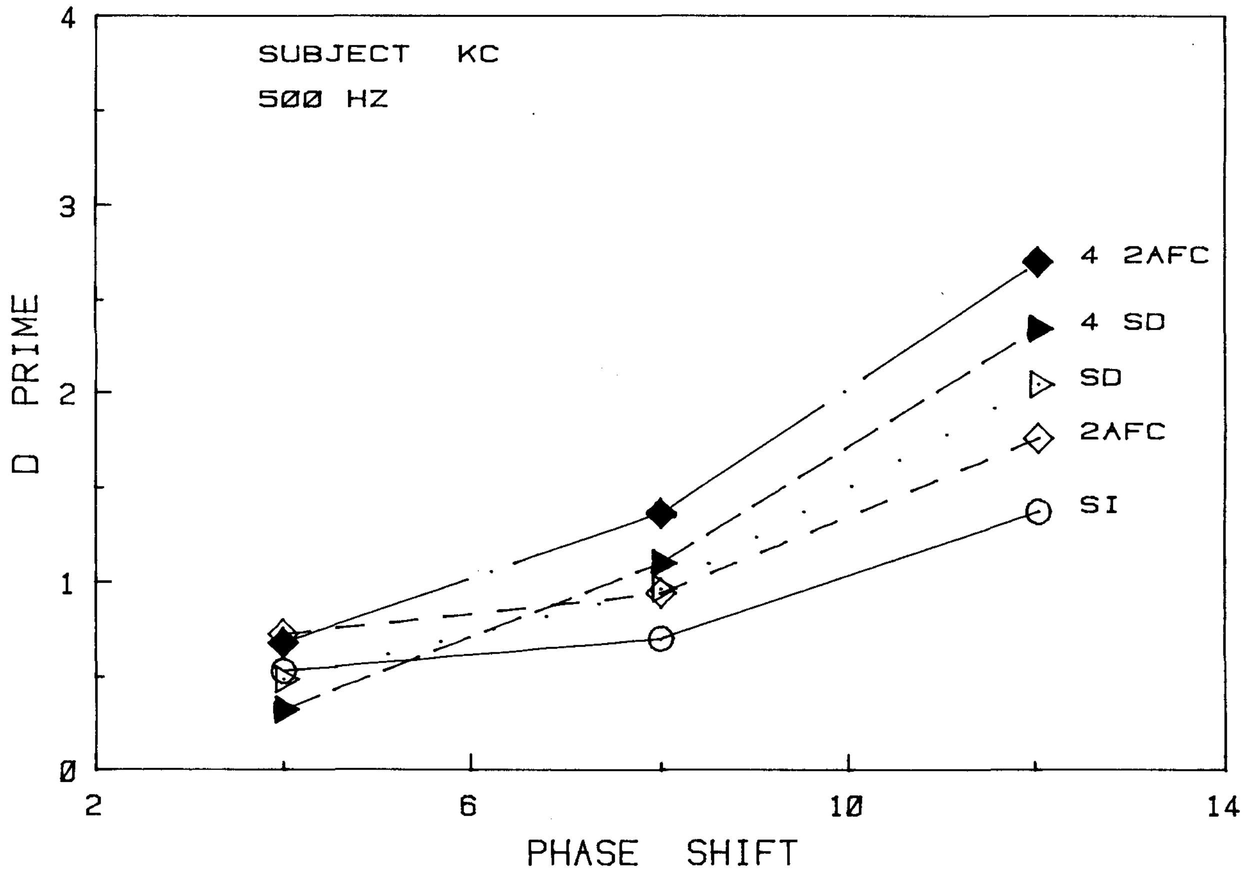
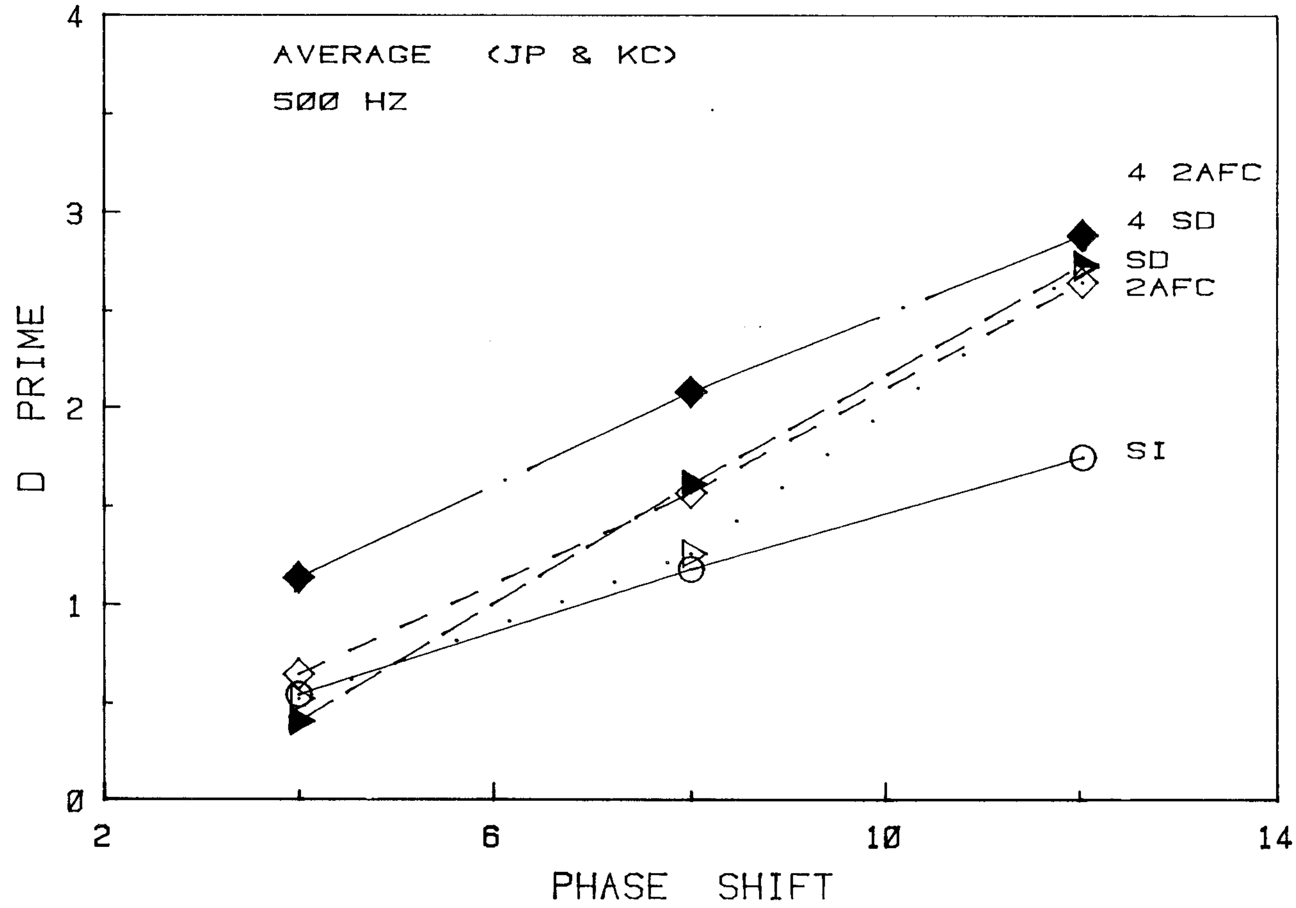


FIGURE 4. d' VERSUS INTERAURAL PHASE : AVERAGE



DISCUSSION I

Ratios of d' were formed and compared to values predicted by the Theory of Signal Detectability. Table 1 summarizes the predicted ratios of d' for the two possible decision variables. Table 2 shows the d' ratios that were obtained.

When considering position as the cue, the ratios are referenced to the SI condition. If the same cue is used in the SI and the 2AFC task, TSD predicts a 2AFC/SI ratio of $\sqrt{2}$ (1.414). In this study, this ratio, averaged across subjects and phase delays, was 1.34. Considering subject variability, this value is not arguably different than that predicted by TSD. With respect to the cue of position, the 4-2AFC task reduces to a 2AFC task. Relevant position information is carried only in the second and fourth intervals, with additional midline-markers provided in the first and third intervals. The theory predicts a d' ratio of 1.414, but the obtained ratio is much greater, 1.87. It appears that the 4-2AFC task increases the information beyond that predicted by the theory, if we assume lateral position to be the cue.

TABLE 1. PREDICTED d' RATIOS FOR POSSIBLE CUES

Position Cue

Task	RATIO Reference - SI
SD	1.0
4SD	1.0
2AFC	1.414
4-2AFC	1.414

Motion Cue

Task	RATIO Reference - SD
4SD	1.0
2AFC	---
4-2AFC	1.414

TABLE 2. RATIOS OF d'
Average across subjects JP and KC

RATIO	12	8	4	AVG.
2AFC / SI	1.47	1.34	1.20	1.34
4-2AFC / SI	1.70	1.82	2.07	1.87
SD / SI	1.54	1.16	0.97	1.22
4SD / SI	1.59	1.43	0.73	1.25

If the cue used is lateral position, TSD predicts that the ratio of the d' measured in the SD condition to that measured in the SI condition should be 1.0, since the position information is the same. The first interval in the SD task is a center-marker (standard). As is shown in the table, the obtained ratio is 1.22, which is greater than the value predicted by the theory. The same argument can be made for d'_{4SD}-to-d'_{SI}. The position information is the same: the first, second, and fourth intervals of the 4SD task are markers. Again, the obtained ratio of 1.25 differs from the predicted ratio of 1.0, indicating that more information is provided in the SD task than is predicted by TSD on the basis of the number of observation intervals.

There are two factors that could account for the superior performance measured in the SD and 4SD paradigms. The first is that the fixed standard provides a memory aid, reducing subjects' uncertainty about what the information-bearing interval should be compared against, as Sorkin (1962) and Jesteadt and Sims (1975) have suggested. The second is that a different cue is introduced during multiple interval lateralization tasks, one to which subjects are more sensitive. Yost et al. (1974) have suggested that multiple-interval lateralization tasks introduce motion as a cue, and that observers are more sensitive to motion than to lateral position.

We proceeded to analyze the data in terms of the motion cue. Note that the d' ratios of SD/SI and 4SD/SI show that once one adds a position marker, additional markers do not improve performance. The present data do not allow us to determine uncertainty differences (differences in the slopes of the psychometric functions), and thus the data were looked at in terms of possible motion cues.

If one thinks of motion as the cue in multiple-interval tasks, then the simplest motion-detection paradigm is the same-different (SD) task in which subjects must distinguish lateral movement to the left (center-left) from no movement (center-center). In classical terms, the SD task becomes a single-interval, movement-detection task, with a pair of intervals generating the relevant cue. Since other paradigms can be thought of as multiple-interval versions of the SD task, d' ratios are referenced to the same-different task when considering intracranial motion as the cue. Table 3 shows these ratios of d'.

Looking at the ratio of the 4-2AFC to SD conditions in terms of the motion cue, TSD predicts a ratio of $\sqrt{2}$ since the 4-2AFC provides both a movement and non-movement interval. The obtained ratio of 1.62 is greater than that predicted from TSD.

TABLE 3. RATIOS OF d'
Averaged across subjects JP and KC

RATIO	12	8	4	AVG
4-2AFC / SD	1.12	1.61	2.12	1.62
4SD / SD	1.04	1.26	0.75	1.02

The theory predicts that d'_{4SD}/d'_{SD} would equal 1.0, and the obtained ratio is, indeed, quite close. Note that TSD predicts the same ratio of d's for these two paradigms regardless of whether lateral position or lateral motion is the cue. However, ratios of 1.0 were predicted for the SD/SI and 4SD/SI when position was assumed to be the cue, yet both were substantially greater. The agreement between the measured ratios and those predicted by TSD is better when multiple-interval tasks like 4-SD and 4-2AFC are viewed as variations of a movement-detection task rather than position-discrimination task.

Note that the last ratio which could be considered, d'_{2AFC}/d'_{SD}, is not amenable to analysis in terms of simple motion, since subjects have to discriminate on the basis of the direction of motion (left-center versus center-left). While discrimination data can be predicted from detection data (e.g., the Theory of Recognition; Tanner, 1960), the absence of prior knowledge of the correlation of the two possible signals in the 2-AFC task makes it difficult to assess the nature of the underlying discrimination variable from d'_{2AFC}/d'_{SD}.

TABLE 4: STANDARD DEVIATION ABOUT d'

Subject	SI	2AFC	4-2AFC	SD	4SD
JP	0.72	1.34	1.36	1.61	1.33
KC	0.84	0.65	0.97	0.74	0.72
AVG	0.78	0.99	1.17	1.17	1.03

TABLE 5: LOG BETA

Subject	SI	2AFC	4-2AFC	SD	4SD
JP	-0.031	0.123	0.009	0.052	0.049
KC	-0.043	0.054	0.089	-0.052	-0.019
AVG	-0.037	0.088	0.049	0	0.015

Table 4 shows the averaged standard deviation about d', across conditions for both subjects, as measured in 50-trial blocks. In general, the deviation was greatest for the phase shift of 12^{o} and lowest for the phase shift of 4^{o}. This is probably due as much to the conversion from P(C) to d' as to any actual variability on the part of the subject. As is shown in the table, there is little difference in the standard deviation of d' across conditions. This was true for all three phases at which data were gathered.

Table 5 shows the averaged log beta for both subjects. Log beta is a measure of the response bias of a subject: a tendency to respond in one way as opposed to another. As with the standard deviations of d', there is little or no difference in criterion across paradigms. Likewise, there did not appear to be systematic shifts in criterion with the value of the phase shift.

The results obtained in this experiment suggest that sensitivity measures obtained in lateralization tasks differ across paradigms. Further, these differences can not be accounted for by TSD if one considers the cue to be position for both single- and multiple-interval paradigms. This was seen by the failure to predict performance in the SD, 4-SD, and 4-2AFC tasks from that obtained in the SI task. The theory is more accurate in predicting the results of multiple-interval paradigms if the underlying cue is considered to be lateral motion. This was shown in the comparison of d's from 4-2AFC and 4-SD with those from SD.

Earlier it was stated that at least one of the factors that might contribute to the superiority of performance in multiple-interval paradigms was the presence of center-markers. It was argued that these markers might serve to reduce uncertainty by providing a memory aid for the standard against which information-bearing intervals are to be compared. One way of demonstrating a decrease in uncertainty is by showing that the psychometric functions grow shallower (Green, 1960) when center-markers are provided. Unfortunately, the present data do not allow accurate determination of the slopes since each psychometric function consists only of three points. This problem is compounded by the fact that most of the functions measured for subject JP have a high point in the range of 97-100% correct and a low point near chance performance. As a result, we were unable to assess the hypothesis that the amount of uncertainty varied across conditions. To this end, a second experiment was undertaken in which the potential effects of uncertainty could be assessed.

EXPERIMENT II

In this experiment, five-point psychometric functions were measured with three of the paradigms used earlier: 1) single interval; 2) same-different; 3) 2-alternative forced choice. Three new subjects participated; all were undergraduates at Loyola University. Although one subject had participated in other lateralization experiments, all subjects were practiced before data were collected. While the slopes of the psychometric functions can be used to provide information regarding signal uncertainty, the analysis relies upon the assumption of a linear relationship between d' and the independent variable. Since we know of no data that strongly support this assumption for interaural phase, we chose to compare the conditions by plotting d'_{SD} and d'_{2AFC} versus d'_{SI}. In this space, TSD predicts both the form (linear) and slope of the functions. Signal uncertainty produces functions below the positive diagonal; as uncertainty increases, the slope of the function increases (Nolte and Jaarsma, 1967).

In addition to providing a means for assessing uncertainty, the data from the second experiment allow the opportunity to check the validity of the conclusions drawn from Experiment I that were based upon the data from only two subjects.

The parameters of the stimulus were quite similar to those in the first experiment: 500-Hz tones of 200-msec duration (20-msec rise/decay times) were presented at 70 dB SPL. For two of the subjects tested (ZC and SB), the interaural phase delays were 12, 10, 8, 6 and 4 degrees. The third subject (RS) was more sensitive to interaural phase, and thus was tested at 6, 5, 4, 3 and 2 degrees. Generation of the stimuli was as described for the first experiment, except that the output rate of the D/As was set to 5 kHz per channel and the anti-aliasing filters were set to 2500 Hz.

RESULTS II

The psychometric functions for subjects ZC, SB, and RS are shown in Figures 5, 6, and 7, respectively. Again, uncorrected d' is plotted as a function of interaural phase delay, with each point representing data from 400 trials.

As before, the individual differences between subjects are quite large, both in terms of absolute sensitivity and the form of functions. For instance, subject RS achieved levels of performance comparable to those reached by the other two subjects, although the interaural phase differences at which she was tested were half the magnitude of those run by the other subjects. In general, there is a tendancy for the SD-function to be parallel to the SI-function but displaced upward. This is not true, however, for subject ZC, whose performance in the SD and SI tasks was nearly identical. Note that the SI-function for subject SB contains only three points. Differences of interaural phase smaller than 8° for this subject resulted in essentially chance performance.

For all three subjects, the d's in the 2-AFC task were greater than those measured in the other two paradigms. For RS and ZC the psychometric functions for the 2-AFC task were steeper than the other functions, while the function for SB is nearly parallel to the SI- and SD-functions but displaced upward.

FIGURE 5. d' VERSUS INTERAURAL PHASE : SUBJECT ZC

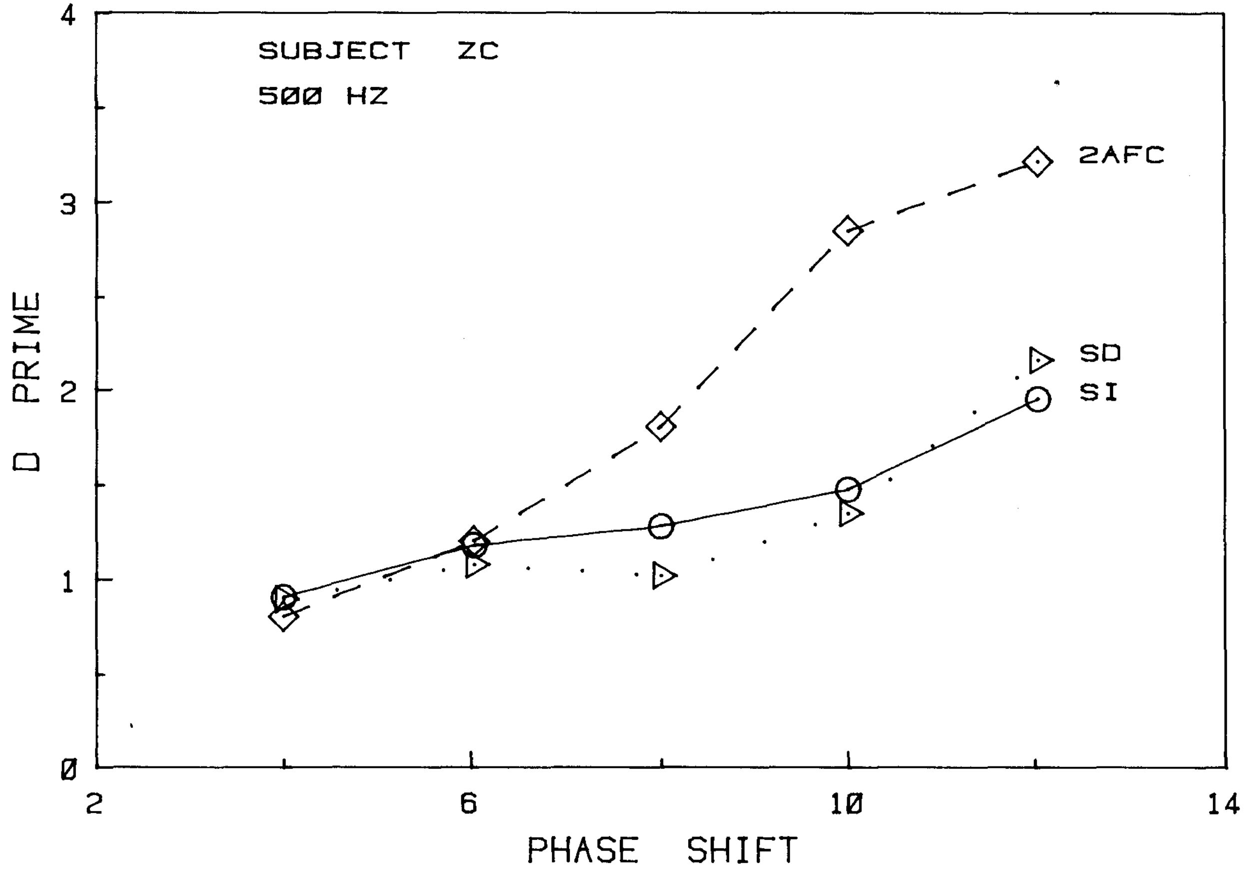


FIGURE 6. d' VERSUS INTERAURAL PHASE : SUBJECT SB

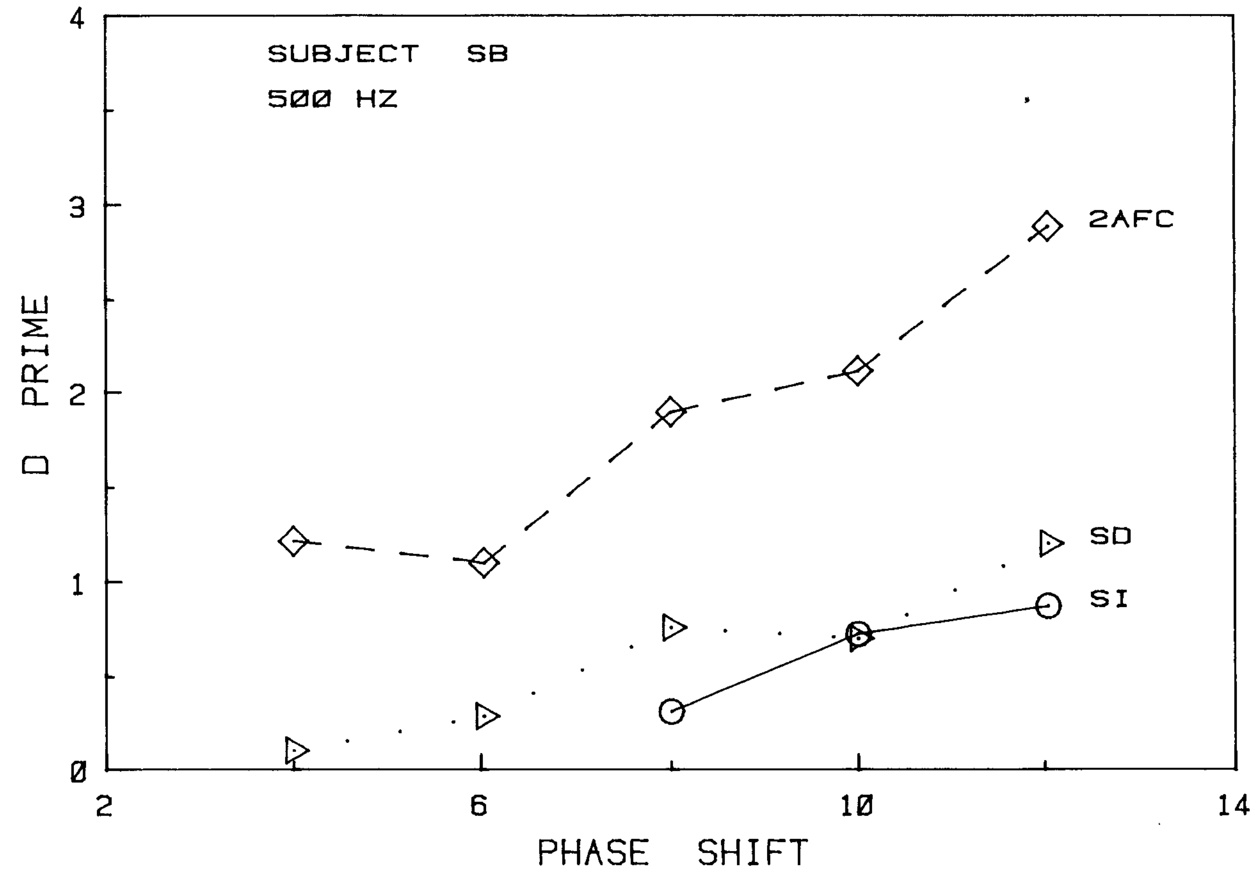
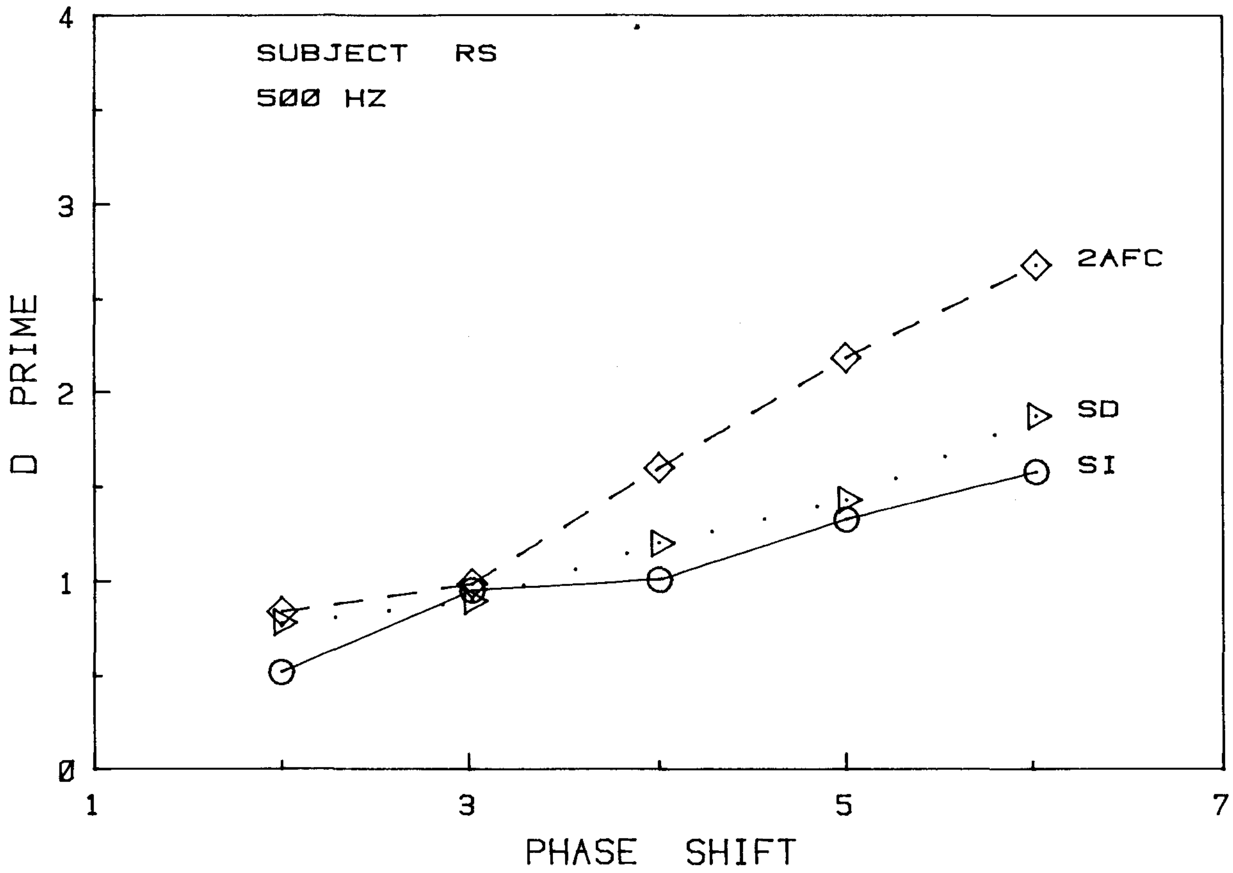


FIGURE 7. d' VERSUS INTERAURAL PHASE : SUBJECT RS



DISCUSSION II

Recall that d' was left uncorrected in order to facilitate the comparison of the ratios obtained with those predicted by the Theory of Signal Detectability. Note that if the cue for discrimination were the same in each task, TSD would predict equal values of d' in the SD- and SI-paradigms, while the slope of the d'_{2AFC}- versus d'_{SI}-functions would be $\sqrt{2}$ steeper when uncorrected d' is used as the dependent variable. The paradigms were again first compared with lateral postion considered as the cue. Thus, the ratios were referenced to the d' value in the SI condition.

Tables 6 and 7 show the d' ratios for subjects ZC and SB, and subject RS, respectively. The ratios are averaged across phases. The first ratio considered is that of SD to SI. TSD predicts a ratio of 1.0 based on position information as the relevant cue. Averaged across the three subjects, the obtained ratio was 1.23. This value agrees very well with the value obtained in Experiment I. Again, it appears that more information is contained in the SD task than in the SI task. This is not what TSD predicts for the SD/SI ratio based on the cue of interaural position.

The next ratio considered is that of the 2AFC-to-SI. TSD predicts a d'-ratio of $\sqrt{2}$. Averaged across subjects, this ratio was 2.33. This number is heavily weighted by subject SB (due to a very shallow SI-psychometric function), as can be seen in Figure 6. Excluding data from SB, the average 2AFC/SI ratio is 1.45, which is very close to the theory's prediction. Thus, more information is present in the 2AFC task than in the SI task, but the difference is consistent with predictions of the Theory of Signal Detectability, assuming lateral position to be the cue.

TABLE 6.
RATIOS OF d'
Subjects ZC and SB

Subject	Phase	SD/SI	2AFC/SI
ZC	12	1.11	1.64
	10	0.91	1.93
	8	0.79	1.41
	6	0.92	1.02
	4	0.99	0.88
AVG		0.94	1.38
SB	12	1.38	3.29
	10	0.97	2.93
	8	2.38	5.96
	6	-	-
	4	-	-
AVG		1.57	4.08

TABLE 7.
RATIOS OF d'
Subject RS

Subject	Phase	SD/SI	2AFC/SI
RS	6	1.18	1.69
	5	1.08	1.64
	4	1.20	1.59
	3	0.95	1.04
	2	1.51	1.62
AVG		1.18	1.52

FIGURE 8. d'_{SD} VERSUS d'_{SI}

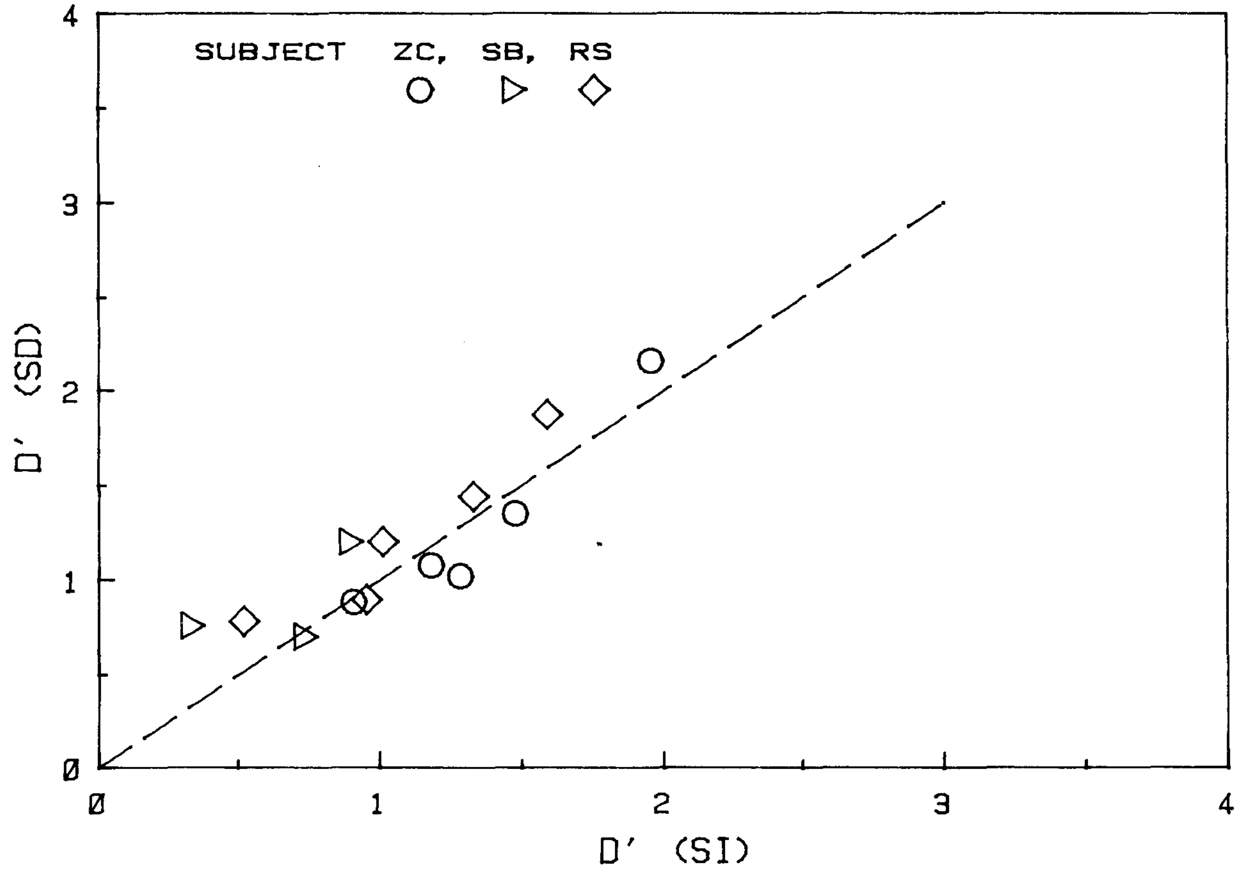


Figure 8 shows plots of d'_{SD} versus d'_{SI} for the three subjects in Experiment II. The dashed line depicts a slope of 1.0 and an intercept of 0.0 --the predictions from TSD. As shown in the figure, the functions for all subjects are parallel with the predicted function; the average slope of the best-fitting lines is 0.97. The unity slope of the plots in d'_{SD} versus d'_{SI} space is consistent with the fact that the slopes of the psychometric functions measured by these two paradigms appear to be the same. Note that except for subject ZC, the obtained d's lie above the function predicted by TSD, which is in accord with the finding that the average ratio of d's was greater than 1.0.

A plot of d'_{2AFC} versus d'_{SI} for the three subjects is shown in Figure 9. TSD predicts a function with a slope of $\sqrt{2}$ and an intercept of 0.0, as is shown by the dashed line in the figure. The slope of the functions for all three subjects are steeper than the predicted slope; the average slope of the best fitting lines is 1.95. This is inconsistent with the average ratio of d'_{2AFC} versus d'_{SI}, which was close to the predicted value of 1.414. This difference can be explained by looking at the values of d'_{2AFC}/d'_{SI} for individual subjects, as shown in Tables 6 and 7. As interaural phase increases, the ratio generally increases. This is also shown in Figure 9: d'_{2AFC}s associated with low d'_{SI}s tend to lie below the predicted function, while those associated with higher d'_{SI}s lie above (except for subject SB, whose function is displaced to the left due to a very shallow psychometric function in the SI condition). The average ratio, thus, regresses to the line.

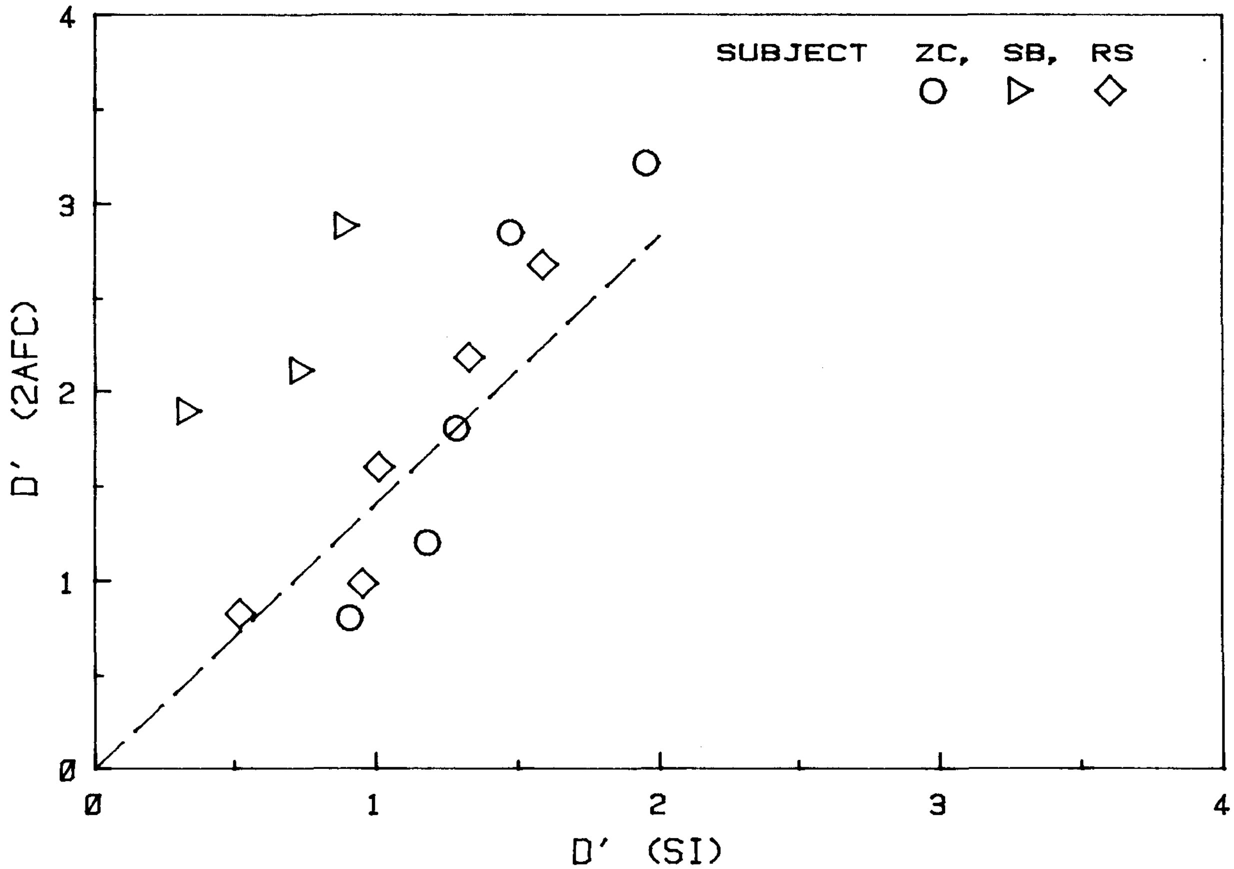
If we resrict attention to the region of d' space most often of interest (d' in the range around 1.0), the obtained functions more closely resemble the predicted function. These points are free of any floor or ceiling effects as described earlier, and thus are probably more valid.

Looking back across all five subjects, several results remain consistent. First, subjects performed better with the same-different task than the single interval task. However, the slopes of the psychometric functions were parallel over the range tested, as reflected in the functions in d'_{SD} versus d'_{SI} space which cluster around the predicted function. The same was true for subjects JP and KC in the 4SD task. It was shown that the addition of one marker improves performance, but that additional markers do not. Whether this signals a change in cue (i.e., motion) or a reduction in uncertainty is unclear, but the apparent parallelism of the slopes of the psychometric functions would argue against a reduction of uncertainty. Thus, the Theory of Signal Detectability does not account for the increase in performance obtained in the SD or 4SD conditions, if the cue is assumed to be lateral position.

The 2 Alternative Forced Choice paradigm was shown to contain more information than the SI paradigm, but the increase was shown to be consistent with that predicted by TSD. Present results indicate that subjects use the same cue (lateral position) in both the SI and the 2AFC tasks.

The 4 observation 2AFC task provides the subjects with more information than is predicted on the basis of the lateral position cue. If the cue was considered to be motion (i.e., referenced to the SD task), the results of the 4 observation 2AFC task are close to that predicted by the Theory of Signal Detectability.

FIGURE 9. d'_{2AFC} VERSUS d'_{SI}



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APPROVAL SHEET

The thesis submitted by Joseph N. Baumann has been read and approved by the following Committee:

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The final copies have been examined by the Director of this thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the Committee with reference to content and form.

The thesis is therefore accepted in fulfillment of the Master's thesis requirement in Psychology.

Dec 2, 1983
Date

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