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ABSTRACT

A study compared the performance of congenitally deaf signers (N=39) and hearing individuals (N=39) on a bilateral tachistoscopic task. Subjects were exposed to pretested linguistic and nonlinguistic stimuli during the task. Analysis of response time indicated that deaf subjects were slower to respond than were hearing subjects across all categories of stimuli. Analysis of accuracy revealed a significant right visual field preference for deaf subjects across all stimulus types; no lateral preference was found for hearing subjects in relation to stimulus type. The findings suggest that strategy factors are a major influence on performance and that auditory experience is not prerequisite to a finding of lateral preference on a behavioral task. (Author/CB)

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PERFORMANCE OF DEAF VERSUS HEARING INDIVIDUALS ON A VISUAL HEMIFIELD TASK

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Abstract

Thirty-nine congenitally deaf signers and 39 hearing individuals were exposed to pretested linguistic and nonlinguistic stimuli in a bilateral tachistoscopic task. An analysis of response time indicated that deaf participants were slower to respond than hearing participants across all categories of stimuli. An analysis of accuracy revealed a significant right visual field preference for deaf subjects across all stimulus types; no lateral preference was found for hearing subjects in relation to stimulus type. These data suggest that strategy factors were a major influence on performance and that auditory experience is not prerequisite to a finding of lateral preference on a behavioral task.

Summary

Recent behavioral studies of laterality which compare the performance of deaf individuals to that of hearing individuals have not shown conclusive findings for linguistic and nonlinguistic stimuli (Bryden, 1982; Kelly & Tomlinson-Keasey, 1981; Poizner & Battison, 1980; Ross, 1983; Wilson, 1983). The purpose of this study was to determine whether clearer results could be obtained if subject characteristics and stimulus quality were more stringently controlled.

Methods

Subjects.

Thirty-nine deaf and 39 hearing subjects were matched on age and sex. Ages ranged from 18 to 50 years. The deaf subjects were selected according to the following criteria: (1) congenitally deaf with at least a 95 dB hearing loss in the better ear, and (2) user of sign language since childhood (learned no later than 9 years of age). The control group consisted of normally hearing individuals who had no recent history of otitis media and little or no knowledge of sign language. All subjects were of normal intelligence (Raven Standard Matrices, 1956; Performance Subtests of the Wechsler Adult Intelligence Scales, 1981) and had normal vision, aided or unaided (Snellen chart). The Edinburgh Handedness Inventory (Oldfield, 1971) was administered to all participants and each was asked to fill out a personal history questionnaire which differed for deaf and hearing groups.

Equipment.

An Apple IIc computer connected to a 13" color monitor was programmed to present the stimuli and store data regarding error rates, response times, composition of the test visual field and the choice screen, as well as the stimulus category. A chin rest, positioned in an adjustable metal stand was placed in front of the monitor such that the subject's eyes were 60 cm. from the center focus point. A desk lamp with a dimmer switch was used to calibrate light levels between sites.

Stimuli.

Four sets of 18 stimuli were selected from pilot data which, through direct magnitude estimation, pinpointed: (1) stick-figure drawings of signs from American Sign Language which were easily understood, (2) line pictures which did not bear any resemblance to signs and were not codable, (3) 4-letter words which had consistent sign-to-word glosses, and (4) nonsense words which least resembled real words. All categories were combined and randomized for presentation.

Procedures

Instructions were given verbally to the hearing subjects and in sign language to the deaf subjects. A demonstration program was used to train each participant in the computer procedures.

Subjects placed their chins in the chin rest and were asked to focus on a centered asterisk which changed to an arrow simultaneously with the bilateral stimulus presentation. This procedure is said to minimize directional scanning (Piazza, 1980; Schmuller & Goodman, 1980). The randomized direction of the arrow indicated which stimulus item was to be retained.

In order to ensure contralateral hemispheric field involvement, the stimuli were placed between 5 and 10 degrees of visual angle from the center fixation point (cf. Poggio, 1974; Riggs, 1966). Stimuli appeared for 100 msec. (+ or - 3 msec.) as calibrated on a storage oscilloscope.

Word stimuli were presented vertically to circumvent left-to-right scanning effects (Bryden, 1972; Kershner & Jeng, 1972; McKavey, Curicio & Rosen, 1975) A 3 msec. blue-out screen was programmed to flash immediately after the stimulus exposure to eliminate after-image on the screen.

Following the tachistoscopic presentation and an ensuing 3 second delay, a randomized choice screen was presented. The choice screen had six possible matches for the target stimulus including the two stimuli presented bilaterally and four foils. All six choices were within the same category of stimuli. Response time was recorded when any number key was pressed indicating a choice.

For each trial involving meaningful stimuli, the subject then typed in the word just seen or, in the case of the deaf participants, a word for the sign just seen.

Results

The data were analyzed as two separate 2 x 2 x 2 x 2 ANOVAs after the tests of the covariates (percentile scores from the Raven Progressive Matrices and Performance IQ from the WAIS) were found to be insignificant for both response time ($F_{2,74} = 1.11$, $p = .3343$) and number of correct responses ($F_{2,74} = 2.86$, $p = .064$). The within factors were Display (words & lines), Meaning ("+" & "-"), and Visual Field (right & left). The between factor was Group (deaf & hearing).

Response Time.

The interaction of Display X Meaning X Group was found to be significant when response time was used as a dependent measure ($F_{1,76} = 4.44$, $p = .0384$). (See Appendix.) When the components of this interaction were considered as simple effects, it became clear that the longer response times of the deaf subjects to signs and to lines in general contrasted significantly with the stable response times for hearing subjects across all categories of stimuli. The data for hearing subjects were reorganized such that words were the only stimuli considered in the analysis of meaningful stimuli. A significant difference in response time was found between meaningful and nonmeaningful stimuli ($F_{1,38} = 12.23$, $p = .0012$). Hearing subjects responded to words significantly faster than the other three categories of stimuli. No visual field effects were found for either group.

Number of Correct Responses.

Three two-way interactions were found to be significant: (1) Group X Visual Field ($F_{1,76} = 6.86$, $p = .0106$), (2) Group X Display ($F_{1,76} = 6.81$, $p = .0109$), and (3) Display X Meaning ($F_{1,76} = 25.33$, $p = .00001$). An analysis of the component simple effects (see Appendix) revealed the following: (1) all subjects were more accurate on words than on lines across meaningfulness and visual field, (2) all subjects were more accurate on real words than on nonsense words and on nonsense lines than on signs, (3) hearing subjects were more accurate than the deaf subjects for both display types and both visual fields, (4) deaf subjects performed significantly better when stimuli were presented to the right visual field whereas hearing subjects performed equally well in both visual fields.

Summary

The overall conclusions that can be drawn from this investigation are as follows:

1. Differing strategies used by the participants rendered response time an insensitive measure of lateral preference. No visual field effects were found with this dependent measure.

2. The longer response times of deaf versus hearing participants may be related to the time required to translate from ASL to English or from English to ASL. The poorer accuracy rate of the deaf group may be related to the intricate visual display for signs and nonsense lines which contained minimally differing meaningful information.

3. Hearing subjects responded to all of the visual stimulus types without a predisposed strategy as evidenced by the lack of a laterality effect for accuracy rates on meaningful and nonmeaningful stimuli.

4. Deaf subjects seem to have used a strategy that led to a right visual field preference for both linguistic and nonlinguistic stimuli. This finding supports the hypothesis that lateralization effects can be demonstrated with subjects who have had no auditory stimulation. Lateralization effects on a behavioral measure of responses to linguistic and nonlinguistic stimuli do not appear to have an exclusive relationship to a history of visuospatial or auditory input for language.

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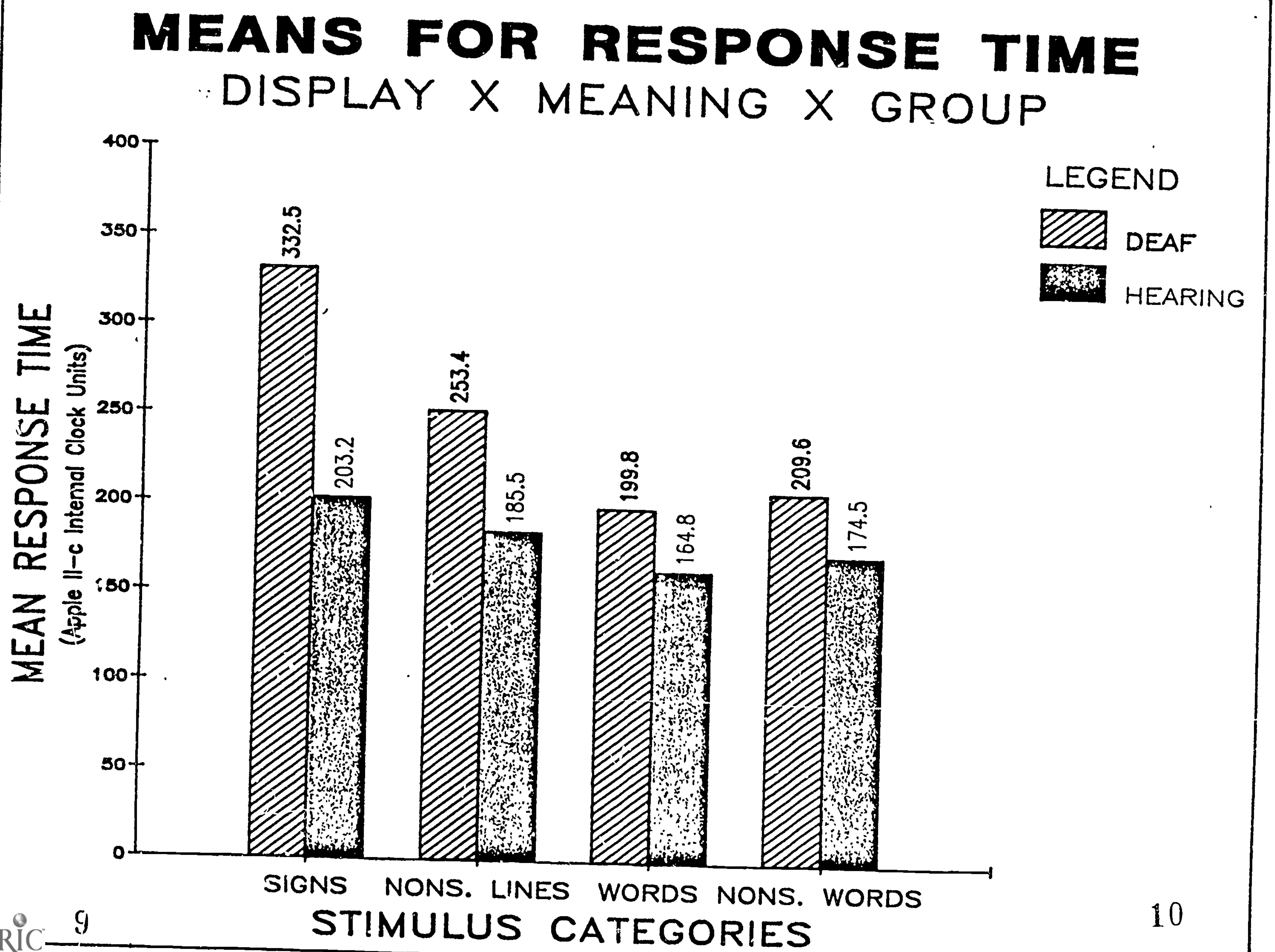
APPENDIX

1. Means for Response Time
   (Display X Meaning X Group)

2. Simple Effects for Response Time

3. Means for Number Correct
   (Group X Visual Field)
   (Group X Display)
   (Display X Meaning)

4. Simple Effects for Number Correct

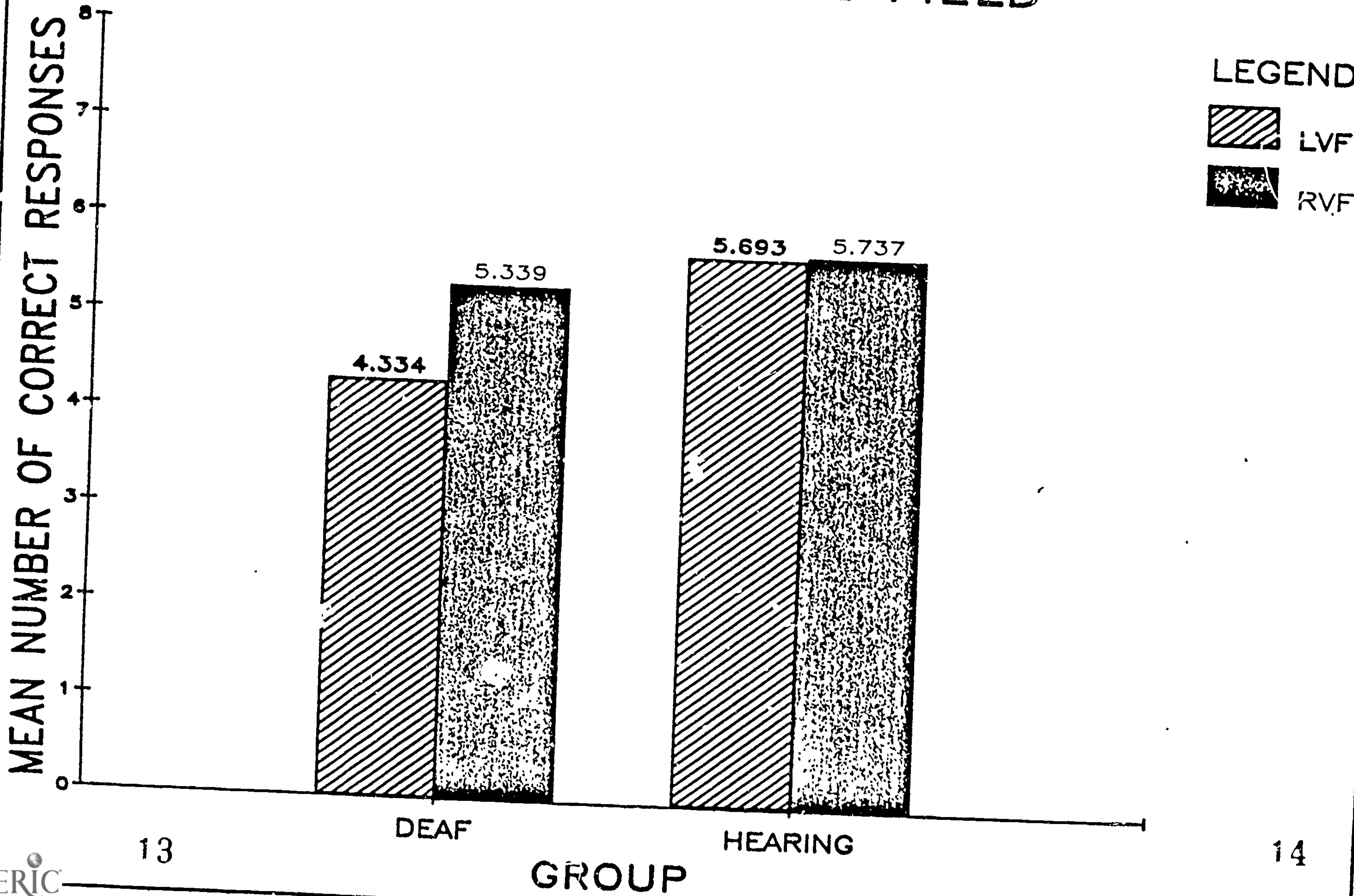


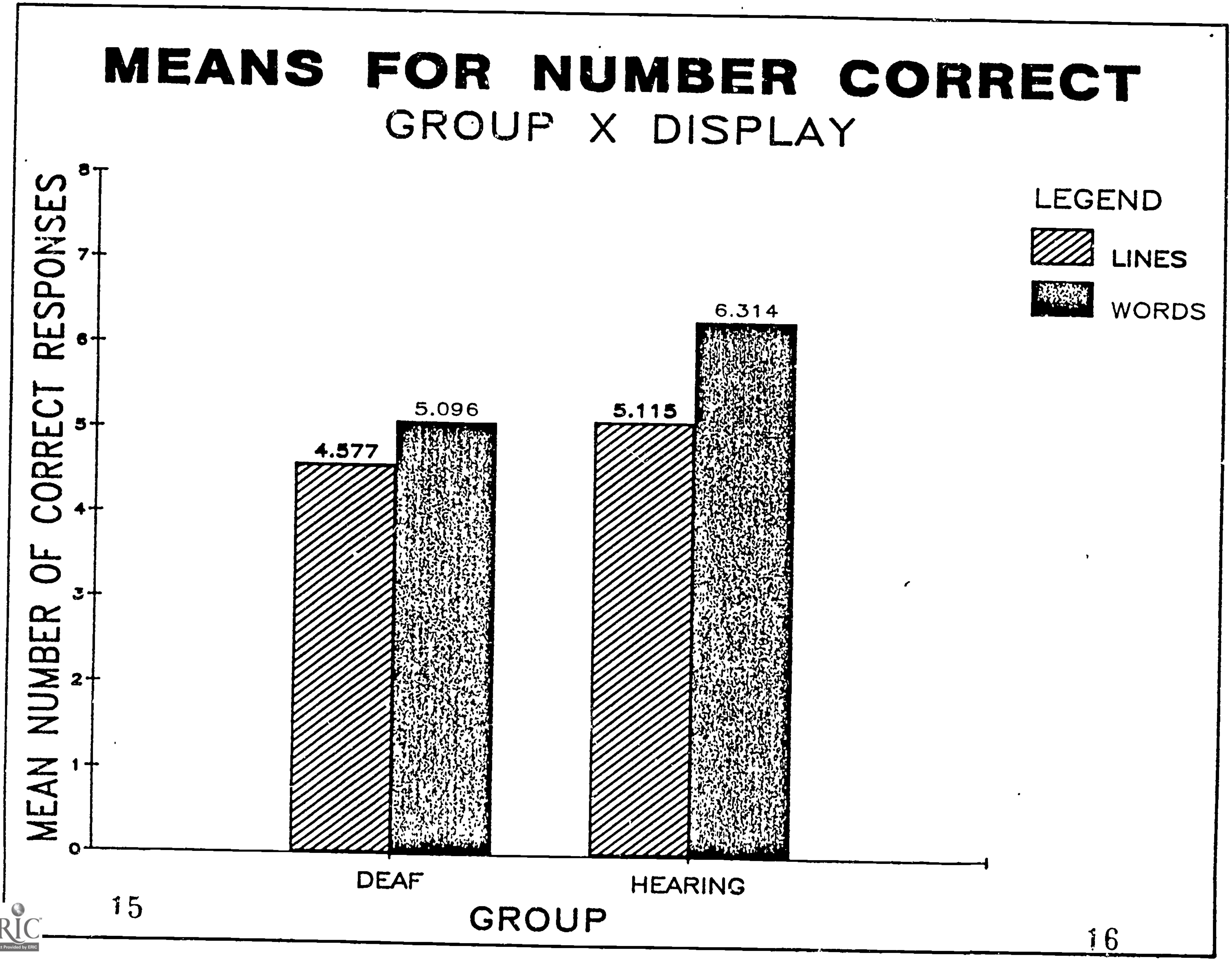
MEANS FOR RESPONSE TIME
DISPLAY X MEANING X GROUP
MEAN RESPONSE TIME
(Apple II-c Internal Clock Units)
400
350
300
250
200
150
100
50
0
332.5
203.2
253.4
185.5
199.8
164.8
209.6
174.5
LEGEND
DEAF
HEARING
SIGNS
NONS. LINES
WORDS
NONS. WORDS
STIMULUS CATEGORIES

Simple Effects for Response Time

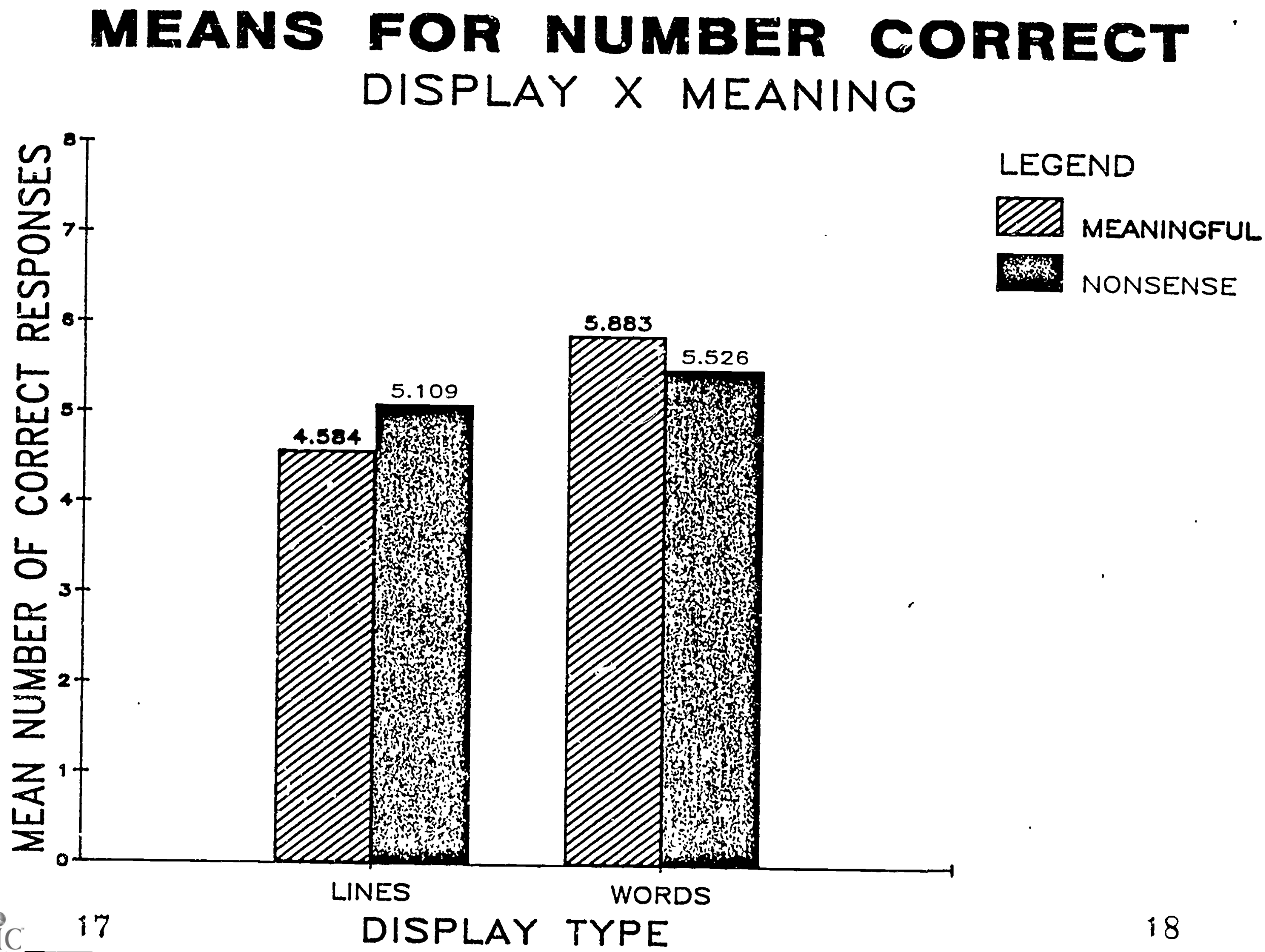
Source	df	F	p
Display X Meaning for Group = Deaf	1	18.59	.00001*
Mngful vs. Non at Display = Line	1	19.46	.00001*
Mngful vs. Non at Display = Word	1	.62	.435
Lines vs. Words at Mng = +	1	36.14	.00001*
Lines vs. Words at Mng = −	1	13.80	.0004*
Display X Group for Mng = +	1	6.81	.0109*
Deaf vs. Hear at Display = Line	1	20.69	.00001*
Deaf vs. Hear at Display = Word	1	3.55	.064
Lines vs. Words at Group = Deaf	1	36.14	.00001*
Lines vs. Words at Group = Hear	1	3.04	.08
Meaning X Group for Display = Lines	1	5.86	.0179
Deaf vs. Hear at Mng = +	1	20.69	.00001*
Deaf vs. Hear at Mng = −	1	9.5	.0029*
Mngful vs. Non at Group = Deaf	1	19.46	.00001*
Mngful vs. Non at Group = Hear	1	.98	.326

MEANS FOR NUMBER CORRECT
GROUP X VISUAL FIELD





MEANS FOR NUMBER CORRECT
GROUP X DISPLAY
MEAN NUMBER OF CORRECT RESPONSES
0
1
2
3
4
5
6
7
8
LEGEND
LINES
WORDS
4.577
5.096
5.115
6.314
DEAF
HEARING
GROUP


MEANS FOR NUMBER CORRECT
DISPLAY X MEANING
MEAN NUMBER OF CORRECT RESPONSES
0
1
2
3
4
5
6
7
8
LEGEND
MEANINGFUL
NONSENSE
4.584
5.109
5.883
5.526
LINES
WORDS
DISPLAY TYPE

Simple Effects for Number Correct

Source	df	F	p
Display X Group	1	6.81	.0101*
Deaf vs. Hear at Lines	1	4.7	.0332*
Deaf vs. Hear at Words	1	13.92	.0004*
Lines vs. Words at Deaf	1	7.96	.0061*
Lines vs. Words at Hear	1	42.4	.0001*
Visual Field X Group	1	6.86	.0106*
Deaf vs. Hear at RVF	1	15.43	.0002*
Deaf vs. Hear at LVF	1	17.70	.0001*
RVF vs. LVF at Deaf	1	15.04	.0002*
RVF vs. LVF at Hear	1	.03	.8632
Display X Mng	1	25.33	.00001*
Mngful vs. Non at Lines	1	11.75	.0010*
Mngful vs. Non at Words	1	11.67	.0010*
Lines vs. Words at Mngful	1	72.94	.00001*
Lines vs. Words at Non	1	6.65	.0119*

$^*p < .05$