DOCUMENT RESUME

ED 136 923 PS 009 167

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TITLE Semantic Comprehension of the Action-Role Relationship in Early-Linguistic Infants.
SPONS AGENCY National Inst. of Child Health and Human Development (NIH), Bethesda, Md.
PUB DATE Mar 77
GRANT NIH-HD-08246-02
NOTE 18p.; Paper presented at the biennial meeting of the Society for Research in Child Development (New Orleans, Louisiana, March 17-20, 1977)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Cognitive Development; *Comprehension Development; *Infants; *Language Development; *Listening Comprehension; Research; *Semantics

ABSTRACT

This study attempted to determine: (1) whether lower-order units (agent or agent-action) within the agent-action-recipient relationship exist in any functional way in the 1-word infant's comprehension of speech; and (2) whether the use of repetition and/or reduced length (common modifications in adult-to-infant speech) used to focus on these lower-order semantic units, facilitates comprehension of the match between a visual event and its verbal description. Sixteen infants (16-20 months old) in the 1-word stage were matched by age, sex, and linguistic level into two groups: those who comprehended, and those who did not comprehend, linguistic descriptions of the agent-action-recipient relationship. Subjects were shown narrated films depicting action-role changes. Each subject was shown the baseline condition which determined comprehension status, and two of four experimental conditions in which the narration was an interaction between one speech modification (repetition and reduced length) and a semantic focus (agent or agent action). A habituation paradigm was used in which correct narrative descriptions of the events were presented until habituation, at which point the narrations were switched to incorrectly describe the role relation being depicited. Dishabituation (heart rate deceleration and visual fixation) at the change to incorrect narrations was viewed as evidence of semantic comprehension. A 2x2x2 analysis of variance with repeated measures showed a main effect for the comprehension status variable. Significant 2-way interactions were found, one between semantic focus and comprehension status and another between speech modification and comprehension status. (Author/SB)

Semantic Comprehension of the Action-Role Relationship in Early-Linguistic Infants

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Semantic Comprehension of the Action-Role Relation in Early-Linguistic Infants

Most current research on early language acquisition focuses on the child's own early speech productions. The question of how much prelinquistic infants attend to and comprehend of the adult speech directed at them receives less study, one reason, undoubtedly, being the difficulty in finding clear and unequivocal measures of speech comprehension. The research discussed today examines the influence of aspects of adult speech that possibly facilitate the semantic comprehension of infants at the one-word stage of language development.

The premise that language acquisition develops out of an earlier cognitive understanding of an event relationship (such as an animate being acting on an inanimate object) is currently receiving support. Such a premise leads to the need to demonstrate whether semantic relationships are functional in early event and language comprehension. Since 1970 there has been a series of experiments at the Cornell Infant Language Laboratory supporting the psychological reality of at least one semantic relationship -- the action-role relationship. (Suci and Hamacher, 1972; Golinkoff, 1975; Gilmore, 1976.)

The action-role concept refers to the distinction between words signifying agents (animate beings who initiate action) and words signifying recipients (animate beings who receives the action) of the event's action. (Fillmore, 1968) Little is known about the pre-linguistic child's comprehension of action-role distinctions within a verbal message. Do the lower-order units (agent alone, or agent-action) within the agent-action-recipient relationship exist in any functional way in early comprehension, as they seem to in later speech productions of young children?

Further, it is not known whether certain aspects of adult speech might differentially affect the infant's comprehension of verbal messages referring to action-roles. Two of the speech modifications commonly reported in mother's speech to children under two are 1) repetition (30-45% of adult speech to children repeats a preceding comment) and 2) reduction in utterance length (more than half of the adult utterances have a length of only 1 to 3 words). Some investigators have suggested that such speech modifications on the part of adults aid the child in recognizing the key phrases or semantic units, thus facilitating language comprehension and speech acquisition. (Benedict, 1975; Depaulo and Bonvillian, 1975; Glazner and Dodd, 1975; Snow, 1972.)

In this study infants ranging in age from 16 to 20 months were used as subjects. A total of 44 infants were tested: 24 who were producing only one-word utterances, six who were producing two-word utterances, four who were used as control subjects, and ten whose data had to be discarded as a result of the subject's fussiness or equipment problems. The mother of every subject was interviewed regarding her child's language development, and the infants were tested to insure that they comprehended the verbal labels for the actual puppets (a dog and a rabbit) used in the stimulus films.

The stimuli for each 11-second trial consisted of a verbal/visual event in the form of a narrated filmed-sequence of one puppet (the agent) crossing the stage to hug (the action) another, passive puppet (the recipient). In this way an action-role relationship was depicted visually while a recorded narration (in a woman's voice using natural intonation) described that relationship linguistically.

Semantic comprehension was the dependent variable, considered as evidence that, given a particular visual context, the subject recognized the accuracy of the verbal message. An habituation paradigm was used, with an infant being presented with a series of filmed-event trials. In each trial the same animal puppets were engaged in the same action, but which puppet was assigned the role of agent, their positions, and their direction of movement varied. Each trial was correctly narrated until the subject was judged to have habituated. A technique was developed to allow on-the-spot judgments of habituation based on changes in the subject's heart-rate and visual fixation patterns. After two trials where it was judged that the infant had habituated (which typically occurred between the 6th and 10th trials) a change was introduced in the match between the visual event and the narration. During the 3-second blackout interval between trials audio channels were switched so that during the following five test trials incorrect descriptions of the same visual events were provided. That is, if the dog was moving across the stage to hug the rabbit, the accompanying incorrect narration for one condition might be "The rabbit hugs." Care was taken that when the incorrect narration was introduced there were no changes in volume, timing, clarity, intonational patterns, etc. accidentally introduced that could account for any resulting dishabituation.

Dishabituation, that is, heart-rate deceleration accompanied by visual fixation, at the shift to incorrect narration was viewed as evidence that the infant recognized the mismatch between the linguistic description and the visual event, showing semantic comprehension of the verbal message.

Figure 1 illustrates the visual context and the type of accompanying narration for the baseline and four experimental conditions. All infants were shown a baseline condition in which the narration was a description of the full agent-action-recipient relationship such as "The dog hugs the rabbit." If a subject dishabituated at the introduction of the incorrect narration on the baseline condition it was classified as a "comprehender" and if it failed to dishabituate at the change if was classified as a "noncomprehender." Each subject was randomly assigned to two of the four possible experimental conditions that were designed to facilitate comprehension of the linguistic message.

These experimental conditions were composed of variations in narration that utilized either repetition or reduced length as a speech modification along with focus on either the agent unit alone or the agent-action unit of the full three-term relationship. Each infant was used as its own control across the baseline and the two speech modification conditions of repetition and reduced length. The design cells were counterbalanced for sex of subject and order or presentation of the conditions. See Figure 2 for a schematic presentation of the design. A partial explanation of the way the heart-rate data was converted for analysis is presented on page 2 of the handout.

In order to examine the effects of the experimental variables a 3-way analysis-of-variance, with repeated measures and uneven cells, was conducted. Performance on the experimental conditions was considered in terms of difference scores -- the experimental performance minus the baseline performance. A summary of the least squares analysis for the group means is shown in Table 1, while Table 2 shows the means and standard deviations by cell. These results show a significant difference in performance existed between the two groups of infants - the comprehenders and the noncomprehenders ($F = 5.95$, $p < .05$). Figure 3 illustrates the direction of these differences.

Separate analyses were done on the two groups, using the recovery ratios from all conditions - the baseline and four experimental conditions. The results of the ANOVA for the noncomprehenders are shown in Table 3, with Table 4 showing the group means for each cell. Those noncomprehenders who received experimental narrations designed to focus on the agent unit showed significant improvement from their baseline performance on both the repetition and the reduced length conditions. There was no significant differences in comprehension between the two types of speech modifications. Those noncomprehenders who received experimental narrations designed to focus on the agent-action unit showed significant improvement only under the reduced length condition. Figure 4 illustrates these relationships. Regardless of the semantic focus, infants who did <u>not</u> comprehend, or notice the inaccurate linguistic descriptions of the full action-role did show comprehension when given narrations that used either repetition or reduced length to modify the language input.

It appears one can not talk about repetition or reduced length speech modifications that focus on the agent or agent-action expressions as facilitating semantic comprehension for one-word subjects in general. However, when one considers whether an infant is a comprehender or a noncomprehender, as determined on baseline performance, a clear relationship is evident.

Two additional variables, sex of subject and order of presentation, were examined. Analysis showed that no significant differences in performance could be attributed to the sex of the subject ($p < .01$) or to the order of presentation of conditions ($p < .01$).

While the general analysis looked at cardiac response changes across events it is also of interest to consider cardiac changes <u>within</u> events. The research questions in this study (e.g. whether adult speech modifications facilitate infant comprehension) would assume that significant changes in comprehension would result only if the subjects attended to the narrated section of the event trial. Therefore it was of interest to note how cardiac response varied in relation to the various segments of the event trial itself. On all conditions the majority of infants showed their greatest number and magnitude of heart-rate decelerations during the 7th and 8th seconds of the trial; at that point the hugging action and verbal narration were occurring, having begun on the 6th second. Using χ^2 analysis, one can reject the hypothesis that such a distribution occurred by chance at the .005 level of significance for the baseline condition and at the .001 level of significance for the experimental conditions.

Most investigators using the habituation/dishabituation paradigm present a fixed number of pre-change trials before introducing any novel stimulus

Such a procedure does not allow for variations in individual rates of habituation. The mean number of trials to habituation for all conditions was remarkably similar -- averaging around 7 or 8 trials. Order of presentation of the baseline condition, though having no effect on performance between conditions, was related to rate of habituation. Subjects who had the baseline as the first of three conditions took significantly longer to habituate on that condition than subjects who had it presented last ($p < .01$). Unlike many studies of infant habituation, this study showed no significant difference between males and females on rate of habituation on any of the experimental conditions. Males tended to take longer to habituate than females on this baseline condition ($p < .05$). There were no significant differences in rate of habituation between comprehending and noncomprehending infants.

The results of this study indicate that there are distinguishable differences in language comprehension abilities among infants who all show very similar levels of production abilities -- the area usually assessed in language studies to determine linguistic maturity. Furthermore, these comprehension differences are related to the infants' responses to various speech modifications present in adult speech.

Footnote

This research was supported by NIH research grant number HD08246-02 from the National Institute of Child Health and Development. The assistance of Steven Robertson, Leah Beckerdite, Bonnie Breitmayer, and Anita Levy is gratefully acknowledged.

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Figure 1

Representation of Conditions

Condition	Input Source	Habituation Trials 1-n					Test Trials 1-4			
Condition I	Visual	D → R	R ← D	R → D	D ← R	D → R R ← D	D → R	R ← D	R → D	D ← R
Repetition: Agent Focus	Verbal	See the dog. The dog hugs the rabbit.	See the dog. The dog hugs the rabbit.	See the rabbit. The rabbit hugs the dog.	See the rabbit. The rabbit hugs the dog.	. . . .	See the rabbit. The rabbit hugs the dog.	See the rabbit. The rabbit hugs the dog.	See the dog. The dog hugs the rabbit.	. .
Condition II	Visual	D → R	R ← D	R → D	D ← R	. . . .	D → R	R ← D	R → D	D ← R
Reduced length: Agent Focus	Verbal	See the dog.	See the dog.	See the rabbit.	See the rabbit.	. . . .	See the rabbit.	See the rabbit.	See the dog.	See the dog.
Condition III	Visual	D → R	R ← D	R → D	D ← R	. . . .	D → R	R ← D	R → D	D ← R
Repetition: Agent-Action Focus	Verbal	The dog hugs. The dog hugs the rabbit.	The dog hugs. The dog hugs the rabbit.	The rabbit hugs. The rabbit hugs the dog.	The rabbit hugs. The rabbit hugs the dog.		The rabbit hugs. The rabbit hugs the dog.	The rabbit hugs. The rabbit hugs the dog.	The dog hugs. The dog hugs the rabbit.	The dog hugs. The dog hugs the rabbi:
Condition IV	Visual	D → R	R ← D	R → D	D ← R	. . . .	D → R	R ← D	R → D	D ← R
Reduced length: Agent-Action Focus	Verbal	The dog hugs.	The dog hugs.	The rabbit hugs.	The rabbit hugs.		The rabbit hugs.	The rabbit hugs.	The dog hugs.	The dog hugs.
Baseline Condition	Visual	D → R	R ← D	R → D	D ← R	. . . .	D → R	R ← D	R → D	D ← R
Full narrative Agent-Action-Recipient	Verbal	The dog hugs the rabbit.	The dog hugs the rabbit.	The rabbit hugs the dog.	The rabbit hugs the dog.		The rabbit hugs the dog.	The rabbit hugs the dog.	The dog hugs the rabbit.	The dog hugs the rabbit

D → R = The dog (as the agent) moves right across the stage to hug a passive rabbit.

Figure 2
Experimental Design

Semantic Focus	Comprehension Status	Speech Modification: Repetition C_1	Speech Modification: Reduced Length C_2
Agent Focus (A_1)	Comprehenders (B_1)	Condition I	Condition II
	Noncomprehenders (B_2)	Condition I	Condition II
Agent-Action Focus (A_2)	Comprehenders (B_1)	Condition III	Condition IV
	Noncomprehenders (B_2)	Condition III	Condition IV

The same Baseline condition was given to all subjects -- but whether it was given first or last varied systematically. Therefore, when a subject was seen it was not known whether they would be designated a comprehender or noncomprehender. For this reason the final number of subjects in each cell was unequal because subjects continued to be run until a minimum number of 4 Ss fell into each cell.

Quantification of Heart-Rate Data*

In order to convert the deceleration areas that were found into analyzable form it was desirable to know the magnitude of each deceleration as well as when and where it occurred. For this reason each deceleration period was calculated, by converting continuous data to a step function, so as to give its integrated heart-rate deceleration area. The area was used because it accounted for both the depth and duration of the deceleration.

In order to specify the degree to which a subject did or did not dishabituate following the change to the test trials and to compare degrees of recovery across conditions the following formula for quantifying recovery was used:

$$\text{Recovery Ratio} = \frac{t - h}{m - h}$$

In this formula 'm' represented the maximum integrated heart-rate prior to the change in narration and was determined by averaging the two consecutive trials showing the highest integrated heart-rate. This figure was meant to establish, for each subject, what level of heart-rate deceleration might reasonably be expected in response to the test trials. The 'h' represented the averaged integrated heart-rate for the last two trials before the change in narration -- i.e., the judged habituation trials. The 't' was the maximum integrated heart-rate following the change in narration -- determined by averaging the two consecutively highest test trials.

When this recovery ratio was used, any infant who failed to dishabituate following the change to incorrect narration would show a very low or, more likely, a negative recovery figure. However, if the infant dishabituated at the change, and showed a deceleration to a magnitude equal or greater than the maximum shown during the pre-habituation trials, the recovery figure would be +1.0 or greater.

*The data conversion methods were developed and verified by Steven Robertson, Cornell University.

Table 1

Least Squares Analysis for 24 One-Word Infants

Source	d.f.	SS	MS	F	Probability
A(Semantic Focus)	1	12.962	12.962	2.041	
B(Comprehension Status)	1	36.557	36.557	5.757	.05
AB	1	.567	.567	.089	
Subj. w. groups [error (between)]	20	126.935	6.35		
C(Speech Modification)	1	.020	.020	.009	
AC	1	.260	.260	.13	
BC	1	2.215	2.215	1.08	
ABC	1	.104	.104	.05	
C x Subj. w. groups [error (within)]	20	41.045	2.05		

Table 2

Mean Difference Scores Between Baseline and Experimental Conditions on Recovery Ratios

	Agent Focus (A_1)		Agent-Action Focus (A_2)	
	Comprehenders (B_1)	Noncomprehenders (B_2)	Comprehenders (B_1)	Noncomprehenders (B_2)
Repetition (C_1)	.592 n=5 S.D.=3.571	1.573 n=6 S.D.=3.381	-.920 n=7 S.D.=1.616	.687 n=6 S.D.=1.040
Reduced Length (C_2)	-.152 n=5 S.D.=.370	1.895 n=6 S.D.=2.177	-1.177 n=7 S.D.=.894	1.120 n=6 S.D.=1.202

Figure 3
Comprehenders and Noncomprehenders Recovery Responses
at the Change to Incorrect Narrations

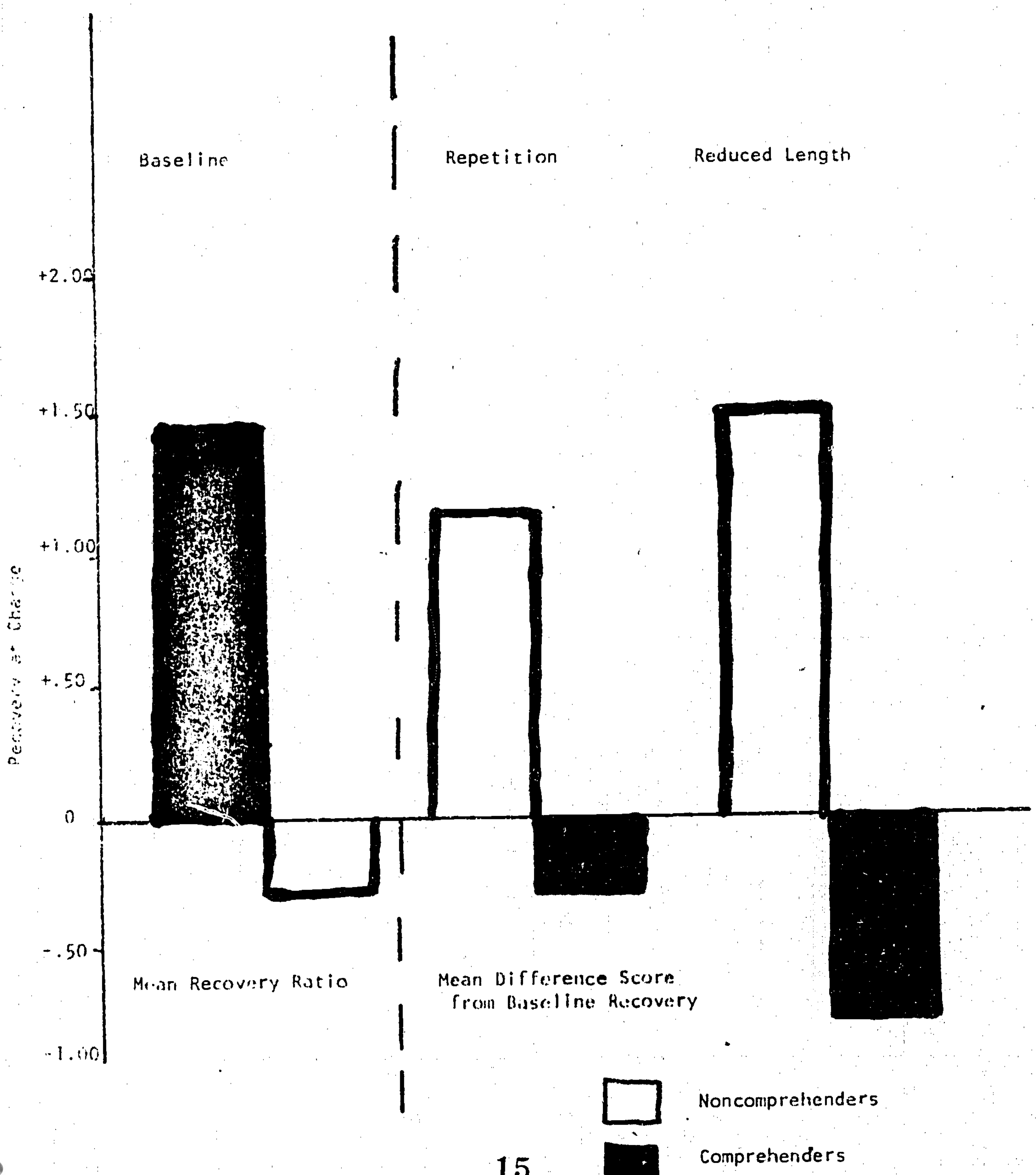

Table 3

ANOVA for Recovery Ratio Scores

Noncomprehenders only - N=12

Source	SS	df	MS	F	probability
A(Semantic Focus)	4.175	1	4.175	8.235	.01
Error(between)	15.217	30	.507		
C(Speech Modification)	13.949	2	6.974	6.524	.01
AC	2.140	2	1.07	1.001	
Error(within)	37.437	35	1.069		

Table 4

Mean Recovery Ratios for Noncomprehenders

	Baseline	Repetition	Reduced Length
Agent Focus	-.97	.90	.63
Agent-Action Focus	.27	.95	1.39

Figure 4
Recovery Ratio Means