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In P. French (Ed.), The development of meaning. Japan: Bunka Hyoron Press, 1979.

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A DEVELOPMENTAL STUDY OF THE COMMUNICATION OF MEANING: THE ROLE OF UNCERTAINTY AND INFORMATION

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When a philosopher claims that the meaning of a statement is determined by its use, it is because he takes the meaning to consist in the role it plays in communication between members of a speech community.

—Jay Atlas (1978)

Our concern in this chapter is with the communication of meaning. From the point of view of communication, meaning can be defined as the message which a speaker intends to transmit to a listener (or listeners). A message must be constructed by a speaker and interpreted by a listener. This construction is based on the speaker's perception and cognition of relations. The construction process of the speaker is the focus of the empirical study to be reported. Thus, our concern is with the construction of messages which communicate meaning.

Bates (1976) defines meaning as "the set of mental acts or operations that a speaker intends to create in his listener by using a sentence." This definition specifies the psychological nature of a message. If we broaden Bates's notion to include physical as well as mental acts, the definition covers the type of communication situation we have set up: one in which the goal is to get someone else to *perform* certain acts, not just to *think* them. The definition is useful for a psychological analysis of the communication of meaning because it suggests that we must conceptualize the nature of the operations, mental or physical, which are to be established in the listener. If operations are to be created in the listener, they must first be organized and constructed by the speaker.

The basic communicative situation of our study is one in which a child must explain to another person how to put together a set of objects in a particular way. Thus, the message is a description of what relations must obtain among which things and how to bring about this state of affairs.

In the communication situation of our study, each speaker had to describe three complex action sequences so that a listener who had the same materials but could not see the speaker's actions could build the same construction. The three action sequences are pictured in Figure 10-1, below. For example, the materials for one task consist of a yellow plastic cup and a set of five wooden beads of different colors and shapes. The task is to place three specific beads in the cup one at a time in any order (see Figure 10-1). Because of the nature of the situation, the elements of the message include both verbal description and material entities. In combinations, these represent what the speaker must communicate to the listener.

The concept of the message implies a particular view of the nature of underlying linguistic representation and the relation between language and action. This view, elaborated elsewhere (Greenfield & Smith, 1976; Greenfield, 1978b), is that there is an amodal cognitive system which structures action, the perception of events, and language in the same way. Because of this, preexisting relations structured in perception and action become a

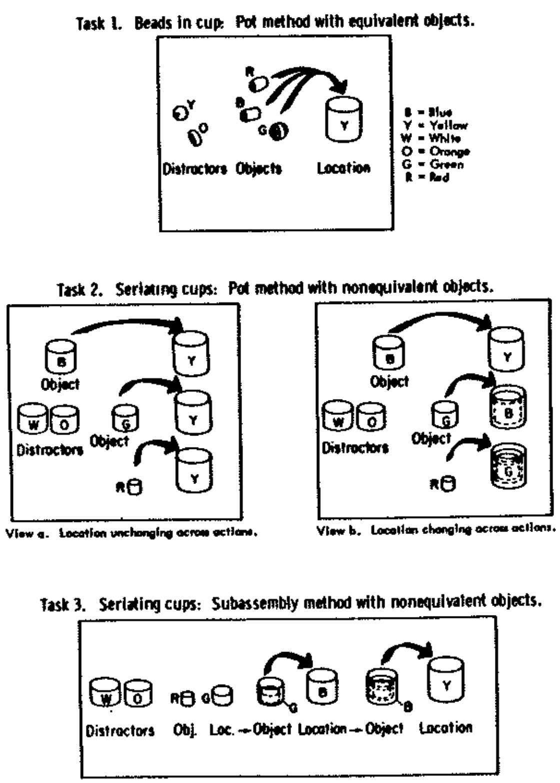

Figure 10-1. Combinatorial action tasks.

framework for emergent language at the one-word stage (Greenfield & Smith, 1976; Zukow, Reilly, & Greenfield, in press) and beyond (e.g., Bowerman, 1973; Bruner, Roy, & Ratner, in press; Schlesinger, 1971; Slobin, 1973). Other research indicates that the development and organization of complex action employs principles in common with the grammatical structure of language (e.g., Greenfield, Nelson, & Saltzman, 1972; Goodson & Greenfield, 1975; Greenfield & Schneider, 1977; Greenfield, 1978b).

The action elicited by language structures has been studied (Huttenlocher and Strauss, 1968; Huttenlocher, Eisenberg, and Strauss, 1968; Greenfield and Westerman, 1978), but the language elicited by active construction has not. This approach can be used to investigate systematic differences in descriptive/communicative messages which depend on perceptual features and action possibilities of different construction tasks. Thus, our study is unique in that descriptive messages are used to investigate the developmental relations of language and complex action in communicative situation. This work is consonant with the viewpoint expressed in earlier studies (e.g., Greenfield & Schneider, 1977) that an amodal cognitive organization underlies performance in all modes including language and action.

A PROPOSITIONAL FRAMEWORK FOR LANGUAGE AND ACTION

In the past we have conceived of this amodal cognitive organization as structured in terms of the propositional form of a case grammar. The idea that knowledge originating in perception can be represented propositionally is proving useful for understanding behavior in a wide range of cognitive tasks apart from language acquisition and the organization of action: memory for prose (e.g., Kintsch, 1972) and verifying information about pictures (e.g., Clark & Chase, 1972) are examples.

A proposition can be conceived as a state or change predicated of a single entity or a relation predicated between two or more entities. In logic, states or relations are called predicates; entities are called arguments. Some propositional notations characterize the internal structure of a proposition simply in terms of the number of arguments it contains. Case grammar, in contrast, specifies the nature of the relation between predicate and argument. Fillmore's (1968) case grammar describes various roles an argument may have in an event: Agent, Object, and Location are the names of the three arguments which are most relevant to the particular situation of our experimental tasks. Whereas Fillmore's original definitions were designed especially for linguistic phenomena, the role definitions will be more suited to an amodal cognitive structure if we eliminate reference to syntactic terms. We can then define Agent as a typically animate instigator of action. Object will be defined as something affected by an action or state. Finally, a

Location is the spatial position or orientation of an action or state. In the situation where someone places three beads in a cup (Figure 10-1, Task 1), the person functions as Agent, each bead has the role of Object, while the cup functions as a Location.

Our conceptualization of the predicate comes from Chafe's (1970) version of case grammar. Whereas Fillmore has a more detailed scheme for the arguments of a proposition, Chafe has a more developed way of treating predicates. In Chafe's view, the act of placing an Object in a Location (e.g., a bead in a cup) would be termed a Locative Action-Process. In this scheme, an Action expresses what someone, its Agent, does; while a Process expresses what happens to something. An Action-Process involves an Agent doing the Action to something. In our experimental situation we call this thing an Object. Locative Action-Processes come about through the combination of a Locative State (the state of being "in," in our example) with an action-process (placing). In Locative Action-Process, an Action-Process results in a change in Location.

Another aspect of our task involves attributes of the Objects or their Location. For instance, the beads in Task 1 (Figure 10-1) are different colors. The predication of a certain color of something is considered a State, or Property, of that thing. Thus, redness is a State, or Property, of one of the beads in our tasks. Finally, there are three discrete events (instances of Locative Action-Process) involved in Task 1. Each one has a place in a temporal sequence. Temporal specification is considered a state of the entire event or proposition.

Thus far, we have used the propositional frameworks of Fillmore and Chafe to describe a way of structuring one of the action sequences used in our study. The framework can also be used to analyze linguistic description of the action sequence. Analysis of language, of course, was the original goal of case grammars. Let us consider the following linguistic description of the first event in the bead task: "First I put the blue bead in the yellow cup". Each element in this sentence can be labeled according to its role in the underlying linguistic proposition.

First	I	put	the	blue	bead
Temporal State	Agent	Locative Action-Process		Property of Object	Object

in	the	yellow	cup
Locative State		Property of Location	Location

This example of linguistic and action analysis of the beads task shows how the same propositional elements can be used to represent the action and the linguistic description. The reader may have noted that the hierarchical structure of the role relations has not been preserved in this representation of the sentence. What this way of diagramming the sentence accomplishes is to specify the role of surface structure elements (the actual words produced in the order they occur) in the underlying propositional structure. Because this propositional structure represents the event also, this notational system allows the relationship between action structure and linguistic description to be indicated in quite a straightforward manner.

Indeed, the goal of our study is to understand how linguistic elements and elements from the event itself are used in the construction of a message. Another way of putting this problem is to talk about why certain aspects of the action structure are more often given linguistic expression than others. The notion of presupposition is relevant to such an analysis.

Information, Presupposition, and Linguistic Expression

Our basic hypothesis is that the elements in the message which are relatively certain from the nonverbal context tend to go unstated, while those that are relatively uncertain tend to be expressed linguistically. Here, our use of certainty and uncertainty captures the general sense of these terms as they are used in semantic information theory.[1] That is, a nonverbal element is totally certain when it is the unique possibility in the situation. It becomes relatively more uncertain as the number of alternatives it must be selected from increases. Thus, uncertainty is in the alternatives perceived in the context, and messages are informative to the extent that they allow selection of the element (entity or relation) referred to by the linguistic encoding.

A similar idea is put forth in Stalnaker's (1974) recent discussion of pragmatic presuppositions. He begins by defining pragmatic presuppositions as the background beliefs of the speaker, propositions whose truth he takes for granted or seems to take for granted in making his statement. In another article Stalnaker (1972) adds that the speaker assumes that these background beliefs are shared by the listener. This may not always be the case, but this shared knowledge is a prerequisite for successful communication. Stalnaker goes on to say:

> Which facts or opinions we can reasonably take for granted in this way, as much as what further information either of us wants to convey, will guide the direction of our conversation—will determine what is said. I will not say things that are already taken for granted, since that would be redundant. Nor will I assert things incompatible with the common background, since that would be self-defeating. My aim in making assertions is to distinguish among the possible situations which are compatible with all the beliefs or assumptions that I assume we share. (p. 199)

Thus, Stalnaker sees assertions or statements as functioning to partition alternatives that "are considered live options in the context" (Stalnaker, 1972, p. 388). On the other side of the coin, he views what can be taken for granted as going unstated. Stalnaker's analysis is most compatible with our idea, put forth elsewhere (Greenfield, 1978a; Greenfield & Zukow, 1978), that the state of certainty or the process of taking for granted is the cognitive basis for presupposition, while perception of uncertainty or change is the cognitive basis for assertion. Indeed, we have found that at the very beginning of language development, what is taken for granted goes unstated by the child, while uncertain or changing elements are given verbal expression in the single-word utterance (Greenfield & Smith, 1976; Greenfield & Zukow, 1978).

If communication is to be successful, the speaker should only presuppose elements shared by the listener. In our experimental communication situation, such elements could be the instructions and the array of materials. How would these presupposed elements affect the resulting linguistic description? First, let us identify the components of the linguistic description.

Strawson, a philosopher in the ordinary language tradition, is instructive here. According to him (1950):

> One of the main purposes for which we use language is the purpose of stating facts about things and persons and events. If we want to fulfill this purpose, we must have some way of forestalling the question "what (who, which one) are you talking about?" as well as the question "What are you saying about it (him, her)?" The task of forestalling the first question is the referring or identifying task. The task of forestalling the second is the attributive (or descriptive or classificatory or ascriptive) task. (p. 17)

Thus, the speaker must communicate to the listener: (1) what thing or things he or she is referring to or mentioning, and (2) what is attributed to or predicated of them.

The role of information and certainty in reference has been formulated in Olson's cognitive theory of semantics. Olson posits that "words designate, signal or specify an intended referent relative to the set of alternatives from which it must be differentiated. In the language of information theory we would say that statements reduce alternatives or uncertainty" (Olson, 1970, p. 264). It follows that statements are informative to the extent that they reduce uncertainty or eliminate alternatives. Olson cites Brown's (1958) earlier idea that objects are usually named at the level of generality which allows us to differentiate them from other objects of contrasting function. Thus, the fact that we use the term *ball* more than *baseball* or *sphere* reflects the nature of potential alternative referents: not usually golf balls or cubes, but rather bats, rackets, kites, skateboards. Thus, the very choice of a label reflects the set of alternatives psychologically present in a given context. Olson's analysis moves from word to message, which is defined as "any utterance that specifies the event relative to the set of alternatives" (p. 26q). Olson's formulation suggests the possibility of analyzing the various elements of a statement for their informativeness. This is precisely the task we have set for ourselves in the present study.

Olson goes on to give a specific example most pertinent to our experimental situation:

> The relation of an utterance to an intended referent can best be illustrated by a paradigm case. A gold star is placed under a small, wooden block. A speaker who saw this act is then asked to tell a listener who did not see the act, where the gold star is. In every case the star is placed under the *same* block, a small, round, white, . . . one. However, in the first case there is one alternative block present, a small, round, *black* . . . one. In the second case there is a different alternative block present, a small, *square,* white . . . one. In a third case there are three alternative blocks present, a round black one, a square black one, and a square white one. These three cases are shown in Figure 10-2.
>
> In these situations we would find a speaker saying the following for case one:
>
> It's under the *white* one;
>
> for case two
>
> It's under the *round* one;
>
> for case three
>
> It's under the *round, white* one (1970, p. 264).

This example shows how a given Property of State of a Location will be expressed verbally if there is an alternative value of the attribute dimension

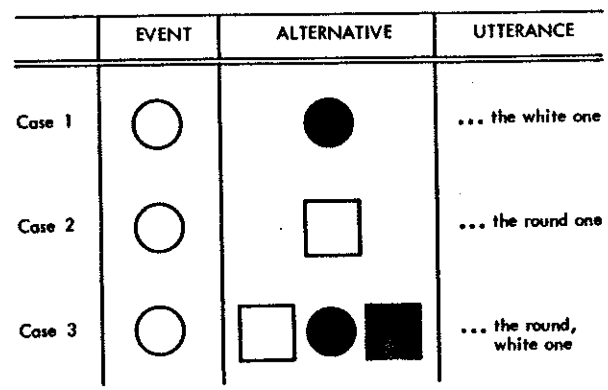

Figure 10-2. The relation of an utterance to an intended referent. From Olson (1970). Reprinted by permission of the American Psychological Association.

present in the context. Thus, for example, in specifying the Location of the star, a speaker will identify it by color if two Locations, similar in shape but varying in color, are present. In contrast, when two Locations are the same color but different shapes, the speaker will identify the Location by shape rather than color. In both cases, the resulting linguistic expression satisfies a basic requirement for pragmatic presupposition: the existence of a unique referent for each referring expression in an utterance. In each case the resulting linguistic expression is informative; it partitions a set of alternative referents.

Thus, in the second example, if color were the only property to be expressed linguistically, the speaker would not be making unique reference, and the listener could ask, "Which one?". Attributes or States of properties which do not contribute to the specification of a unique referent, by allowing elimination of alternative possibilities, should not receive verbal expression. So, where color is not a relevant attribute, ideally color will not be expressed in the speaker's linguistic description.

The Development of Referential Communication

A number of studies have looked at the development of the ability to uniquely specify referents by linguistic means. Many of these studies have been summarized by Glucksberg, Krauss, and Higgins (1975). They conclude that adults generally provide information to a listener which discriminates between the referent and potentially confusable nonreferents (Rosenberg & Cohen, 1966; Krauss & Weinheimer, 1967), but that this ability develops with age. Our study will verify this developmental trend by observing verbal descriptions in a variety of complex action contexts. Although one unpublished pilot study looked at communication in an action context (Glucksberg & Kim, 1969), linguistic expression of action was not analyzed. This task is central to our study. By investigating how children describe complex action in a communicative situation, it is possible to see the development of predication as well as reference. It is also possible to see just how cognitive and situational variables influence description.

OVERVIEW OF THE STUDY

We have four conditions for communication, and the listener's requirements remain constant across all four. Insofar as the speaker is adapting the message to the listener, there should be no difference in performance across conditions. Insofar as cognitive factors unrelated to communication to a listener intervene, there should be differences across conditions. In our study, children described their own actions in two of the experimental conditions, and those of another person in two other conditions. Another variation in conditions was whether the child described the action while it was in progress or afterward. The children represented two age levels, six and ten years.

We are concerned with the construction of messages which communicate meaning and with how this ability develops in children. Both the referential and predication aspects of the description can be analyzed because our study involves children describing action. The manipulative actions and materials of the tasks are analyzed for uncertainty, the verbal elements for informativeness. This analysis allows a discussion of which elements children choose to encode verbally in terms of what is given in the situation and therefore potentially pragmatically presupposed.

METHOD

Subjects, Procedure, and Design

A total of 96 children participated in the experiment. They were of varied race and socioeconomic status (all were native English speakers), and they were attending an elementary school in a middle-income neighborhood. There were 48 six-year-olds and 48 ten-year-olds with equal numbers of boys and girls.[2] All participants described a specific series of complex actions to an adult who, the child was told, could not see the action. There were four conditions and three tasks (action sequences) described. The tasks are shown in Figure 10-1. For each child the physical setting was the same. That is, one adult, experimenter (E_1) and the child sat on one side of a table with a second experimenter (E_2) sitting across the table. Between E_2 and the child there was a white wooden screen with an opening at the level of E_2's face (see Figure 10-3).

The children in each age group were randomly assigned to one of four conditions with the restriction that sex of the participants was balanced across conditions. Table I presents the four conditions and the instructions given for each task in a given condition. The basic procedure was to present the child with a model of the finished construction and the toys necessary to copy the model (plus distractors). Then E_1 either modeled the action and then had the child construct and describe it (active condition), or E_1 performed the action and the child described it (passive condition). The methods of combination were modeled to insure that the particular series of actions that were of interest were performed. This modeling also served to clarify the instructions. In addition to the activity dimension, there was a timing dimension. That is, the description was either simultaneous with the action (simultaneous conditions) or after the action (post conditions). If the

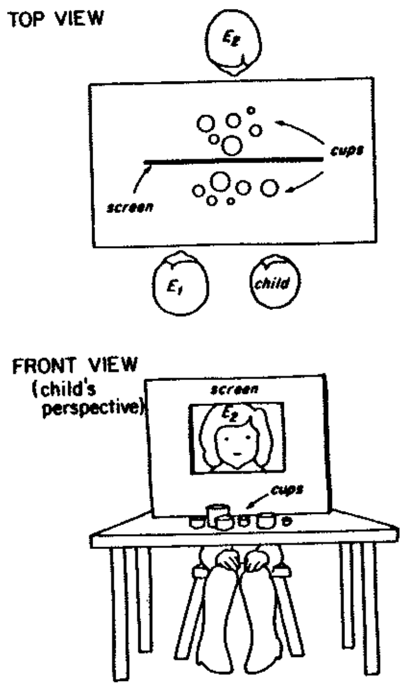

Figure 10-3. Schematic drawing of the experimental situation.

child did not understand the instructions, they were repeated, and it was stressed that the child should tell E_2 just what each action was. All sessions were audiotaped, and those in which the child performed the actions were videotaped.

As Figure 10-3 shows, all persons could see each other's faces; and the child could see only the face of E_2, not her hands or toys (E_2 always had the same toys as the child). Each child was told that E_2 could see the child's face but not his or her hands or what he or she was doing. In actuality, the E_2 could see what the child did and so always produced exactly what the child made. Since from the child's point of view the problem was to tell E_2 what she or he was doing so that E_2 could build the same thing, the child never failed. Each child described three tasks; the order of tasks was counterbalanced across sex and condition. (See Figure 10-1 for illustration of the tasks.) If a child did not perform the actions as modeled, then the particular construction involved was repeated after all three tasks had been performed. The instructions and modeling were repeated without change, and

Table I
Four Conditions of Action Description and the Instructions Given in Each Condition

	ACTIVITY	
Time	**Active (child performs action)**	**Passive (child watches E_1 perform action)**
Simultaneous (description simultaneous with action)	*simultaneous active* E_1 Here are your toys, and I'll give (name E_2) the same toys. This is what I want you to copy (E_1 points to model—model always present). E_2 can't see this, and she can't see what you're doing, so tell E_2 what you're doing while you copy it so that she can build the same thing. She can't see this, and she can't see what you're doing. So remember to tell her what you're doing. OK? Now watch me. (Demonstrates action.)	*simultaneous passive* E_1 These are my toys, and I'll give E_2 the same toys. I'm going to copy this (points to model—model always present). E_2 can't see this, and she can't see what I'm doing. You tell her what I'm doing so she can build the same thing. She can't see this and she can't see what I'm doing, so you have to tell her what I'm doing. OK? (E_1 performs action.)
Post (description after action)	*post active* E_1 Here are your toys, and I'll give E_2 the same toys. This is what I want you to copy (points to model —model always present). E_2 can't see this, and she can't see what you're doing. So when you're all done, tell her what you did so she can build the same thing. She can't see this, and she can't see what you're doing, so when you're all done, tell her what you did. OK? Now watch me. (Demonstrates action).	*post passive* E_1 These are my toys, and I'll give E_2 the same toys. I'm going to copy this (points to model—model always present). E_2 can't see this, and she can't see what I'm doing. When I'm all done, you tell her what I did so she can build the same thing. She can't see this, and she can't see what I'm doing, so when I'm all done, tell her what I did. OK? (E_1 performs action.)

the language used for the second performance of the tasks was used in the analysis of elements encoded. The simplest task was to put three specific beads out of five (Playskool wooden beads) in a yellow cup in any order (Task 1). The next most complex task was to combine the seriated cups using the pot method (Task 2), and the most complex task was to combine the seriated cups using the subassembly method (Task 3). There were distractor cups and beads so that the child could not simply use "I put the cups together" or "I put the beads in the cup" as a description and be sufficiently informative. For successful communication, a more detailed description was required; the elements to be used had to be differentiated from those not used in the actions.

The task which was most often repeated was the subassembly method of combining seriated cups. Thirteen ten-year-olds and 3 six-year olds did not perform this task correctly the first time, and so they described it a second time. There were 2 ten-year-olds and 2 six-year-olds who had to repeat the pot method of combining the seriated cups. No one performed the beads task incorrectly. The number of children who did not perform the task correctly the *second* time is as follows: 1 ten-year-old and 3 six-year-olds—subassembly task; 3 ten-year-olds and 1 six-year old—pot task. We used their second descriptions even though the task was not correct rather than not use the data at all. This should only provide noise in the data and the patterns that are found are robust to this noise factor.

Data Analysis

The audio tapes of the children's descriptions were transcribed, and these transcriptions were scored for expression of action elements belonging to the following categories: Agent (Ag), Object (O), Location (L), Action-Process (AP), Temporal State (TS), Property of Object (PO), Locative State (LS), Property of Location (PL). The derivation of these categories from Fillmore and Chafe has already been described. The application of these categories to the linguistic productions in the present study were derived from an "ideal" (maximally complete) description of the actions (see Table II). The categories are defined as follows:

Arguments

Agent (Ag): animate initiator of action-process
Object (O): inanimate entity affected by the action-process
Location (L): location or spatial orientation of the action-process

Predicates

Action-Process (AP): action which is performed by the agent and affects the object

Table II
Propositional Categories Used for Coding Expression of Elements

Task		Coding of Maximally Complete Descriptions*									
		TS	*Ag*	*AP*		*PO*	*O*	*LS*		*PL*	*L*
Beads	Pot method	First,	I	put	the	blue	bead	in	the	yellow	cup.
		Then,	I	put	the	green	bead	in	the	yellow	cup.
		Then,	I	put	the	red	bead	in	the	yellow	cup.
Cups	Pot method	First,	I	put	the	blue	cup	in	the	yellow	cup.
		Then,	I	put	the	green	cup	in	the	blue	cup.
		Then,	I	put	the	red	cup	in	the	green	cup.
Cups	Subassembly method	First	I	put	the	red	cup	in	the	green	cup.
		Then,	I	put	the	green	cup	in	the	blue	cup.
		Then,	I	put	the	blue	cup	in	the	yellow	cup.

*Type of propositional element Temporal State (TS), Agent (Ag), Action-Process (AP), Property of Object (PO), Object (O), Locative State (LS), Property of Location (PL), Location (L)

Temporal State (TS): modifier of action which indicates sequencing of action
Property of Object (PO): state or condition of object
Locative State (LS): state of object which results from locative action-process
Property of Location (PL): state or condition of location

The verbal encoding scores are based on the total number of combinatorial actions linguistically referred to by the child. A combinatorial action was defined as the putting together of two items from the array of materials; for instance, placing a bead in the cup (Task 1). Since each task is composed of three combinatorial actions with eight elements in each, a child could verbally encode from 0 to 24 elements in a task. Table II illustrates the coding of maximally complete descriptions. The actual frequency of linguistic encoding (0, 1, 2, 3) for each kind of element (e.g., Agent) was divided by the total number of combinatorial actions referred to, yielding a percentage score for each category (Agent, Object, and so on). In most cases, the children linguistically referred to all three actions comprising each task. Seventeen of the 96 children failed to refer to all three component actions for one or more of the tasks they described.

The scoring of a maximally complete and prototypical description is illustrated by the categorizations shown in Table II. Rules for coding less prototypical descriptions are as follows. Spontaneous self-corrections were not coded. Occasionally, a combinatorial action was linguistically encoded in two utterances or two conjoined simple sentences; for example, a ten-year-old began her description of the subassembly method for seriating the cups by saying,

(1) *Take the red one. I put it inside the green one.* Such productions were treated as the verbal encoding of a single combinatorial action. When a type of propositional element occurred in both utterances, it was counted only once. This happened most often with Action-Processes, as in this example (*take* in the first, *put* in the second).

Proforms used to encode the stimuli were counted as the deletion of an argument since such a form indicates that the referent has already been specified by the context, either verbal or nonverbal. (Osgood, 1971, provides empirical support for this interpretation of proform function.) Thus, if a child used pronouns as in *Put it in* or *Put the blue one in,* the Object element was coded as absent. The use of personal pronouns (I, you, she) to encode the Agent was, in contrast, counted because these do, in fact, partition the potential agents in the situation. From a semantic point of view, "thing" seemed equivalent to a pronoun and was coded as such. Similarly, use of a prolocative form such as "there" was coded as the deletion of Location. In general, if a word did not eliminate any alternative possibilities, it was not counted as verbally encoding an element. For this reason certain adjectives (Properties of Object or Location), such as "another," were not coded, but this was an extremely rare phenomenon.

Since most adverbs named the sequencing of actions (for instance, "first," "next"), it was decided to code only for Temporal State adverbs. Thus, some adverbial modification (for example, "together") was not counted in our system. In all but one case the verbs used were the action-process verbs "put," "take," "make," or "build," with "put" used by far the most frequently. One child used the action verb "goes," but this was coded in our action-process category. Locative States were most often the prepositions "in" or "inside," but prepositional phrases such as "on top of" and "on the right side" were also coded as Locative States.

The type of description which was most problematic for coding was that in which the child named only the colors of the cups. In this case the order of mention was used to determine whether the cup was Object or Location. For example, in the Pot task if the description were "blue /green/red" each of these words would be scored as verbally encoding Object since a listing of Locations would have been "yellow/blue/green." The latter never occurred. The Subassembly task was sometimes described as "red/green/blue." These were scored as verbally encoding Object since a list of Locations would be "green/blue/yellow." Again, this latter list did not occur. For the simultaneous active condition it was possible to check video-

tapes. If the object referred to was in the process of being moved or had just been moved, it was scored as Object. If the object named was not being moved and was a receptacle, it was scored as Location. In addition, when a child named the color of the largest cup, which was always a Location, this was scored as naming the location.

A repeated measures analysis of variance (ANOVA) was performed on these scores in order to ascertain how much of the variance in the scores was due to the effects of age, treatment conditions, and task structure. The propositional categorization of action was used as the repeated factor in the design so that a relatively detailed analysis could be made of the effect of within-task structure on linguistic encoding. Thus, the design was a 2(age) X2(activity)X2(time)X3(task)X8(action element) factorial design with repeated measures. The significant main effects and interactions are given in Table III. The probability levels of the F statistic are corrected using the conservative Geiser-Greenhouse correction (Kirk, 1968), since it is very likely that variance-covariance assumptions underlying the ANOVA were not met (cf. McCall & Applebaum, 1973).

Post-hoc analyses were performed to pinpoint the locus of significant differences. Where only two data points were involved, a t-test was used. Where more than two data points were involved, a simple main effects test (which tests for any difference among the points simultaneously) was used first. If this test was significant, then pairs of points were tested using a t-test. Since t-tests are not conservative and we are using them for post-hoc analyses, we set the alpha level at .01 in order to reduce the likelihood of Type 1 errors.

The results show that there are main effects of age, task, and type of action element. In addition, the following interactions were significant: task by type of action element, time by type of action element, and age by task by type of action element.

Table III
Results of the Analysis of Variance

Source of Variance	F	Corrected Probability Level
Age	4.22	$p = .043$
Task	17.77	$p < .001$
Type of action element	106.78	$p < .001$
Task X type of action element	26.92	$p < .001$
Time of description X type of action element	6.13	$p < .001$
Task X age X type of action element	2.52	$p < .025$

Task Analysis

The results are interpreted in terms of an analysis of the tasks based on uncertainty. Uncertainty arises when there are alternative entities to choose from or when entities or relations are changing. Thus, we analyzed the tasks in terms of when the entities (arguments) and relations (predicates) occurred in sets of alternatives at one point in time or changed as the task progressed. A summary of this analysis is shown in Table IV and explained below. First features common to all three tasks, and then features specific to each, will be taken up and analyzed with respect to uncertainty.

Table IV shows the patterns of uncertainty in the task analyzed for *alternatives* within each action and *change* across actions, the two basic types of uncertainty. Uncertainty about what is to be done (Action-Process) and the resultant relations among the materials (Locative State) exists within each action for all three tasks. That is, there are a range of possibilities for manipulating the materials. However, Action-Process and Locative State remain constant from action to action within a given task. From the speaker's perspective, the initial uncertainty about Action-Process and Locative State is exaggerated for the listener who, the speaker has been told, cannot see what is being done to the materials. Agent is, in one sense, relatively certain both within and across actions; that is, who will be performing the actions is specified in the initial instructions (Table I) and does not vary from action to action within a task. In another sense, Agent is uncertain within an action, for there exist three potential Agents within the experimental situation, the child and the two experimenters. For this reason, Agent appears in the left-hand column of the table with question marks next to it.

Table IV
Loci of Uncertainty in Each Task

	Alternatives Within Each Action	Change Across Actions
	Task 1. Beads: Pot method	
Arguments	Agent(?)	
Predicates	Action-Process	Property of Object
	Locative State	
	Property of Object	
	Task 2 (View a). Cups: Pot method	
Arguments	Agent(?)	
Predicates	Action-Process	
	Locative State	Property of Object
	Property of Object	Temporal State
	Task 2 (View b). Cups: Pot method	
Arguments	Agent(?)	
Predicates	Action-Process	
	Locative State	Property of Object
	Property of Object	Property of Location
		Temporal State
	Task 3. Cups: Subassembly method	
Arguments	Agent(?)	
Predicates	Action-Process	
	Locative State	Property of Object
	Property of Object	Property of Location
	Property of Location	Temporal State

In Task 1, the Beads task (Figure 10-1), the Agent must first select a bead rather than a cup. Therefore, the nature of the Object carries some degree of uncertainty. However, verbally encoding the Object with a noun ("bead") would be uninformative because it does not partition the alternative Objects, all of which are beads. The informative element is the Property of Object, because color or shape differentiates the subset of Object beads from the distractors. Property of Object appears as uncertain in the left-hand column of Table IV (alternatives within each action) because a bead must be selected from alternative possibilities on each move. Property of Object also appears in the right-hand column (change across actions) because a different Object must be selected for each move (Figure 10-1). Once Locative State has been communicated by the word "in," Location is, in contrast to Object, relatively certain, for the cup is, practically speaking, a unique container for the beads. Because there is only one cup in the array, there is no uncertainty about any Property of Location; all properties are determined once it is known that the Location is a cup. Since the beads can be placed in any order, Temporal State of the actions is not a relevant variable.

Task 2, seriation of cups by the pot method (Figure 10-1), differs in that the materials contain only one type of entity (argument), cups. For this reason, the nature of both Objects and Locations is totally certain. As in Task 1, uncertainty lies in the Property of the Object (Table IV) because a particular cup must be chosen as an Object for each move and because Property varies across actions. Unlike Task 1, a particular order of placement (from largest to smallest) is required to complete the task (seriate the cups). Therefore, Temporal State is a relevant variable (right-hand column of Table IV). (Although some children probably interpreted the modeled order in Task 1 as relevant, order would, overall, have been less salient than for the seriation tasks [2 and 3].) Within an action, Property of Location is never uncertain because once the Locative relation (inside of) has been specified and the Object selected, there is only one possible Location in which that Object could fit (see Figure 10-1). This is true because the seriated cups are combined from the largest to the smallest; the largest cup (yellow) is the only container in which the next largest (blue) will fit. In the simpler view of

Task 2, View a (Figure 10-1), the task can be seen as placing a series of cups in the largest yellow cup. Because the yellow cup is always seen as the Location, Property of Location does not vary across actions. The largest yellow cup is seen as the simple receptacle or pot into which all the other cups are placed. The Location is constant. The more complex view of the task (View b, Figure 10-1) involves seeing the last cup placed in the yellow cup as the location for the ensuing action. For example, first the blue cup is placed in the yellow; the next action then takes the blue cup, not the yellow, as its location. Thus, this view produces an additional source of uncertainty: Location, distinguished by its color or size (Property) changes across actions. Thus, it is possible to view the pot method of seriating cups as involving a variable Location for each move.

The task which involves the most uncertainty is Task 3, seriation of cups by the subassembly method (see Figure 10-1). In this task, cups are combined beginning with the smallest cup rather than the largest. Therefore, there not only exist alternatives of Property (color/size) for the Object of each action, but also alternatives of Location, identified by color or size (Property), since the smaller cups can fit into any of the larger ones (reflected in the left-hand column of Table IV). This was not true for the pot method of construction where the larger cups are placed first. As with the pot method, order (Temporal State) is a relevant variable across actions because of the constraints of seriation (right-hand column of Table IV). The Properties of both Objects and Locations also change across actions (also reflected in the right-hand column of Table IV).

If we weight each locus of uncertainty equally, this analysis shows an increasing degree of uncertainty from Task 1 to Task 2 (on either view) to Task 3. These patterns of uncertainty should lead to certain patterns of verbal encoding when the tasks are described. It was hypothesized that uncertain rather than certain elements would be verbally encoded. The resulting linguistic descriptions would thus be informative, for they would partition the alternatives existing for speaker and listener communicating about a particular task structure. In general, it was expected that within-action uncertainty would produce linguistic encoding of a particular element for the *first* action in a task sequence, while between-action variability would motivate the *continued* verbal encoding of an element during the second and third actions in a sequence. How particular patterns of information and certainty are reflected in specific types of linguistic productions will be described in the section that follows.

RESULTS AND DISCUSSION

The strategy of this section will be to present in detail the results of the analysis of variance, summarized in Table III, and to select concrete examples to illustrate the particular effect being described. In this way, we hope to communicate the linguistic flavor of individual performance, even though the analysis of variance is limited to giving us information about factors affecting the performance of a group as a whole. Because the linguistic descriptions are structured wholes, not a concatenation of elements, it is important to understand how people respond to discrete factors by creating comprehensible, structured descriptions, and examples will be needed for this purpose.

The main effect of age in the analysis of variance reflects the fact that ten-year-olds linguistically realize more than six-year-olds. More specifically, six-year-olds on the average verbally encode 33% of the elements in combinatorial actions they mention, while ten-year-olds verbally encode 43%. Since each overall task sequence contains 24 elements (Table II), these percentages mean that the typical six-year-old who refers to all three component acts is, on the average, realizing eight elements in linguistic form, whereas, a typical ten-year-old realizes ten. Here are two examples which illustrate these typical performances. They come from a six-year-old and a ten-year-old carrying out the same task (pot method for seriating cups) under the same conditions (child describes action while he or she is carrying it out).

First, the six-year-old, with an eight-element description:

(2) *Take a yellow / and then the blue / and then the green / and then the red*

(The convention in this example and the ones that follow is to place a slash between the descriptions of each component combinatorial action.) This six-year-old provides just enough information to specify the entities which will be used (Figure 10-1, Task 2), but fails to indicate relation among them by realizing the Locative State slot with a word such as "in." For this reason, the description can be considered communicatively inadequate.

In the next example, a ten-year-old provides the following ten-element description under the same circumstances (a false start, which the child undoes has been eliminated from the example):

(3) *I'm putting in the blue / putting in the green / putting in red*

This description is more communicatively adequate than (2) as the locative relation has been specified with the word "in" for each component act. While locations are never specified, they are quite certain once the object and relation "in" have been specified because there is at every point in this task only one cup into which a given cup, selected as object, could fit (see Figure 10-1, Task 2). This child does, however, use some redundant information, repeating "putting in" three times. Basically, the same information could have been communicated by, "I'm putting in the blue / the green

/ and the red" This would have contained only five propositional elements, one fewer than the less adequate communication from the six-year-old. These two examples demonstrate that a less adequate communication may contain either fewer or more linguistic elements than a more adequate one. It is the relation of the verbalized elements to the informational structure of the task which is crucial.

There is additional evidence that the ten-year-olds produced more adequate descriptions from the point of view of the communicative task than did the six-year-olds: there was a lower frequency of complete failure to refer to a component action in a task among the tens than among the sixes. Only 6 ten-year-olds left an action out of their descriptions, and they did so on one task only. In contrast, 11 six-year-olds did so, typically on two out of three tasks.

Discussion of the foregoing examples makes it clear that frequency of linguistic realization varies as a function of the type of element, and the reliability of this effect is confirmed by the analysis of variance (Table III). Figure 10-4 shows the amount of linguistic encoding for Agent, Object, Location, and each of the other categories of element. Looking at these results in relation to the analysis of uncertainty summarized in Table IV, we see

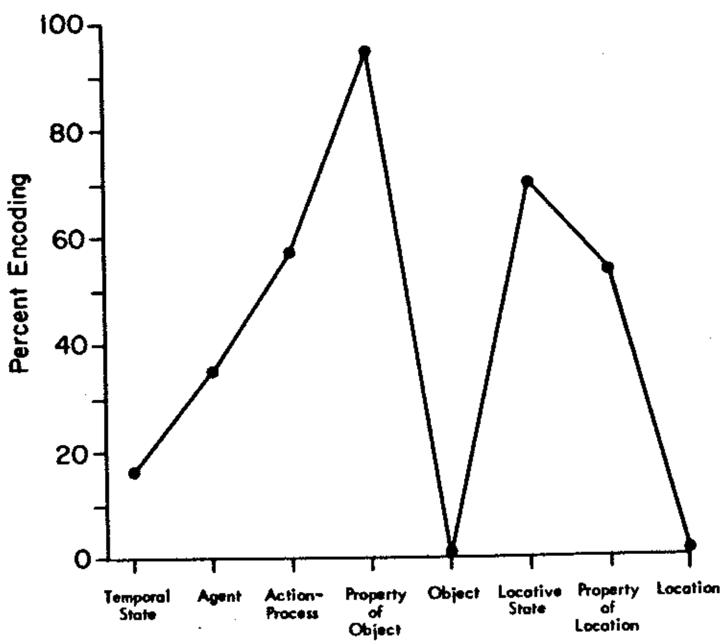

Figure 10-4. Linguistic encoding of different elements in a combinatorial action sequence.

that there is an overall correspondence, such that elements categorized most often as uncertain in the table are linguistically expressed most frequently. Thus, Property of Object, the most uncertain element across tasks, according to Table IV, is most often realized in the linguistic descriptions (Figure 10-4). Action-Process, Locative State, Temporal State, and Property of Location fall in the middle in terms of uncertainty as indicated in Table IV, and this middle position is, with the exception of Temporal State, reflected in the graph of Figure 10-4. The anomolous results for Temporal State, which encodes the variable of order, may stem from the possibility of communicating order information through the linear sequence of action and description. That is, the component acts are described in a given order. On the assumption that the listener is carrying out each component act as it is specified by the instructions, references to temporal order like "first," "next," and the like, would be redundant. This interpretation is supported by the nature of the significant interaction between time of description and type of action element, to be discussed below.

The Agent categorization is somewhat complex. By the criterion that the Agent is given in the instructions and is, therefore, certain, it should be linguistically realized only rarely. By the criterion that there are three potential agents present and therefore, there are alternatives, it should be linguistically encoded. The actual position of Agent in the graph just below the other members of the middle group thus seems to reflect both considerations. Finally, in Table IV, two categories never appear as uncertain: Location and Object. The graph in Figure 10-4 shows that these elements are encoded least frequently.

The analysis of another actual description will illustrate how aspects of our informational analysis of the tasks are reflected in the children's linguistic productions. The following example, from a six-year-old girl describing Task 1 (Figure 10-1) while she is doing it, matches the profile of frequency for various action elements shown in Figure 10-4.

(4) *I'm putting the red one in the yellow one / and the green one in the yellow one / and the blue one*

In example 4, as in the graph (Figure 10-4), Agent and Action-Process are mentioned somewhere around one-third of the time; Objects are consistently specified by their Properties rather than by a noun; Location is never specified by a noun and is sometimes omitted altogether; the Locative State is mentioned most, but not all of the time; and Temporal State is not encoded at all. Note that those elements that do not change from action to action (i.e., elements not appearing on the right side of Table IV for Task 1) stop being linguistically encoded as the task progresses. Thus, Agent and Action-Process (*I'm putting*) are encoded for the first action only, while Locative

State and Property of Location (*in the yellow one*) drop out after the second repetition. With respect to Task 1, this description is sufficiently informative to communicate the action to a listener, and even a bit redundant in the initial mention of *yellow* (to refer to cup) and in the repetition of *in the yellow one.* (Compare Example (3), which succinctly communicates the message without making any explicit reference either to "yellow" or to "cup.")

The discussion thus far has implied a different structure of information and certainty for each task and a correspondingly different pattern of linguistic encoding. These differences are manifest in the analysis of variance as a main effect of task, graphed in Figure 10-5. This main effect means that overall the proportion or frequency of elements encoded varies as a function of the task: Task 3, the subassembly method of seriating cups, elicits the highest proportion of linguistically realized elements (45 percent: typically 10 or 11 elements); Task 2, the pot method of seriating cups, elicits an intermediate amount (38 percent: typically 9 or 10 elements); and Task 1, the pot method of placing beads in a cup, elicits the least (31 percent: typically 7 or 8 elements). This order is consistent with our analysis of the uncertainty in the Tasks (Table IV), which shows that the loci of uncertainty become more numerous from Task 1 to Task 2 to Task 3.

This gradient of uncertainty should be, however, specific to certain action elements; Property of Object, for example, does not vary in certainty across tasks; whereas, Property of Location does (see Table IV). A corresponding concentration of the effect of task differences on the linguistic realization of particular elements is manifest in the analysis of variance as a significant interaction between task and type of action element (Table III). This effect is graphed in Figure 10-6. Post-hoc *t*-tests confirm what is clear from visual inspection: that differences are concentrated in the frequency of verbally encoding Locative State and Property of Location. The analysis of

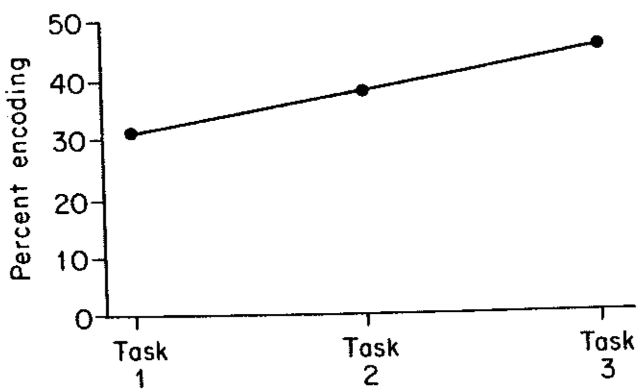

Figure 10-5. Amount of linguistic encoding as a function of task structure.

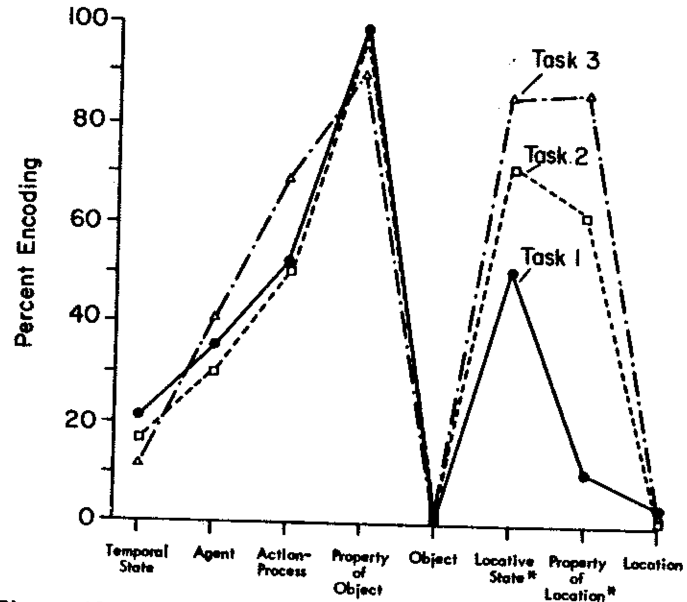

Figure 10-6. Effect of task structure on the linguistic encoding of different elements.
*Simple main effect significant.

uncertainty in the tasks (Table IV) shows that the Property of Location element is progressively more informative from Task 1 to Task 3 since it does not vary in Task 1, changes across actions in Task 2 (View b) and involves alternatives within action as well as change across actions in Task 3. This uncertainty pattern is reflected in the results which show that Property of Location is verbally encoded significantly more often in Task 3 than in Task 2, significantly more often in Task 2 than in Task 1 ($p < .001$).[3] The post-hoc *t*-test on the means for each task showed that Locative State was encoded significantly more for Task 3 than for Task 1 ($p < .005$). This is most likely due to the fact that Property of Location is uncertain in Task 3, and to name the Property of Location requires encoding Locative State. That is, for Task 3 children tend to say something like, "Put the red one in the green one," naming both Property of Object and Property of Location since both elements must be selected from an array of alternatives and both change across actions. They would not say, "Put red one / green one" because it is ungrammatical and nonspecific as to the entire Action-Process. However, when the Location is constant as in Task 1, the Locative State can be named once and then left out as in, "Put in the red / the green / the blue."

Specific examples will bear out the reality of this task analysis in terms of their effect on the actual linguistic behavior of individual children. The following examples are from a ten-year-old who described the experimenter's actions after each task had been completed; each description is prototypical in that it contains the mean number of elements used to describe that task, as shown in Figure 10-5. This child's description of the bead task realized 8 elements and goes as follows:

(5) *She put in the red / then a blue / and then a green*

In this description, Agent, Action-Process, and Locative State, constants throughout, are expressed one time each. The Objects, all beads, are specified in terms of their color Property each time an object is manipulated. Order is specified twice with *then*, the only "extra" elements in this communicatially adequate description. This description is similar to that of the ten-year-old presented earlier in Example (3), in that no reference is made to the yellow cup, a totally certain element once the relation "in" has been specified.

Compare her ten-element description of the pot method for seriating cups:

(6) *She put in a yellow one / then a blue / and then a green / and then a red*

One unusual but interesting aspect of this description must first be noted: although the distribution of the elements is consistent with the task structure, one part of the syntax is not; the yellow cup functions as Location, not Object, in the modeled action, yet the child says, *She put in a yellow one.* Essentially, *in* has been misplaced. The description is basically similar to the one elicited by Task 1 Example (5), except that the "pot" or container, identical to the one in the beads task, is verbally specified at the outset (*the yellow one*). This corresponds to a difference in informational structure: in Task 2, the "pot" must be selected from a number of alternative containers, all of them cups; in Task 1, in contrast, there is but a single container present, the yellow cup.

This same child gives the following eleven-element description of the subassembly method for seriating the cups:

(7) *She put the red in the green / the green in the blue / and the blue in the yellow*

Notice in this case that Location, which varies from move to move (Figure 10-1, Task 3) is specified via the color Property for each move. Once again, the uninformative word "cup" does not appear in the description. As we have seen in other examples so far, the absence of repetitive elements yields structures which are, from a syntactic point of view, conjoined.

These examples are a perfect illustration of Figure 10-6, which shows that the locus of task differences lies in the encoding of Property of Location and Locative State: in the Task 1 description, Example (5), no reference is made to Property of Location; the task 2 description, Example (6) mentions Property of Location once (*yellow one*); and the Task 3 description, Example (7) specifies Property of Location three times through mentioning color. The significant difference between Task 1 and Task 3 in frequency of encoding Locative State is also reflected in these examples: the Task 1 description, Example (5), includes the word *in* one time only; the Task 3 description, Example (7) repeats it three times, once for every move.

In contrast to the examples presented so far, some children seem to conceptualize the pot method of seriating cups as involving a variable Location for each move (Figure 10-1, Task 2, View b). This manifests itself in a description which linguistically specifies the Location of each Object as in the Subassembly Task. Here is an example from another ten-year-old who was tested in the identical condition:

(8) *You took the blue; put it in the yellow / took the green; put it in the blue / took the red; and put it in the green*

Thus, the mean amount of linguistic encoding of Locative State and Property of Location for Task 2, the pot method of seriating the cups, may well represent the average of a bimodal distribution in which some subjects linguistically encode it as if Location remains constant (the yellow cup) over moves, while others treat Location as a variable element (yellow, then blue, then green).

While the verbal descriptions of children of both ages reflect the different patterns of uncertainty in the different tasks, those of the ten-year-olds do so to a greater extent. This difference is manifest in the results of the analysis of variance in a significant interaction effect among age, task, and type of action element; this effect is graphed in Figure 10-7. The graph indicates that task variation in the tendency to verbally encode Property of Location and Locative State is greater for the ten-year-olds than for the six-year-olds. Thus post-hoc *t*-tests show a significant difference between six-year-olds and ten-year-olds in verbally encoding Property of Location and Locative State that is specific to certain tasks. Six-year-olds linguistically realize Locative State less often than ten-year-olds for Task 2 ($p < .01$) and for Task 3 ($p < .005$), but not Task 1. Six-year-olds linguistically realize Property of Location less often than ten-year-olds for Task 3 ($p < .005$), but not Tasks 1 and 2. Why this age difference does not manifest itself in the verbal encoding of the other highly informative element, Property of Object, is, however, not clear. It may relate to the greater salience of the moving Object in comparison with the stationary Location. Physical movement, being a type of change, constitutes a basic type of uncertainty. Hence, this

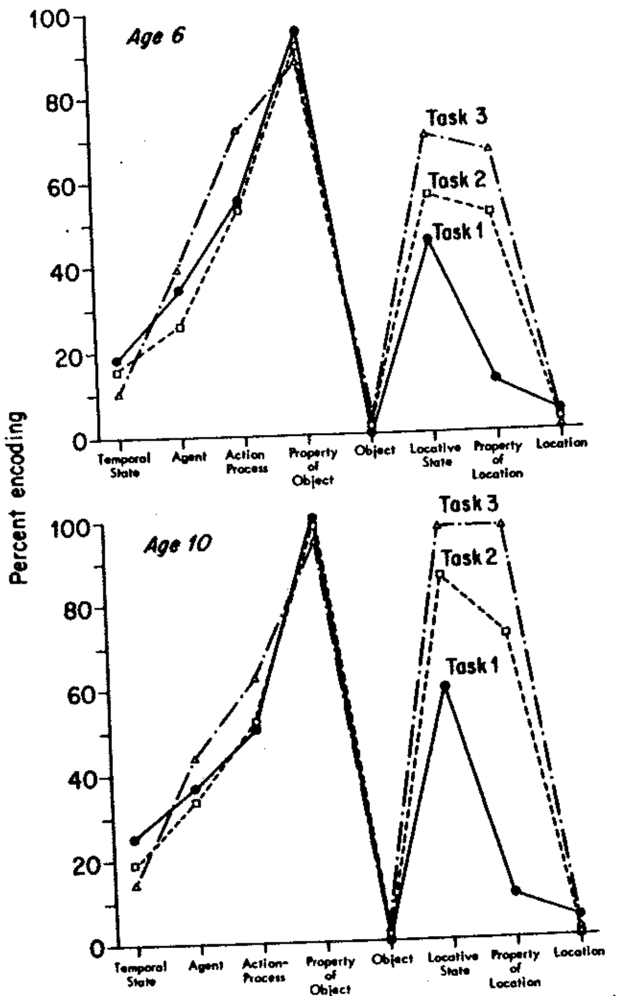

Figure 10-7. Age differences in the effect of task structure on the linguistic encoding of different elements.

result can be incorporated within the framework of an informational analysis.

When a task is described after it has been completed (post condition), rather than while it is being performed (simultaneous condition), some elements become more uncertain for the speaker, and others, more certain. This phenomenon is reflected in the results of the analysis of variance by a significant interaction effect between time of description and type of element. This effect is graphed in Figure 10-8. The basic fact revealed by the two curves is that, as we have seen in our other results, elements are linguis-

tically encoded more, the less perceptually obvious (and therefore more uncertain) they are. Temporal State, Agent, and Action-Process, no longer perceptible once the action is over, are encoded more frequently when description takes place *after* the action. Locative State and Property of Location, more perceptually obvious after the action has been completed, show the opposite effect. Two children have been selected to illustrate how certain propositional elements are encoded more frequently when descriptions are simultaneous with action, while others are encoded more frequently when descriptions occur after the completion of the action. One ten-year-old, in describing the pot method of combining seriated cups (Task 2), while he was performing the task (simultaneous condition) said:

(9) *Green into the blue / red into the green / blue into the yellow*

In comparison, another ten-year-old described the same task after he had performed the action (post condition) by saying:

(10) *First I put the blue one in / then the green one / then the red*

These examples are consistent with the results presented in the graph in Figure 10-8, which shows that when description is after action (post condition), Temporal State, Agent, and Action-Process are linguistically realized

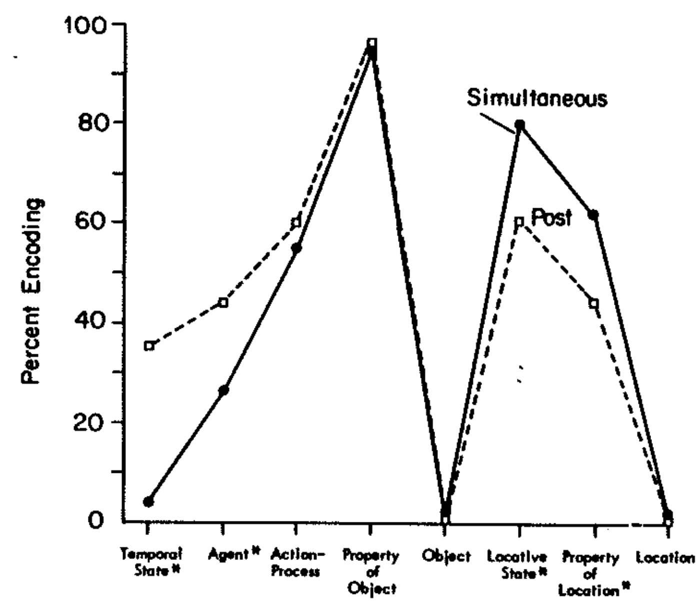

Figure 10-8. Effect of time of description on the encoding of different elements.
*t-tests significant.

more often than when action and description are simultaneous (TS, $p < .001$; Ag, $p < .05$, AP, ns.). At the same time, those elements that are less perceptually obvious *during* the action, i.e., Locative State and Property of Location, tend to be linguistically realized more when action and description are simultaneous (LS, $p < .001$; PL, $p < .025$).

SUMMARY AND CONCLUSIONS

We have presented a theoretical argument and the results of an experiment which relate to the communication of meaning. By approaching the problem of meaning from the perspective of communication, it is possible to analyze the effects of verbal and nonverbal context on the linguistic elements used to construct a meaningful message. This type of analysis is relevant to pragmatics as a branch of linguistics, in which the use of language in a given situation is studied. It is also relevant to psychology since it emphasizes the cognitive abilities which underlie the use of language. We are interested in the development of the ability to combine linguistic elements with elements of the nonverbal event context in order to construct a message. Developmental study of this problem is important because determining something of the progressive growth of the ability to comprehend and communicate can help elucidate some central problems in the study of language and cognition.

More specifically, it is possible to learn of the developmental interaction of the perceptual/cognitive system with the way in which language is used in context to communicate. A first step is to identify the relevant contextual variables and the cognitive abilities required to make use of linguistic and nonlinguistic elements in order to achieve effective communication. We have argued that uncertainty in the nonverbal context, and an amodal cognitive system which can coordinate performance in terms of perception, action and communication, are the important aspects of the communication of meaning. It is posited that this amodal system is structured in the form of propositions such that entities (arguments) are apprehended in terms of states or relations (predicates).

Uncertainty is being used in the information theory sense to refer to the state of affairs in which alternatives exist and choice or selection is called for. In addition, when an element is changing, it is uncertain in the sense that alternatives exist over time. Uncertainty can be seen as the cognitive basis of assertion, and certainty as the cognitive basis of presupposition. Using Stalnaker's (1974) definition of pragmatic presupposition—the background beliefs of the speaker—it is clear that if something is believed to be true, doubt or uncertainty does not exist. Since information, in the sense of allowing selection among alternatives, exists only when there is doubt,

something will tend to go unstated unless there is doubt in the mind of the speaker or perceived doubt in that of the listener. The resolution of uncertainty is the function of assertion. Pragmatic presupposition is the matrix of certainty within which uncertainty exists.

In order to further clarify the interrelation of uncertainty (the existence of spatially distributed alternatives or change over time) and language in communication, we performed a study in which children explained how to carry out complex action sequences involving physical objects to someone who could not see the action. Because the action tasks were predetermined, it was possile to do a clear-cut analysis of the various sources of uncertainty in each action task. The concept of a propositional organization of the cognitive system allows a parallel formulation of the organization of action and of the linguistic description.

The experimental situation was such that children of two ages (six and ten years) described construction activities for three tasks (beads into cup, cups seriated in two ways) to someone who supposedly could not see the action. The combinatorial tasks were analyzed for uncertainty in terms of alternatives within actions and change across actions for both entities (arguments) and relations (predicates). The transcripts of descriptions obtained were coded for the lingusitic realization of elements derived from a maximally complete description of the overall action sequence. When the probability of linguistic encoding was analyzed in terms of the factors of age, task, activity, time of description, and kind of element, a complex and interesting pattern of results was obtained. This pattern revealed the perception of uncertainty as a general cognitive process determining selection of elements for linguistic realization.

In general it was found that the descriptions of children of both ages were informative in that they tended more frequently to verbally encode the more uncertain task elements: Property of Object, Property of Location, Action-Process, and Locative State. These four elements were most frequently given verbal expression when type of element was considered independently of the other factors. In addition, when task was considered, it was found that the number of elements verbally encoded increased as uncertainty increased across the three tasks.

The pattern of results is basically the same for both six- and ten-year-olds. However, ten-year-olds generally verbalize more than six-year-olds. This tendency to verbalize more is particularly pronounced for Task 3, which has more uncertainty than the simpler Tasks 1 and 2. Thus, in comparison to the descriptions of the six-year-olds, those of the ten-year-olds reflect to a greater extent patterns of information and certainty inherent in the structure of a complex task. This is evidence that ten-year-olds are better at discerning communicatively important elements over a wider range of conditions. This finding is not inconsistent with those of referential communication studies which have shown that the ability to verbally encode distinguishing features of objects increases with age (Rosenberg & Cohen, 1966; Krauss & Weinheimer, 1967); however, it also indicates that the complexity of the referential situation must be taken into account in describing this ability. Our study extends the range of research on referential communication from the description of isolated object elements to the integrated description of action events.

A final factor which affects the verbal encoding of a message is the time of description relative to the action described. Elements which are not perceptually present to the speaker after the action has been completed (Temporal State, Agent, and Action-Process) are linguistically realized more often in the post condition than in the simultaneous condition where they are perceptually present. Elements which are not as perceptually obvious during action (Locative State and Property of Location) as after the action has been completed are, in contrast, linguistically realized more when description is simultaneous with action. Thus, time of description affects the linguistic message by changing the relative certainty of the various task elements for the speaker. Note that time of description does not affect certainty for the listener, who is always operating under the same conditions. Hence, the effect of time of description is a manifestation of egocentrism: the speaker's message varies to some extent as a function of his or her own informational needs, independent of those of the listener. This variation is not, however, so great as to wipe out the effects of patterns of uncertainty which are operative for listener as well as speaker (note the similarity of the two curves in Figure 10-8). Because of the size and nature of the effects, it seems unlikely that the differences under the two conditions were such as to render any descriptions communicatively inadequate. Thus, even though the speaker, age 6 or 10, is affected by his or her point of view, the message remains sufficiently adapted to the needs of the listener.

By using an experimental approach to studying the communication of meaning, we were able to manipulate contextual variables which influence the construction of messages. We found that age, task, and time of description affected the likelihood of linguistically realizing task elements. The activity factor, whether the child performed the task or watched an adult perform the task, did not produce a statistically significant effect; it seems that the tasks are simple enough that the child's understanding and linguistic encoding are not increased through active manipulation of the materials. By analyzing such variables, we have begun to delineate which aspects of the psychological and physical context predict what is chosen for linguistic realization in the construction of a message to communicate meaning.

Our study is not alone in stressing the importance of contextual uncertainty for the structure and content of what is said. Osgood (1971) reports a study of adults describing simple events involving the manipulation of physical objects. He interprets his findings in terms of the effect of perceptual variables on linguistic descriptions, and discusses presupposition and uncertainty in a manner consonant with our treatment. He stresses that presuppositions are nonlinguistic and dependent on contrasts in the context of the utterances. Uncertainty is used to discuss the choice of specifying adjectives in noun phrases. Osgood's findings with adult parallel ours with children. For example, Osgood concludes "if the perceptual entity must be contrasted with others of its class, then we find an increased likelihood of adjectival modification" (Osgood, 1971, p. 513).

Ford and Olson (1975) did a study of young children's (four to seven years of age) descriptions of objects where the context of alternatives was the major independent variable. They found, as we did, that even young children's utterances reflect the descriptive function of differentiating an event from a set of perceived alternatives. As the referential situation got more complex (more attributes and more stimuli), the performance of the younger children broke down, failing to reflect the informational structure of the situation. Similarly, Dickson (1979) found that referential communication between age four and eight was sensitive to the context of alternatives only when the differentiating attributes were salient. The pattern of these two studies also encompasses our finding that the six-year-olds' communications were less reflective of informational structure, the more complex the task. The fact that the descriptions of our six-year-olds were much less disrupted by the more complex tasks than the subjects in the other two studies probably relates to task differences; only our study involved communication about action.

These findings, like ours, indicate that if the referential situation is within their cognitive capacities, children conform to Stalnaker's (1972) notion that statements function to select from alternatives that are live options in the context. This idea is closely related to Chafe's (1976) notion of contrastiveness. The function of a contrastive sentence is to assert which candidate from an implicit list of possible candidates is the correct one in a particular context of background knowledge. The selected candidate, called the focus of contrast, is distinguished by higher pitch and stronger stress from other elements in the sentence. Our results indicate that linguistic realization per se may also distinguish a focus of contrast from other elements in the message where no set of alternative candidates exist. Take, for example, Tasks 2 and 3, where all the stimuli are cups, but the candidates can be distinguished by color. In this situation, color words are used to select from among the potential candidates, but the word "cup" goes unspoken. Note that this expansion of Chafe's concept is founded in the idea of the message as including both verbal and nonverbal elements. In other words, the entity, cup, is seen as part of the message even though it is not linguistically realized.

The conceptualization of our results is also related to the distinction between given and new information as articulated by Haviland and Clark

(1974; Clark & Haviland, 1977) and, particularly, by Chafe (1976). Chafe defines given information as "knowledge which the speaker assumes to be in the consciousness of the addressee at the time of the utterance" (p. 30). New information, in contrast, "is what the speaker assumes he is introducing into the addressee's consciousness by what he says" (p. 30). Chafe goes on to say that "given information is conveyed in a weaker and more attenuated manner than new information" (p. 31). Our results illustrate this distinction in the fact that elements tended to be linguistically realized the first time they occurred, i.e. when they were new, and drop out on subsequent appearances [see Examples (4), (5), (6), (7)].[4]

Pea (1979) has suggested salience as an alternative to uncertainty in the analysis of word choice by young children first learning language. Pea hypothesizes that children are more likely to mention situational elements which are salient. Greenfield (1980) points out that we must still understand the nature and determinants of salience and that uncertainty (in the sense of alternatives and change over time) helps account for why certain elements are salient. The salience of a given feature shifts as the context changes, and this shift is a function of alternatives and change.

Dent and Rader (1979) also deal with the relation of salience and uncertainty. On their view, salience implies relatively involuntary attention to single discrete aspects of the perceptual field. The perception of uncertainty requires distributed attention to possible alternatives or changes in elements. Thus, the attentional mechanisms that underlie the perception of uncertainty are more complex and structually tuned to the environment than those usually detailed to account for salience effects.

On the side of comprehension, there is evidence of a complementary effect of uncertainty in adults. Greenfield and Westerman (1978) gave verbal instructions to perform various tasks with nesting cups similar to the ones used in this study. Each set of instructions was presented in two different linguistic forms. It was found that where the task was perceptually obvious from the structure of the materials (e.g., instructions to seriate the cups in a nest) the linguistic form did not affect ease of comprehension. Where the task was not obvious from the materials (e.g., instructions to stack the cups in a nonseriated fashion), ease of comprehension was affected by the linguistic form. The implication is that comprehension processes bypass linguistic cues when characteristics of the nonverbal referential situation make them relatively obvious or certain, just as production processes omit what can be taken for granted. Studies of comprehension in children as young as age 2 have also revealed this phenomenon. Where the nonverbal context is such that the child sees fewer alternative interpretations of a set of verbal instructions, his or her use of syntactic cues (e.g., word order) declines (e.g., Bever, 1970; Huttenlocher & Weiner, 1971; Strohner & Nelson, 1974). The younger the child and the less knowledge he or she has of syntax, the more comprehension of the message depends on reduced alternatives, constrained possibilities in the nonverbal referential context (Strohner & Nelson, 1974).

There would seem to be two major directions for future research. One is to perform more fine-grained analyses of nonverbal indices of uncertainty in the type of describing situations used in the research discussed thus far. This would involve measures of attention to various aspects of the situation (cf. Greenfield, 1979). Eye-gaze would seem to be an obvious variable to measure. Possibly, physiological measures of arousal could be used to ascertain what aspects of an event are being attended to. These attention measures would then be used in conjunction with language analyses in an attempt to relate salience and perceived uncertainty to the content and structure of utterances.

The second direction of future research is to delineate at what points in development the requirements of the listener affect the descriptive utterances produced (cf. Ford & Olson, 1975). This research effort should involve both naturalistic and experimental data. All the data discussed in the present paper are experimental. Yet there are situations in real life where a person must describe something to another person who can't see what is being described. For instance, a parent in a separate room and out of sight of their child might call, "What are you doing?". The child then has to describe to the parent something that is only visible to the child-speaker. As for the experimental research, there should be studies that vary not just the events described and the age of the describer, but also differences in background knowledge between listener and speaker. This could be done, for example, by adding a condition in which listeners have a more diverse array of objects than do speakers and speakers are informed about this difference before they communicate.

In our view, meaning is the intended message, and this message is constructed through the coordination of perception, cognition, and language. One of the most important contextual variables to which the perceptual /cognitive system is sensitive is that of uncertainty; the system must be sensitive to the features of objects and actions which are relevant for detecting change and differentiating among alternatives for both self and others. Our study shows how the linguistic communication of children, aged 6 and 10, also functions to mark change and differentiate alternatives in the nonverbal context, thus manifesting the close coordination of language with other modes of cognizing a referential situation.

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NOTES

[1]For a more detailed discussion of the relation of our work to information theory, see Pea, 1979 and Greenfield, 1980.

[2]One child in the younger group was seven years, two weeks old. The teacher indicated that the child was six and when we found he had just had his seventh birthday we judged it appropriate to include him in the six-year-old group. Similarly, one child in the ten-year-old group was nine years, eleven months old.

[3]Some children seemed to interpret Task 1 such that the position of the beads in the cup was relevant. Thus, they indicated the position with a prepositional phrase that included an encoding of Property of Location where this Location is another bead (e.g., "put the blue next to the red"). The number of children who did this is as follows: 5/48 6-year-olds, 10/48 10-year-olds. Otherwise, Property of Location and Locative State would have been verbally encoded even less frequently than they were in this task.

[4]Haviland and Clark's distinction between new and old information in terms of whether or not knowledge is already in memory makes it less applicable to our experiment than Chafe's definition in terms of whether or not knowledge is in consciousness. For example, the fact that Agent is often mentioned for the first combinatorial action in each task does not, after the first task, seem to involve lack of memory of Agent so much as consciousness of Agent. That is, the listener could remember who served as an Agent on the first task, but, because of intervening instructions, be unaware of the relevance of the memory for the second task until brought to his or her conscious attention by the speaker.

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SUBJECT INDEX