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The Role of Mutual Knowledge in the Development of Perspective Taking

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Analysis of research on the development of perspective taking and social cognition leads to a new theoretical synthesis centered around the concept of mutual knowledge. Mutual knowledge is shared, and assumed by the knower to be shared, with other people. Attention to individual mental states, the usual subject matter of social-cognitive research, is necessary only in problematic interactions such as misunderstandings, deceptions, or other strategic interactions in which the ordinary assumption of mutual knowledge must be put aside. The present formulation is able to account for the structural transformations in social-cognitive development while retaining the processing capacity assumptions of the information-processing approaches.

Research on children's knowledge of the social world (Chandler, 1977; Shantz, 1975, 1984) has followed on the enormous interest in cognitive development of the last two decades. Social-cognitive development has been carved out as a research domain defined by the features that make the social world distinctive. Chief among these is perspective taking or taking the point of view of another person. Only in the social world are the objects of cognition simultaneously subjects of cognition. The attention to individual perspectives or mental states has, however, limited the scope of theories in this domain and led to unnecessary conceptual confusions.

In this paper, I argue for a different formulation. Instead of focusing on the aspect that makes social cognition unique, my focus is on a feature that all kinds of knowledge has in common—the fact that it is shared with other people. "Mutual knowledge" is a concept borrowed from the philosophy of language that forms the basis for my reformulation of current theories. From this point of view, a central issue for social-cognitive development is the child's growing understanding of the world held in common with others.

I begin with a review of current conceptions of perspective taking that contrasts an approach based on the child's growing capacity to form rep-

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resentation of other individuals with an approach based on the child's growing understanding of the relations between the perspectives of different individuals. As we will see, however, neither approach is adequate to account for the full range of phenomena. A case in point is presented in the subsequent section which reports a study of children's understanding of social strategies. The third section introduces the concept of mutual knowledge and its relationships to perspective taking and to the older concept of role taking. The fourth section sets out a mutual knowledge-based task analysis of perspective-taking problems which illuminates a developmental progression. I conclude by suggesting how this approach can be extended to the general study of cognition.

CURRENT CONCEPTIONS OF PERSPECTIVE TAKING

There have been two primary conceptions of social-cognitive development, each of which, in its own way, shows the influence of Piaget. The first keys off Piaget's notion of childhood "egocentrism" (Piaget, 1955) or the lack of differentation by young children between external reality and their own individual point of view, which results in a confusion of their own point of view with the point of view of other people. Much of the research in this tradition has really been about "psychological cognition," that is, the child's knowledge of others, in particular, their thoughts, intentions, and feelings (Shantz, 1975, 1984). A contrasting approach is taken by cognitive-developmentalists (Kohlbert, 1969; Selman, 1980) who focus on the development of special cognitive structures that form the basis for moral judgments and other interpersonal relations (Damon, 1977; Selman, 1980). The critical differences between these two research traditions can be seen in their approach to a task, the Nickel–Dime game, used by both in their research.

Psychological Cognition Approach

A considerable amount of research has shown increases over the preschool and elementary school years in children's ability to describe another's emotions, intentions, knowledge, and other mental states or perspectives (Shantz, 1975, 1984). In this research tradition, children's perspective-taking capacity is measured by presenting a problem in which the perspectives of two characters are at odds with one another (Chandler & Greenspan, 1972). Often the assumption is that development can be described, in information-processing terms, as an increase in capacity or cognitive resources (Shatz, 1978).

This assumption is most clearly seen in tasks in which two people are thinking about each other. In such situations an interesting phenomenon emerges. For example, Ernie, a character we will see more of later in this paper, can think about his friend Bert, and Bert can think about Ernie. But in addition, Ernie can think about Bert thinking about Ernie or about

Bert thinking about Ernie thinking about Bert and so on. When Ernie and Bert are both thinking about each other, an indefinite number of loops becomes possible. These loops have been called "recursive" perspective taking. An increase in perspective-taking capacity is seen as an increase in the number of recursions that the child can handle (Landry & Lyons-Ruth, 1980; Miller, Kessel, & Flavell, 1970).

Such recursive thinking has been identified in several games of strategy (DeVries, 1970; Shultz & Cloghesy, 1981). Flavell, Botkin, Fry, Wright, and Jarvis (1968), for example, used a simple game of strategy in which the subject had to guess which of two cups her opponent (actually a second experimenter) would choose. One cup had a nickel glued on top and a nickel under it; the other had a dime on top and a dime underneath. The subject"wins" if she correctly predicts her opponent's choice and removes the coins from the cup he then choses. At the least sophisticated level (judged by the subject's verbally stated rationale), the subject removed the dime simply because that seemed to be the opponent's most likely choice. At a more sophisticated level, the subject thought that her opponent would realize that she would try to block his (the opponent's) most likely move so she removed the nickel. At the most sophisticated level, this recursive consideration of what the opponent would think the subject would think was taken one or more steps further.

Flavell et al. comment that the point at which the child understands that these recursions can become an infinite regress "strikes one, intuitively, as an important milestone in the ontogenesis of social cognition" (p. 53). Whether this "infinity" level implies a qualitative change or simply a quantitative extension of the recusions is not made clear in their analysis. The value of this approach, however, is that these recursive levels of perspective taking both form a plausible developmental sequence based on increasing capacity and provide the beginnings of a task analysis for other experimental situations.

Cognitive-Developmental Approach

Perspective-taking recursions provide some of the most fascinating features of social cognition but one for which the theoretical interpretations have remained at odds. An alternative interpretation is found in the cognitive-developmental paradigm set out primarily by Selman (1980). Unlike researchers taking a more psychological approach, the structuralist paradigm does not take the individual mental state as the central topic. Their focus, rather, is on the relations between the mental states or perspectives (Feffer, 1970; Selman, 1980). Their concern with social relations motivates an interest in moral judgments (Kohlberg, 1969; Selman & Damon, 1975), understanding of conventions (Turiel, 1978), friendships (Damon, 1977; Selman, 1980; Youniss, 1975) and institutions (Furth, Baur, & Smith, 1976). The concern with relations is also consistent with a

theory of developmental change in which the progressive coordination of perspectives plays a central role (Kohlberg, 1969).

Over the last decade, Selman and Byrne (1974; Byrne, 1973; Selman, 1980) have outlined and documented a sequence of levels of perspective taking that children go through. Their descriptions and terminology have changed over time, but the general principles have remained the same. At the first level (about 5 to 9), they describe the child as recognizing that he and others have potentially different interpretations of the same situation. This fundamental perspective-taking ability forms the foundation for the levels that follow.

At the second level (about 7 to 12), the child attributes her own level 1 understandings to the other. This creates the possibility of recursions. It is important to note that at level 2 the recursions can be extended indefinitely so, unlike Flavell et al.'s levels, Selman's level 2 is not defined in terms of a certain number of recursions. The essential structural feature that characterizes this level is its "sequentiality." Each step in the recursive representation is constructed only after the earlier step is constructed.

At the third level (about ages 10 to 15), the child is able to attribute her own level 2 understandings to the other. The child can now construct a recursive representation and realize that the other is engaged simultaneously in the same activity and furthermore that the two actors mutually know about each other's activity. This differs from simple recursive perspective taking in that the actor can think in terms of the simultaneous recursive perspective taking of the two actors and see this as a system of mutuality. Children at this level, confronted with the Nickel–Dime game invented by Flavell et al., often throw up their hands in despair, realizing that whatever attempts at one-upping they make can be simultaneously anticipated by the opponent. This analysis may help to explain why a large percentage of the older children in Flavell et al.'s sample were not codable by their scheme based on a steady increase in recursive capacity. Perhaps these children were simply opting out of the task.

A Synthesis of the Two Paradigms

Flavell's and Selman's paradigms both have their strengths. Flavell's approach provides the beginnings of a useful task analysis for experimental purposes, while Selman's approach points to the phenomenon of level 3 mutuality, which is systematically overlooked by Flavell. In subsequent sections of this paper, I provide a theoretically motivated analysis of perspective-taking tasks that draws on both approaches and that provides a reanalysis of the course of social-cognitive development. The key to the synthesis is the notion of mutual knowledge which arises long before the kind of thinking identified by Selman as level 3 mutuality. I

argue that when children first begin to be able to think about other people's perspectives (Selman's level 1), they also begin to think about the beliefs they hold in common with other people. The early adolescent achievement of boredom with the Nickel–Dime game arises from knowing the strategies held in common with the opponent, a sophisticated form of mutual knowledge, the precursors of which can be found in much younger children.

A STUDY OF STRATEGIC PERSPECTIVE TAKING

The arena of social strategies seemed to be the liveliest domain for a confrontation of the two approaches to perspective-taking development I have reviewed. Newman, Dowley, and Pratt (1978) discovered a source of social strategies in a rather unexpected place: skits produced for telecast on *Sesame Street*. We were surprised at the intricacy of the social strategies that a Muppet character named Ernie used in interactions with his good friend, Bert. In several of the skits, we found Ernie playing elaborate tricks on Bert involving such maneuvers as pretending to misinterpret Bert and getting Bert to cooperate with him by using a false pretext. We were encouraged by the fact that, in spite of the intricacy, preschoolers enjoyed the skits. We were also encouraged by the fact that, in spite of the simple topics (e.g., sharing, being angry), graduate students were no less attentive, thus making it possible to compare interpretations across a wide developmental spectrum. The skits provided excellent stimulus materials with which to apply the kinds of interview techniques used by Selman (1980) and Flapan (1968) who investigated children's understanding of more ordinary social interactions. In what follows, I provide a brief overview of methods and findings of a study using these materials (Newman, 1981; Newman & Bruce, in press). These findings are a challenge to current approaches to social cognition because they highlight children's understanding of the characters' strategic use of mutual knowledge.

Method

Forty-eight subjects were interviewed to elicit their interpretations of three Bert and Ernie skits. There were 12 subjects from each of Grades 1, 3–4, 6 and college. The interviews lasted about 50 min and consisted of showing each skit (which lasts about 2 min) twice, the second time stopping the videotape at four predetermined places to conduct a clinical-style interview about the subject's interpretation of a particular crucial utterance and of the events in the skit up to that point. Most of the questions were aimed at eliciting the subject's interpretation of Ernie's plan of action, though others asked about Bert's reactions and thoughts. At the

end of each skit, several questions were asked about whether Ernie was being fair.

The interview procedure provided an in-depth picture of the subject's interpretation of what Ernie was doing. The coding scheme that we applied to the transcripts of these interviews was not guided by an a priori set of categories (e.g., levels of recursive perspective taking) but asked a large set of specific questions about what the subject thought (Newman & Hirsch, 1980). We used specific configurations of these features for each skit to define a small number of basic types of interpretation of Ernie's plan. What concerns us here is these general plan types that represent a summary of the interview as a whole.

An Analysis of the Interpretations

In the first skit, "Ernie Shares Bert's Cookie," Bert has a cookie. Ernie bursts on the scene and somewhat greedily tries to take it. But when Bert stops him, Ernie begins to try to talk the hungry and reluctant Bert into sharing the cookie. Ernie argues that if the cookie were his, he would share it with Bert. When Bert says he doubts that he would, Ernie takes the cookie, saying that he is just going to demonstrate. He gets Bert to ask him if he (Ernie) would share the cookie with Bert. Bert goes along with the pretend scenario and asks Ernie, who breaks the cookie in half, gives Bert half, and walks off eating his half self-righteously saying "see, I told you I would share it with you." Bert is left dumbfounded.

Children's interpretations of this interaction are presented in detail in Newman and Bruce (in press). Briefly, the coding revealed two quite different ways of understanding Ernie's plan. About half of the subjects, and these were predominantly first graders, believed that Ernie was trying to get the cookie shared or otherwise sincerely trying to show Bert the proper way to act. In these plans, Ernie wants part of the cookie and may even be acting unfairly, but he is not deceiving Bert. While it was usually the case that these children saw Ernie as fair, it was not always the case. For example, six subjects thought that Ernie divided the cookie unevenly in his own favor. These subjects, however, thought that Ernie would think he was being fair.

The remainder of the subjects believed that Ernie was trying to deceive Bert, and this trick made Ernie's actions unfair. There were several versions of the trick interpretation. In one of them, Ernie is trying to get part of the cookie but he is also conning Bert by leaving him with the impression that Ernie is sincerely concerned with sharing.

Comparing the two types of interpretation, we find that they are hierarchically related. The sincere plan is a component of the trick plan, that is, the sincere interpretation is the plan Ernie wants Bert to think is in effect. Like Bert, the younger children tend to be taken in by Ernie's

ploy. The older children see that sincerity and fairness is a facade Ernie constructs in order to reach his goal. The younger subjects, however, do not appear to be entirely unsuspicious of Ernie. But the suspicion is attributed to Bert sometimes adding to their evaluation of Bert as unfair. The belief that Bert is not suspicious of Ernie occurred predominantly among older subjects.

In the second skit, "Bert Gets Angry," Ernie comes up to Bert and asks if Bert, as a favor, would pretend to be angry. Ernie explains that he is just trying to imagine what people look like when they are angry. Bert objects that he has nothing to be angry about so Ernie suggests that he pretend that Ernie lost his favorite toy down the sewer. Bert gets angry and Ernie is delighted. Ernie gets him to be angry a second time, but on the third request Bert pleads that he is too tired to get angry again. At that point Ernie admits that he really did lose the toy and Bert faints.

Most of the subjects realized by the end that Ernie had deceived Bert and claimed that his statement, "I'm just trying to imagine what people look like when they are angry," was a lie. They believed that Ernie was trying to exhaust Bert or at least get him used to the idea that Ernie lost the toy. Nine of the younger children took a very different view. They thought Ernie was sincerely trying to learn about anger. Interestingly, five of these children thought Ernie was lying at the end when he claimed to have lost the toy—this was just another attempt to get Bert to display anger. Like the "Cookie" skit, we can see here a relation between the two kinds of interpretations. The sincere interpretation is the pretext Ernie constructs for carrying out his strategy of exhausting Bert.

In the third skit, "Bert and Ernie Share a Banana," Bert wants Ernie to share a banana and Ernie, after some prodding, agrees. But he immediately goes ahead and finishes the banana. When Bert objects, he hands Bert the peel saying "I took the inside part, here's the outside part for you."

This skit did not elicit two strikingly different kinds of interpretation. Ernie's trick was sufficiently explicit for even the youngest children to comprehend (in fact, Ernie says at the end "I was only kidding Bert," drawing attention to his deception). While everybody agreed that Ernie was lying when he said, "I'm going to divide this banana up so both can have some," interesting differences were found with respect to whether the subject understood that Ernie was telling the literal truth (Newman, 1982). Younger subjects missed the subtle joke contained in his lie. They do not see the way in which Ernie is playing on the understandings that we all (Ernie, Bert, and viewers) share about the meaning of the sentence he uttered (cf. Robinson, Goelman, & Olson, 1983).

Discussion

The subtle differences in the "Banana" skit are similar in important

ways to the grosser differences found in the other two skits. In all cases Ernie is playing on the understandings that he can expect Bert to have. It is obvious that the perception of Ernie's trick requires perspective taking, since the subject must form separate representations of the two mental states: Ernie's and Bert's. But since Ernie's tricks occur in the interaction, there is also a "mutuality" involved. Bert's understandings are not peculiar to Bert but are things that anybody would think. In fact, they are understandings that Bert would assume that Ernie shared as well. Ernie's tricks consist in manipulating the beliefs that (Ernie hopes) Bert assumes they both hold in common. These cases appear to require a synthesis of perspective taking and shared cultural knowledge. In the next section I attempt to sort out the conceptual issues and arrive at an adequate framework for understanding development in children's understanding of strategic interactions such as Ernie's, as well as of other perspective-taking tasks.

MUTUAL KNOWLEDGE

In this section I introduce a concept from the philosophy of language, "mutual knowledge," that is the basis for a reformulation of the development of social knowledge and perspective taking. We will see that mutual knowledge bears a superficial and sometimes confusing relation to recursive perspective taking. Sorting out the differences motivates a crucial distinction between perspective taking and what is more properly called "role taking." Armed with these distinctions, it is possible to set out a consistent analysis of developmental sequences in tasks as diverse as interpreting Bert and Ernie and playing the Nickel–Dime game.

Ordinary Situations

One thing that Ernie's strategies make clear is that deception mimics the cooperative activities he and Bert do together (e.g., a good lie sounds like the truth). So a characterization of deception must begin with a characterization of ordinary (cooperative) social interaction.

An "ordinary situation" can be defined as one in which the actors are not cognizant of any discrepancies between their two perspectives. Philosophers of language (Lewis, 1969; Schiffer, 1972) have noted something resembling recursive perspective taking in such ordinary situations. Schiffer illustrates "a very common, ordinary, feature of our everyday life" (p. 30) with the following example:

> Suppose that you and I are dining together and that we are seated across from one another and that on the table between us is a rather conspicuous candle. We would therefore be in a situation in which I am facing the candle and you, and you are facing the candle and me. (Consequently, a situation in which S is facing the candle and A, who is facing the candle and S, who is facing . . .) I submit that were this

> situation to be realized, you and I would mutually know* that there is a candle on the table. (p. 31)

Schiffer thus defines mutual knowledge* in terms of the following set of states (where S and A are the actors, k = knows, and X = some fact):

Sk X
Ak X
Sk Ak X
Ak Sk X
Sk Ak Sk X
Ak Sk Ak X

and so on. There is a crucial difference between this concept and the idea of recursive perspective taking, namely that in Schiffer's definition both actors are recursively thinking about each other simultaneously. In this respect the concept somewhat resembles the situation that Selman and Byrne refer to as level 3 mutuality. I argue that mutual knowledge is neither recursive perspective taking nor level 3 thinking. Rather, psychologically, it is a very simple notion that, nevertheless, as Schiffer argues, is the basis for any kind of social understanding.

Copresence heuristics. In their discussion of how speakers and listeners can refer to things and know (and know the other knows, etc.) that the other will know what is meant, Clark and Marshall (1981) present what appears at first to be a paradox. For somebody to be certain that another understands her words to refer to the same thing that she understands seems to require that she check the truth of all the propositions in Schiffer's definition. But, as they point out, referring to something in ordinary discourse could not possibly require that much processing.

To avoid this apparent difficulty and to account for the ordinariness of mutual knowledge, they suggest a set of heuristic strategies. Their idea is that if you know the fact that would form the grounds for inferring the infinity of states (given certain assumptions and a schema for induction), it is not necessary actually to go to the trouble of generating the inferences. In the case of the candle on the table between A and B, the grounds for inferring that there is full mutual knowledge is the simultaneity of A and B attending to each other and the candle and the assumption (that both make and can be expected to make) that the other is rational and would be drawing the same conclusions from the same facts. "This is what gives the copresence heuristics their power. Once one has found proper grounds for mutual knowledge, that is enough" (Clark & Marshall, 1981). Physical copresence is only one basis for mutual knowledge. They note that knowing somebody is a member of the same culture is the basis for a wide range of mutual knowledge.

Clark and Marshall go on to argue that if the person has the necessary assumptions and inferential machinery, mutual knowledge can be treated

as a "single mental entity." They also note that "When mutual knowledge is treated as a primitive, it follows that most cases of non-mutual knowledge will require a more complex memory representation." The kinds of scenarios in which somebody knows she knows something that the other does not know are harder to understand than the cases in which there was full mutual knowledge, they observe.

Mutual knowledge and mental states. Mutual knowledge does not call for perspective taking in the ordinary sense of thinking about another's private mental states. We can extend this analysis to mental states, themselves, which are commonly, but I believe incorrectly, assumed to require perspective taking. Mental states such as intentions or beliefs may be mutually believed. For example, Ernie and Bert can mutually believe that Ernie intends to demonstrate his sincerity. When mental states form part of the conventional rule system of communication, they are systematically available to both interactants. According to Searle's (1969) analysis, for example, mental states can be "expressed" in speech acts whenever they are specified in the sincerity condition of the act. On the assumption that Ernie is being cooperative (cf. Grice, 1975), Bert can work backward from the public act to the mental states implied. Since the speech act is a "public" act, both Ernie and Bert know that each knows that those mental states were expressed in the action. If we restrict the meaning of perspective taking to its common usage, namely, representing another person's particular or unique mental states, then we would hesitate to apply the term to our mutual beliefs about what people mean or express when they say things in ordinary conversation.

If we can assume that mutually believed mental states do not require perspective taking, then cooperative interactions like the sincere interpretations of the Bert and Ernie skits are also possible without engaging specifically in perspective taking. Cooperative social episodes require Ernie to have a representation of the activity Ernie and Bert are doing together, but Ernie's representation of the interactive situation will be assumed to be shared. Such interactions do, however, have differentiated roles. That is, Ernie and Bert both have different, though reciprocally related, plans. But role taking, I want to argue, is a different kind of thing from perspective taking.

Role Taking

The original concept of role taking as used by Baldwin (1897) and Mead (1934) is orthogonal to the problem of representing another person's individual mental states. For Baldwin and Mead the issue is the social construction of the self (cf. Kohlberg, 1969). The "roles" involved are not particular perspectives that are at variance with each other, but social roles that have a relation to each other. The problem for the child is to incorporate in her own sense of self the roles reciprocally related to her

(e.g., her playmates, parents, teachers) and to understand the general coordination of roles. These roles are public and often conventional; they are not hidden, private mental states that the child must discover.

Characterizations of young children as "sociocentric" (Garvey & Hogan, 1973) is a recognition that a shared social reality is a feature of the interactive competence of very young children. Observations of young children indicate that they are able to orient to facts of the social situation that apparently require mutual knowledge. For example, Newman (1978) has shown how a group of nursery school children created and sustained the fact that two of them had temporary rights over a toy and others did not during the course of a play episode. It is the collaborative coordination of social actions, both verbal and nonverbal, that keeps the social facts alive. From a very young age, coordinated activity provides a concrete representation of knowledge held in common with others.

An important difference between adults and young children is found in the complexity of the understandings that are shared and the objective truth of the assumptions. The child must learn the "social category information" (Higgins, 1981) and the "scripts" (Nelson & Gruendel, 1981; Schank & Abelson, 1977) that inform the child about what social facts are possible, what social functions are served by various role relations, and what the child and people playing a particular role can be expected to do. This knowledge, which is understood to be shared by others in the community, consists both of facts, procedures, social rules, etc., and of inference or reasoning processes. However, the development of this knowledge is not only an accumulation of facts. The sociocentric preschooler who already shares an array of social schemes with her classmates may still be "egocentric" in the important sense of not clearly differentiating between her own knowledge and the mutual knowledge shared in common. It is likely that the differentation of individual and mutual knowledge is part of the same process which results in the differentation between the self and other individuals that is usually called perspective taking.

Perspective Taking

Perspective taking occurs outside of mutual belief usually in strategic or problematic situations. Perspective taking becomes necessary, for example, if Ernie undertakes to convince Bert of something. Here Ernie may have to consider what facts would be persuasive to Bert given Bert's present knowledge state. Similarly, if Ernie and Bert cooperatively take on the problem of understanding the other's ideas, Ernie will have to form a specific representation of Bert's idea as distinct from his own.

Perspective taking also comes into play in situations of conflict or de-

ception. Whatever can be done cooperatively can also be done deceptively. Acting deceptively is more complex than a similar cooperative action because the deceiver must keep the false belief and the true belief in mind simultaneously. A con artist must maintain a careful differentiation between his own beliefs and those of the other without allowing that differentiation to become common knowledge.

As we have seen, deceptive strategies can involve the whole plan of action that Ernie and Bert are doing together. Bruce and Newman (1978; Bruce, 1980) have called plans such as the one that Bert thinks they are doing together a "virtual plan" since it only appears to be guiding Ernie's actions. In cases like these, Ernie must distinguish between his own view of the situation and the mutual view which Bert assumes to be shared and which Ernie, himself, must overtly act consistently with.

Perspective taking must be defined in terms of a differentiation of one's own perspective from that of the other and from that which is shared in common. Both kinds of differentiation must be considered if we are to analyze complex social understandings correctly. My introduction of the concept mutual knowledge is not meant to replace the concept of perspective taking. Rather it broadens the range of things from which an individual's perspective must be distinguished.

A REANALYSIS OF PERSPECTIVE-TAKING DEVELOPMENT

Drawing on the concept of mutual knowledge, I can now present a method for analyzing and representing perspective-taking situations. After defining the elements of a notation system, I apply it to the Bert and Ernie skit, discussed above. I then apply it to the Nickel–Dime game, reanalyzing cases originally reported by Flavell et al. In both cases we can discern a developmental progression which includes the concept of mutual knowledge. I then outline the implications for Selman's theory of levels and for task analyses based on levels of difficulty.

The Notation

Bruce and Newman (1978) applied a notation system to the representation of an episode from "Hansel and Gretal" in order to show the relation between the parents' plan to get rid of the children and Hansel's plan to counter their attempt. Using the same notation, a detailed analysis of the children's interpretations of Bert and Ernie is presented in Newman and Bruce (in press). In previous work we have used a two-dimensional version of the notation that allowed us to construct complex diagrams of the characters' plans. For the present purposes a linear version of the notation will suffice. This version is ideal for displaying the relations among perspectives and the embeddings involved in recursive perspective taking. It cannot efficiently display the content of the characters' or

actors' perspectives, but that level of detail is not necessary for the current exposition.

The notation uses capital letters to stand for actors or characters and lower case letters to represent mental states (b = believes and i = intends). So "Subject believes" is "Sb," "Other intends" is "Oi," and so on. *M*b stands for the mutual beliefs held in common by two (or more) characters. (We talk of mutual belief rather than mutual knowledge in this context since in the situations to which we apply the notation the truth of the propositions is often in doubt.) Physical, emotional, or social facts that are believed or intended are placed between quotation marks. (Normally, these are expressed as completed facts, but in this presentation they are occasionally expressed in active voice for ease of reading.) Square brackets are used to set off levels of perspective-taking embedding. Thus "the Subject believes that the Other believes that cookies are tasty" would be represented as

[Sb [Ob "cookies are tasty"]]

Each set of left and right brackets sets off what we call a belief space. It is important to note that belief goes in only one direction. That is, each level is opaque to the levels it contains. In the representation above, for example, Other does not know that subject believes he likes cookies.

Consider, to begin with, subjects' interpretations of the "Cookie" skit in which Ernie tries to convince Bert to share the cookie. (He does this by "demonstrating" he would share the cookie if it were his.) Many of the younger subjects took Ernie at his word. From their point of view, there were two *roles* but not two *perspectives*. Their interpretation can be represented using only a mutual belief space (cf. Newman & Bruce, in press):

$$\left[\text{Sb}\left[M\text{b}\begin{array}{l}\text{[Ei "convince Bert to share"]}\\ \text{[Bi "listen to Ernie's argument"]}\end{array}\right]\right]$$

An understanding such as this does not call for perspective taking as we are defining it. However, it does call for role taking, that is, understanding a differentiation of publily defined roles.

The subjects who understood that Ernie was tricking Bert clearly did perspective taking, since a contradiction is introduced between two perspectives on what Ernie believes. We can represent the basic structure as follows:

$$\left[\text{Sb}\begin{array}{l}\text{[Ei "trick Bert into sharing"]}\\ \text{[Eb [Bb [}M\text{b [Ei "convince Bert to share"]]]]}\end{array}\right]$$

The contradiction is between Ernie's intention to trick Bert and his in-

tention to convince Bert to share. The latter is found deeply embedded within Ernie's picture of what Bert thinks is mutually believed.

This particular structure appears to be a general structure for strategic interaction. That is, one actor thinks about how the other actor is understanding the shared situation. It can be made more complicated in a number of ways. For one thing, additional embeddings can be added *to the left of* the mutual belief level. Many viewers of the Cookie skit believed that Bert was suspicious of Ernie. Such an interpretation would require an additional embedding in order to represent Bert's perspective.

[Sb [Bb [Eb [Bb [*M*b [Ei "p"]]]]]]

A second way to add complexity to the basic structure is to add embeddings *to the right of* the mutual belief level. For example, Ernie can think about Bert's mutual belief in Ernie's recursive intention to get Bert to try to get Ernie to share the cookie with Bert.

[Sb [Eb [Bb [*M*b [Ei [Bi [Ei "share the cookie"]]]]]]]

In the discussion below of the Nickel–Dime game we will see other situations in which a mutual belief space is found at some middle level in the structure. These situations have in common one actor's consideration of how the other actor understands their mutually believed predicament.

A Reanalysis of the Nickel–Dime Game

The guessing game devised by Flavell et al. provides a good illustration of a developmental sequence in a somewhat different context. Watching the Bert and Ernie skit, the subject's task is to think about two characters but not to interact with them. The Nickel–Dime game is played against a live opponent. The relation between a subject's perspective-taking abilities vis-à-vis another person and her ability to attribute those skills to story characters remains an interesting empirical problem. Our notation, however, can be used to represent either kind of situation. By analyzing protocols provided by Flavell et al., I can demonstrate the role that mutual knowledge plays in perspective-taking development.

The game involves two participants: the subject and a second experimenter who plays the role of the guesser. The subject (the hider) has to hide either a nickel under a cup which is labeled with a nickel or two nickels under a cup which is labeled with two nickels. The guesser leaves the room knowing that when he returns either the nickel cup or the dime cup will have a coin under it.

At the simplest level of playing the game, the subject knows the rules that she shares with the opponent but is not using what we would call a strategy, i.e., she is doing role taking with respect to the competitive roles but is not doing strategic perspective taking. This basic understanding can be represented as

$$\left[\begin{array}{l} \text{Sb}\ \left[\begin{array}{ll} \textit{M}\text{b} & \text{[Si ``O does not find the coin'']} \\ & \\ & \text{[Oi ``O finds the coin'']} \end{array}\right] \end{array}\right]$$

[Si "The (nickel or dime) is hidden"]

Within the mutual belief space both parties understand that S is trying to prevent O from finding the coin and that O is trying to find it. S then hides one of the coins as is expected on the basis of the role she is playing.

Strategy A. The first strategy that Flavell et al. describe goes beyond the basic plan of action in that S now is hypothesizing about O's thoughts about the game. A typical example is illustrated in the following transcript (experimenter in parenthesis):

> Do you want me to tell you? (Umhum. Which one do you think he'll choose?) The dime. (You think he'll choose the dime cup. Why do you think he might choose that one?) He'll get more money—if the money is under there. (p. 47)

The child's reasoning is based on the fact that the dime is worth more than the nickel. (Flavell et al. carefully made that fact clear by using two nickels instead of a dime coin, which is smaller in size than a nickel.) It is safe to assume that the relative value of the coins is a background assumption that is not specifically attributed to either of the players. That is, it is mutually believed that the dime is more valuable. On the basis of that fact the child reasons about the other's most likely intentions. Thus, the representation of this strategy requires an additional level of embedding.

$$\left[\begin{array}{l} \text{Sb}\ \left[\begin{array}{ll} \textit{M}\text{b} & \text{[Si ``O does not find the coin'']} \\ & \text{[Oi ``O finds the coin'']} \\ & \text{``The dime is the more valuable coin''} \end{array}\right] \\ \quad \text{[Oi ``O gets the more valuable coin'']} \end{array}\right]$$

[Si "The nickel is hidden"]

Strategy B. Strategy B contains additional recursions in S's perspective taking. An example subject described her thinking as follows:

> (Why do you think he'll take the one-nickel cup?) Well, I figured that, uh, if it was me I'd take this one (two-nickel cup) because of the money I'd get to keep. But he's gonna know we're gonna fool him—or try to fool him—and so he might think that we're gonna take the most money out so I took the small one (the one-nickel cup), I'd go for the small one. (p. 47)

In this view of the situation, both S and O (i.e., O as S perceives him) appear to think they are one-upping the other. O thinks that he knows what S's trick is going to be but, S thinks that she knows what O's thinking is going to be. That is, while O is seen as having inferred what S's trick is going to be, he is not seen as being aware that S would know

that he would have inferred it. The structure of strategy B is a simple expansion of strategy A:

[[*M*b "Same content as in strategy A"]
Sb [Ob [Sb [Oi "O gets the more valuable coin"]]
[Si "The nickel is hidden"]
[Oi "The nickel is chosen"]]]
[Si "The dime is hidden"]

In this subject's thinking, it is as though O stepped outside (to the left) of the first strategy. O now sees the [Sb [Oi "p"]]structure that we saw in strategy A.

Strategy C. Flavell et al. provide the following transcript as an illustration of the level C strategy which they describe as "analogous to Strategy B but . . . carried one or more steps further."

> [1] Uh, when we were, he chose the dime cup the first time . . . and uh . . . well, let's see . . . I think that he would, I think that he would think that we would choose the opposite cup. (Opposite cup from what?) From the, in other words this cup, the nickel cup, [2] but then might, he might, he might feel that we, that we know that he thinks that we're going to pick this cup so therefore I think we should pick the dime cup, [3] because I think he thinks, he thinks that we're going to pick the nickel cup, [4] but then I think he knows that we that we'll assume that he knows that, so we should pick the opposite cup. (Okay, so we should pick the dime cup?) Yes. (p. 47, proposition numbers added)

In Flavell et al.'s analysis, strategies B and C are differentiated by a simple linear increase in the number of embeddings. A careful examination of the protocol suggests an alternative view.

One thing that makes this protocol particularly interesting is that it seems to be more a working out of the strategy than a simple report. An analysis therefore must consider each segment in turn. The first proposition refers to an event that both parties obviously had access to: in the demonstration trial, O chose the dime. This fact is the basis for the rest of the strategy, which hangs on what both parties would expect (and expect the other would expect) to happen next. S says that she thinks that O would expect her to hide the coin which is opposite from the one he picked. It becomes clear as the protocol proceeds that for some reason she assumes that this alternation procedure is known to both of them and is, in fact, mutually believed. The first proposition can be represented as follows:

[Sb [[Si "O does not find the coin"]
*M*b [Oi "O finds the coin"]
[Oi "The dime is hidden (on the practice trial)"
[Xi "The opposite coin is hidden (on subsequent trials)"]]
[Ob [Si "The opposite coin—the nickel—is hidden"]]]

The fact that O hid the dime is now represented as a mutual belief about what O had intended to do. The expected alternation procedure is represented as a mutual belief about what anybody ("X") would be expected to do on subsequent trials.

In Proposition 2, S begins to construct an elaborate "sequential" strategy like the one that we saw in strategy B. S sees O as stepping outside (to the left) of her thinking in Proposition 1. That is, S's thoughts about O are now attributed to O, and S changes her mind about what to choose. We can represent these thoughts as follows:

$$\left[\begin{array}{l} [M\text{b "Same content as in Proposition 1"}] \\ \text{Sb} \\ [\text{Ob [Sb [Ob [Si "The opposite coin–the nickel–is hidden"]]]}] \end{array}\right]$$

[Si "The dime is hidden"]

Our analysis of strategy C indicates that it is not simply an increase in recursions that makes it different from strategy B. We do find an additional recursion (4 levels in B and 5 levels in C), but the extra level in C does not come from extending the sequential strategy one more step. Rather it comes from using, as the basis for the sequential reasoning, a mutually believed fact that consists of an intention (to alternate) rather than a simple fact (the dime is more valuable). In other words, we find a greater complexity in the subject's understanding of what might be mutually believed between her and her opponent than is found in the lower level strategies. Such a difference cannot be accounted for by an increase in recursive capacity alone. There appears also to be a more sophisticated understanding of what she can expect the other to know about guessing games of this sort.

The microgenetic change in the strategy C subject from the first to the second proposition interestingly recapitulates the ontogenetic change that Flavell et al. illustrate between strategies A and B. In both cases, a recursive loop is added when O is understood to step outside (to the left) of the subject's initial perspective. A further step in the microgenesis of a strategy is suggested by a subtle change in the wording between Propositions 2 and 4. The difference between "he might feel that we know" and "he knows that we'll assume" might suggest that S has realized that the topic (his knowing that S would probably alternate) had become mutually believed. If we accept this interpretation, then the representation of the last propositions would look different from 2 above.

$$\left[\begin{array}{l} [M\text{b "Same content as in Proposition 1"}] \\ \text{Sb} \\ [\text{Ob [}M\text{b [Si "The opposite coin—the nickel—is hidden"]]]}] \end{array}\right]$$

[Si "the dime is hidden"]

This representation has the same form as Ernie's strategies illustrated above. Regardless of the correctness of this analysis of Proposition 4, the general pattern of change in which a sequential strategy collapses into mutual belief is quite plausible. As soon as the subject appreciates that the process of inferring each other's strategies is going on simultaneously, the recursions, themselves, would become mutually believed.

The Selman's Levels Reconsidered

The reanalysis of the Nickel–Dime game showed the importance of mutual knowledge. This factor also provides a basis for a reinterpretation of Selman's (1980) levels of perspective taking. Recall that in Selman's sequence of levels each level is a restructuring of the earlier one and contains emergent qualities. At level 1, the child is aware of other perspectives:

[Sb [Ob "p"]]

At level 2, the child attributes this ability to the other, thus setting up sequential recursive structures:

[Sb [Ob [Sb [Ob "p"]]]] etc.

At level 3, according to this theory, the child is able to step back from this system and view it from a "third-party" perspective. The mutuality of this level cannot be represented in our notation without the introduction of mutual belief. But we have seen that mutual knowledge plays a role in even very young children's social understandings. Thus there are important precursors to Selman's level 3, which do not play a role in his analysis.

The alternative to Selman's theory that I propose starts with the basic differentation between self and other characteristic of young children at level 1. But in addition to being able to represent the other person as distinct, the child can also represent mutual knowledge as distinct:

[Sb [*M*b "p"]]

At level 2, in addition to being able to represent recursive sequences, the child can represent strategic situations such as Ernie's tricks which we can represent as

[Sb [Ob [*M*b "p"]]]

Already at this level we begin to see what can be considered a "third-party perspective." To use mutual beliefs in social strategies (deceptively or cooperatively) requires considering how the interactional system

works (e.g., when the other is likely to make inferences). In other words the child is looking at the system from outside.

What Selman calls level 3 mutuality can now be interpreted as a very interesting special case of level 1. This can be illustrated with the Nickel–Dime game. Level 3 thinking in the Nickel–Dime game is characterized by the realization that whatever strategy S can think of can be simultaneously anticipated by O. These subjects typically give up trying to outsmart the opponent and simply choose randomly, hoping for the best. They realize that the sequential ("one-upping") strategy will be mutually known and so there will be no way to obtain an advantage. In the case of the Nickel–Dime game, the critical mutual belief is, itself, the level 2 sequential strategy. The understanding that these children have can be represented at level 1 as [Sb [*M*b "p"]] where "p" is the mutually understood level 2 strategy.

The level 2 strategy would necessarily have to precede, ontogenetically (and probably microgenetically as well), the "level 3" realization that it was mutually believed. In learning to play such a game, the child would work out strategies first in the interaction with another person before she could see that the strategy she just discovered is also available to the opponent. The "strategy C" subject analyzed above is apparently transitional between Selman's levels 2 and 3, attributing to mutual belief part of "what anybody knows about the game" but still tracing in a sequential manner other parts through several embeddings outside of mutual belief.

In situations that are not as interpersonally complex as the Nickel–Dime game, a child may be able to understand the use of mutual knowledge long before she can understand how to use mutual knowledge about inferences that, themselves, require recursive perspective taking. For example, Ernie's tricks involved the manipulation of Bert's belief about mutually believed intentions. The analysis of this is equivalent to level 2 understanding is supported by the interviews of children (Newman, 1982; Newman & Bruce, in press) showing that a majority of children beyond first grade understand the trick.

The notion that the differentiation of the individual perspective from the perspective of other individuals is part of the same differentiation that distinguishes the individual perspective from the perspective held in common with others has also found support. In a recent study (Newman, 1984), I used a version of Schelling's (1960) game of pure coordination in which pairs of children had to coordinate their choices of picture cards over a series of trials. On each trial, the pair seated across from each other was each presented with three cards that had the same pictures across trials, although their position and color changed. The task for the pair was to cooperate in choosing the same card as the other five times in a row. While the game of pure coordination may appear to implicate

Level 3 mutuality (Byrne, 1973; Schelling, 1960), the fact that second graders had little difficulty here suggests that the mutual construction of a sequence of choices calls for only the basic differentation characteristic of the beginning of school age.

One of the important contributions of Selman's theory is the notion of level 3 perspective taking. This level takes us beyond simple increases in capacity and accounts for the sense of infinite regress which is recognized as a milestone in social cognition. The concept of mutual knowledge, however, puts level 3 understanding in a new light. In this view, we can see the continuity of the child's growing knowledge of the world shared in common with others. Already at level 1, the child can differentiate that knowledge from her own individual perspective. Level 3 thinking does not require a new mental structure in Selman's sense. It can be understood more simply as the use of mutual knowledge of recursive strategies.

Task Difficulty Redefined

The concept of mutual knowledge helps to simplify an area of research that is often confusing. The distinction between recursive perspective taking and the embeddings that constitute mutual knowledge relieves perspective taking of the burden of accounting for phenomena that derive primarily from mutual knowledge. A revised concept of task difficulty can be of considerable value as a part of a psychological theory. This section outlines the conclusions for psychological task analaysis.

Mutual knowledge as "ordinary." One assumption that has emerged from this discussion is that mutual knowledge is identified with the unproblematic. Mutual knowledge is based on how things usually happen. The implication of the difference between the sincere and the trick interpretations of Ernie's actions is that somehow the shared world—the world in which the plans of the two characters are coordinated—is the least complex situation. In the terms of the notation structure, the mutual belief level is the zero point. Embeddings to either the left or right (i.e., outside or inside) of mutual belief represent additional complexity.

Perspective-taking levels. The levels of perspective taking can be thought of as locations in which cognitive processing takes place. By processing, I mean cognitive activities such as representing a situation, formulating a plan of action, drawing an inference, etc. We can assume that the further from mutual belief these processes have to be carried out, the more difficult they will be. At the first level, unselfconscious or "mindless" (Langer, Blank, & Chanowitz, 1978) actions take place, in some sense, in the mutual belief space—in the world assumed to be shared in common. Conscious planning or what is often called "metacognitive" activity (Brown, Bransford, & Ferrara, 1984; Flavell, 1979) requires, in terms of the current discussion, stepping back from the shared in

common world to consider its properties. Ernie's unproblematic knowledge of "p" can be represented as

[*M*b "p"] (where E has *M*b with either Bert or general other),

while the case of his having to stop and think about "p" can be represented as

[Eb [*M*b "p"]].

At this level, Ernie is just thinking about the fact "p," perhaps questioning whether it is true. When Ernie consciously plans a speech act, for example, he considers how best to influence the current set of mutual beliefs that he shares with Bert. When Ernie plans a strategic deception, like that which we saw in the cookie skit, then another level is formed. We can continue defining more complex belief spaces by adding additional embeddings, but there is, of course, a limit. Hansel's counterplan that we described elsewhere (Bruce & Newman, 1978) required an embedding beyond those we needed to represent Ernie's tricks. Interacting plans more complex than Hansel's are very rare.

But measuring recursions or embeddings is far from a straightforward matter for psychological task analysis. Several interesting empirical questions remain.

First, embeddings of beliefs may occur inside or outside of mutual belief and these two kinds of embeddings are quite different. The embeddings outside of mutual belief are not consistent with what the other believes. The embeddings inside of mutual belief are by definition shared by the two actors and are based on shared understandings and inference procedures. The total complexity of a situation is some combination of the embeddings to the left and the right of mutual belief but the actual function remains an open question.

Second, the difficulty of representing a level may be closely related to the content of that level. Presumably the content that is different from the next lower level will give that level a certain weight that would have to be considered in reckoning its demand. An embedding that is empty in the sense that contains nothing other than the next lower space should require less effort. Thus the "empty" embedding formed when the subject observes, but does not interact with, a story character may add little to the complexity of the situation. Likewise, we should expect that complex strategies should be more difficult to represent than simple strategies formulated at the same level (cf. Newman & Bruce's, in press, analysis of the difference between Ernie's trick and con plans).

CONCLUSION

I have outlined an alternative conception of social cognition that changes the focus from understanding and coordinating private thoughts

to understanding and using the cultural knowledge we share in common with others. This reformulation also makes social understandings less of a special case. The research domain of social cognition is usually defined in opposition to the domain of "cognition." The opposition of these two domains may not be at all necessary, however. Piaget (1973) himself clearly considered the logical and social to be indistinguishable, describing development as the "socialization of individual intelligence." In their study of spatial understandings, Piaget and Inhelder (1956) used the famous "three mountains" task to demonstrate the inability of young children to coordinate a set of possible perspectives on an object. While the study is often cited as a forerunner of the field of social-cognitive development, Piaget and Inhelder were studying the concept of space, not the concept of other minds per se. It is just that for Piaget, the coordinated concept is essentially a socialized concept. Thus, his famous notion of egocentrism is as much logical as social.

Rationality is not something that applies only to the child's private thoughts. It originates in social interactions and is the essential basis for community membership. For both cognitive and social-cognitive development, the central process is the acquisition of shared knowledge. Social cognition raises the special problem of learning what (under particular cultural circumstances) others would think and learning to make use of that information—to reflect on the fact that others would also come to those conclusions.

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