Understanding Human Action
Charles F. Schmidt
Rutgers University
New Brunswick, N.J.

INTRODUCTION

Wittgenstein has said, "If a lion could talk, we could not understand him" (1958). The point of this rather cryptic comment is undoubtedly Wittgenstein's contention that we have knowledge of the lion's social reality. Consequently, Wittgenstein would contend that this lion's exhibition of speech would not result in our being able to communicate with him nor he with us.

If Wittgenstein were here today, he might well contend that a computer that isn't understand the forms of life of man will not really be able to understand the speech of man.

Such an assertion would probably generate quite a bit of controversy amongst those of us interested in natural language understanding. Clearly, how one reacts to this assertion will depend upon how one assesses the notion of understanding. As a psychologist primarily interested in how persons understand and communicate with each other, I am inclined to take Wittgenstein's contention quite seriously.

The work on belief systems, which will be discussed here, has been aimed at exploring and explicating this relationship between language use or language games and the larger social reality or forms of life within which these language games are played. Consequently, the focus of this work has not been upon the parsing of sentences nor even upon the understanding of aragraphs, but rather upon the understanding of human action.

In pursuing this line of research, it has been assumed that language use is not understood in this narrower sense of understood unless what someone says can be elated to and understood in terms of the speaker's beliefs, intentions, and goals.

The central notions in reasoning about human action are the concepts of a plan and a reason or motive for performing a plan. Person's action is explained or understood when this action can be identified as part of the actor's plan and the reason why the actor chose to perform that plan can be given.

A model of how persons reason about human action must include then: (1) assumptions about how actors reason about human action, that is, how a person arrives at a plan; (2) assumptions about what can count as a reason for a person choosing to perform or carry out a plan of action; and, finally, in order to use this theory as a recognizer of plans one must include (3) procedures for moving from the observation or linguistic report of actions to the identification of the plans and motivations that have generated these reported or observed actions of other persons.

Natural language is used to describe, explain and evaluate human action and speaking is itself a human action. Thus, natural language provides both the meta-language that is used to discuss human action and the vehicle for performing the various human actions which Austin, Searle, and others (cf. Austin, 1962; Searle, 1969; Strawson, 1964; Gandhi, 1974) have referred to as speech acts. Consequently, a goal of this research is to develop a system which will accept a linguistically encoded description of a sequence of actions and then be capable of answering questions about the beliefs and motivations which the system believes explains these actions.

Since natural language represents the meta-language within which human action is described and explained, natural language has been examined in order to identify the concepts which are peculiar to the discussion of human action. Once these concepts are identified, then the problem is one of determining: (1) how to represent these concepts; (2) how these concepts are organized into a "theoretical" system; and (3) the nature of the processes which use this system of concepts to reason about reported or observed actions. In the development of BELIEVER some fairly concrete ideas about the representation and organization of these concepts have been developed and various procedures for using these concepts to identify the plans and purposes of the actor have been tried, but this latter problem remains an area where a great deal of work must yet be done.

In order to try to communicate our thinking as succinctly as possible the introduction of technical notation will be avoided. The papers by Schmidt (1973) and D'Addamio (1973) and by Bruce (Bruce and Schmidt, 1974; Bruce, 1974) all focus upon representation and organization. The papers by Schmidt (1973) and Brown (1974) discuss the implementation of earlier algorithms for plan recognition and the interested reader is referred to these papers for additional detail and technical discussion.

The assumption that action is understood by attributing a plan and motive to the actor has highlighted the importance of the following types of concepts which are found in natural language. Those concepts which have figured prominently in the theoretical development are: (1) Act such as: give, buy, say, ask, promise, help, ... (2) Act Relations such as: make possible, motivate, prevent, allow, ... (3) Cognitive
States such as: believe, know, expect, ...
(4) Dispositional Properties such as: can, ought, ...
(5) Motivational States such as: want, desire, ...
(6) Role Relations such as: father of, friend of, ...
(7) Evaluative States such as: values, likes, hates, ....

Conceptual types 1 through 3 above and the concept of 'can' figure most prominently in reasoning about plans, whereas conceptual types 5 through 7 and the concept of 'ought' are importantly involved in reasoning about motive.

II. PLANS AND THE REPRESENTATION OF ACTS

Considered from the point of view developed here, a plan is not simply an appropriately structured sequence of actions.

Rather, a plan is the internal representation or set of beliefs about how a particular goal may be achieved that is attributed to the actor in order to explain the observed or reported actions of that particular actor. This distinction is important to recognize in thinking about human action. Failure to maintain this distinction can lead one to consider the following two statements to be equivalent: (A) P performed act(i) and state(k) was a consequence of act(i) and state(k) enabled P to perform act(j). (B) P performed act(i) and state(k) was a consequence of act(i) and state(k) enabled P to perform act(j) and P performed act(i) in order to be able to perform act(j).

It is obvious from the way in which A and B have been stated that B implies A but not the converse. The second statement attributes to the actor the belief that doing act(i) would result in his being able to do act(j). Thus, the logic of explaining action in terms of plans involves more than a recognition of an intersection between a consequence of one action and a precondition on some subsequent action. If it did not our jails would be much fuller.

If plans do involve beliefs of this type and if we agree that statement A does not imply statement B then precisely how are we able, as observers of actions, to move at times from an observation or report which satisfies A to a statement equivalent to B? One possibility is that we might directly observe beliefs. Except for a few staunch believers in ESP, this position seems to have very few adherents. A second possibility is that we are able to make observations of one kind or another which are independent of the observed actions which allow us to regularly and reliably infer the beliefs states of others. There are a few psychologists who seem willing to argue for this position in principle although I know of no psychological evidence to support this position. In any case, it seems unlikely that our commonsense theory of human action contains rules of inference of this type which have somehow escaped the notice of the scientists in psychology.

Having argued that beliefs are attributed to another neither through a process of deduction nor a process of induction, the problem of trying to characterize exactly what kind of 'logic' is involved remains. The logic of this type of reasoning may be roughly characterized in the following way.

First, if the observer has made some observation which is of the form of statement A, then the observer recognizes that this observation counts as one reason for believing that a statement of the form of B is the case. The observer may know or believe other propositions which may also count as reasons for believing a proposition of the form of B and the observer may know or believe still other propositions which may count as reasons for not believing that a statement of the form of B correctly characterizes the beliefs of the actor. Next, the consistency of these various reasons must be assessed. The action is understood when the observer has arrived at some consistent set of reasons for attributing to the actor certain beliefs and motives which explain the actor's performance of the action in question.

Now if this accurately characterizes the reasoning process, then acts must, for purposes of reasoning about plans, be represented in a fashion that will yield access to the kinds of beliefs that must be attributed to the actor if his action is to be described using a particular act concept. For example, the action 'P handing a quarter to R' where P and R are two different persons, may under various circumstances be described as an act of 'buying,' 'repaying,' 'helping,' and so on. Which particular description is most appropriate will depend upon whether or not there is a basis for attributing to the actor, P, the additional beliefs and motives that are implied by the concepts 'buy,' 'repay,' and 'help.' The class of actions termed speech acts has been extensively discussed and the nature of our approach to representing acts may be briefly exemplified by the speech act 'request' or 'ask.' Table 1 presents in a very informal way the kinds of information which must be represented and associated with 'request' in some way in order to capture the structure of the plan or subplan that 'request' stands for. Those terms in Table 1 which have been capitalized form the basis for the formal representation of speech acts. Except for those statements which appear under the subheading of Outcome Possibilities, each statement refers to psychological states of the actors. Thus, an act name is simply a way of organizing a set of beliefs about how a 'move' of this type might be related to other moves or actions and to the cognitive and motivational states of the actors.

The statements referred to as the Can Conditions express those conditions which must be true in order for this action to have been planned. Cl expresses the fact that the agent must have believed that he was able to transmit his message to the recipient. This is expressed at a very
Act Name: Request

Argument List: agent: A; recipient: R; message: M; requested response: X

Can Conditions: C1: A EXPECTS that A CAN CAUSE some action such that that action results in R KNOWING A's message. C2: A EXPECTS that R will CHOOSE to UNDERSTAND A's message C3: A BELIEVES that R BELIEVES certain propositions; AND A EXPECTS that [R's KNOWING A's message AND R BELIEVING certain propositions] will result in R BELIEVING: (1) A WANTS X (2) A WANTS R to CAUSE X (3) A BELIEVES that R CAN CAUSE X (4) A EXPECTS that A's REQUESTING may MOTIVATE R to CAUSE X (5) A BELIEVES that R was NOT MOTIVATED to

CAUSE X prior to A's REQUEST.

Goal Hypotheses: G1: R BELIEVES that A WANTS R to CAUSE X

G2: A's REQUEST may MOTIVATE R to CAUSE X

Outcome Possibilities: O1: R will UNDERSTAND A's COMMUNICATIONACT O2: If Someone PERCEIVES A's message, then that Someone CAN UNDERSTAND A's COMMUNICATIONACT

Motivational Hypotheses: M1: A WANTS R to BELIEVE that A WANTS R to CAUSE X M2: A WANTS X

M3: A WANTS R to CAUSE X

Normative Obligations: N1: If someone BELIEVES that A is COMMUNICATING then that someone BELIEVES that A OUGHT to UNDERSTAND A's message N2: If R BELIEVES that A is COMMUNICATING to R then R BELIEVES that R OUGHT to UNDERSTAND A's message N3: If R BELIEVES that A is REQUESTING that R CAUSE X AND R EXPECTS to NOT CAUSE X then R BELIEVES that R OUGHT to EXPLAIN to A why R EXPECTS to NOT CAUSE X

TABLE 1. Representation of the Action REQUEST
general level by stating that any causing which the agent performs which brings about
the recipient's knowledge of the agent's
message can count as an action done in order
to partially make possible the performance
of the request. For example, uttering a
sentence in the recipient's presence,
sending the recipient a telegram or letter,
requesting another person to give the
message to the recipient, etc. are all
actions which could under the appropriate
circumstances be viewed as part of the
agent's requesting X of the recipient.
Thus, the information in C1 provides a basis
for generating hypotheses about how other
observed actions might be related to this
plan of requesting.

Statements C2 and C3 differ from C1 in
that whereas C1 states that some action of a
particular type must be taken by the agent,
statements C2 and C3 simply state
expectations that the agent must have.
However, by stating what conditions the
agent must expect, these statements may also
provide a basis for recognizing that
previous actions are related to the plan of
requesting. For example, if the agent first
addresses the recipient by name, this action
may have been done in order to provide a
basis for expecting that the recipient will
listen to his request. Similarly, the agent
may precede a request for a ride home with a
request for information about whether or not
the recipient drove to work today. This
information would provide the agent the
basis for forming a belief about condition
(3) of C3.

Whereas the Can Conditions provide a
basis for generating hypotheses about how previous actions might fit into the plan of
requesting, the Goal Hypotheses provide the
information needed to generate hypotheses
about how the action of requesting might
itself fit into some larger plan of the
agent.

For example, G2 provides the basis for
the hypothesis that the purpose of the
agent's request was to create in the
recipient some set of beliefs that will
partially provide the reason or motivation
for the recipient to cause X.

The Outcome Possibilities express the
information needed to recognize cases where
A's plan goes awry or generates side-effects
which enable latter actions which were not
the focus of the agent's plan. For example,
someone might overhear the agent's request
and offer to fulfill the agent's request.
This would then be a very different
situation from the one that might result
from a similar offer from the intended
recipient of the request.

In O1, O2 and in the various normative
statements the concept UNDERSTAND is
introduced. UNDERSTAND is being used here
in a technical sense that deserves an order:
From the point of view of an observer, part of
the actor's knowledge of his social world is
that other person's are capable of
interpreting and coming to an understanding
of any observed action. That is, other
persons also possess belief systems and
therefore in communicating with another one
must recognize that the overt action, what
has been termed, will be interpreted by others within the context of their beliefs about the actor's plan and
motive. Thus, the theory of human action is
essentially recursive. This is recognized
more explicitly in the statement of C3 which
states that the agent must select a message
which when taken together with the agent's
beliefs about the recipient's current
beliefs can be expected to result in the
recipient arriving at an understanding of the
agent's action as a request. This
characteristic of communication helps to
explain why most everyday communication
occurs in such an abbreviated form. To use
a non-abbreviated form can be insulting
since it could be interpreted by the
recipient as a presupposition by the agent
that the recipient is unable to recognize and understand the other's action. The term
COMMUNICATIONACT is used in O1 and O2
in recognition of the fact that the recipient
or observer of an action may understand the
agent's action in a way other than that intended by the agent.

The Motivational Hypotheses and
Normative Obligations represent statements
which are most importantly involved in
reasoning about motives. The Motivational
Hypotheses provide the basis for generating
hypotheses about the agent's wants whereas
the Normative Obligations provide information about the motivational side
effects of performing actions to which
various social norms apply. For example, N1
is essentially a statement of the sincerity
norm which applies to all communication acts
and asserts that the communicator ought to
believe what he is communicating. N2 states
that it is improper to ignore someone whom
you believe is speaking to you.

N2 is related to C2 since N2 provides the
norm which can be used to provide the
basis for expecting another person to try to
understand the agent's message. Finally, N3
states that if the recipient has understood
the agent's action as a request and if the
recipient is not planning to fulfill that
request, then the recipient ought to explain
to the agent why he will not honor the
request. Thus, this norm provides a basis
for generating hypotheses about the
recipient's response to the agent's request
or the agent's response to the lack of a
response from the recipient. This latter
case is especially important since one of
the interesting characteristics of human
action is that under certain circumstances,
the lack of a response counts as an action
which itself must be explained.

Clearly, if an act of omission is to be
recognized, the observer must have a basis
for expecting the act that was omitted. N3
also provides the basis for various
strategic actions. For example, the
panhandler who asks a bypasser for a dollar
and then demands with great moral
indignation an explanation for the
bypassers lack of response is playing upon
this particular norm.
Having focussed in some detail upon the presentation of this one particular act, it is now possible to briefly and roughly state the position that this leads to concerning memory and inference. First, it assumed that human conceptual memory is some sense organized around various points-of-view. The representation sketched in Table 1 suggests the meaning of "request" from our Belief System point of view. However, "request" also has a representation from a linguistic point of view and this would require that different kinds of information and relations be specified that would reflect this point of view. Thus, the general assumption is that concepts can play various roles in various "theories" that the Understander possesses at a particular point of view is "active", and that knowledge plays within the "theory" that the Understander uses to reason about the domain. The various subheadings provided in Table 1 and the discussion of this information was intended to reflect the view that the conceptual structures of human memory contain information about how they fit into or can be used to answer or reason about the various types of questions that must be answered and answered by a reasoning process that is attempting to understand an action in a particular way. Thus, these concepts are "hypotheses" laden structures which serve as the basis for generating the goals and subgoals of the reasoning process. From this point of view, reasoning about action is itself a goal driven process where the "top-level" goals are to find a plan and motive for the actor which explains his action. An attempt to view the actor's action as a request provides the basis for generating new goals for the understanding system. That is, the request structure identifies the kind of additional information to be assembled which would count as reasons or viewing the observed act as a request.

Finally, since it is assumed that the understanding of human action is a theory-driven process, it is also assumed that the representation of particular events in memory reflects the operation of this theory. Understanding is viewed as a constructive process and what will be "remembered is not simply a representation of 'what happened", but rather an organization and elaboration of what happened that reflects the way in which the observer has understood what happened.

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