Believing, causing, intending: 
The basis for a hierarchy of sign concepts in the reconstruction of communication

R. Posner (Berlin)

1. Introduction

1.1 Cybernetic ancestors of communicating machines

When cybernetics was experiencing its heyday in the 1960's, there was a team of researchers in Berlin which worked towards the development of teaching machines (cf. Cube, 1985). Felix von Cube, Helmar Frank, Herbert Stachowiak and other professors at the West Berlin Teachers' Training College prepared a scenario that became facetiously described as

a computer sitting in the professor's armchair and talking via loudspeakers to a class of students who eagerly copied what the machine had to say on pieces of paper lying in front of them.

Docile as they were, the students involved in the project ironically proposed a seemingly even more efficient solution to the teaching and learning task:

If we can replace the professor by a machine that teaches through loudspeakers why not replace the students by cassette recorders!

With this modification, the scenario of a fully automatized classroom was to become a proverbial nightmare of German educational planning authorities in the seventies and eighties.

What was it that made this scenario so horrifying?
It was the attempt to automatize a set of activities often considered essentially human, namely
- learning and teaching,
- gaining experiences and passing them on to others,
- forming one's personality by self-determined exposure to the circumstances of life as well as to reports about the life of others.
What intensified the horror was the blatant inadequacy of the machines designed for that purpose in the sixties. The students therefore made a good point when they ridiculed a teaching machine which consisted of little more than
- a *memory* filled with pedagogically structured data and
- a device for the *transmission* of these data through auditory or visual display
by confronting it with a learning machine which consisted of not much more than
- a device for the auditory or visual *registration* of these data and
- a *memory* in the form of a cassette tape.
If classroom communication consists in the unmodified transmission of ready-made data from one memory to another, it seems superfluous. Humans can do without it because they have more efficient ways of information intake, such as solitary reading; machines do not need it because there are devices for more direct information transfer available, such as machine-internal duplication of data from one data-carrier onto another.

1.2 Communication and Artificial Intelligence

You may ask what this story from our cybernetic ancestors can tell us today in the age of Artificial Intelligence (A.I.), where expert systems with inference machines and internal and external testing devices for incoming information have replaced the crude devices of the old days.

The irony of the story is that the shortcomings that led to the rejection of the computer in the classroom (and to the rejection of much of the cybernetic approach with it) have also turned out to be responsible for the present conceptual crisis in the development of intelligent systems (cf. Andersen, 1990 and Jorna, 1990). It is no use filling a system's memory with millions of pieces of encyclopedic data if we cannot provide it with powerful devices for organizing and reorganizing these data with respect to changing purposes. Artificial information processing systems must become capable of
- *responding to questions* by quickly restructuring their memorized data, so that they make the relevant stored information accessible within the short time typical for human interaction;
- *sustaining a dialogue*, i.e., jointly constructing relevant homogeneous pieces of complex information by putting together data that have been stored in separate systems;
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- **jointly setting goals** for their dialogue, and modifying them in mutual agreement in the course of the dialogue, so that each system can treat the encoded information made available by its dialogue partner as a contribution towards the common goal.

In other words, in order to function as intelligent systems, computers must become capable of goal-oriented information search, joint composition of information from separate sources and co-operative information processing. Possessing information and being able to encode it in some external expression does not suffice for a system to be called intelligent, it must also be able to design this expression as a contribution to a specific mutually determined dialogue goal and to process the dialogue partner's output as a contribution to such a dialogue goal. In short, for an information processing system to be intelligent, it must not only have the capacities of 'knowing' and 'saying' something but also of 'meaning' something when 'saying' it and of 'understanding' something 'said' by a co-operating system: what makes a machine an intelligent system also enables it to communicate.

One of the greatest obstacles to the design of communicating computers has until now been the application of the code concept in information theory. Software engineers have taken the code to be a mechanism that maps one symbol structure onto another, and have thus hypothesized understanding to consist in nothing but the activation of such a mapping device. They have not been sufficiently aware of the fact that communication involves a complex interplay of sign processes, occurring on various levels of reflection and leading to continuously modified hypotheses about the communication partner's dialogue goals, his available knowledge and knowledge deficits, the depth of knowledge sought at each stage of the communication, etc. (cf. Dennett, 1987). They have not been aware of these processes because these mostly occur beneath the surface of verbal behaviour in human communication and are rarely made the topic of an explicit exchange of information. Communication is not just encoding and decoding given information (cf. Posner, 1992), it involves

- beliefs,
- intentions to make others believe,
- intentions to modify one's own beliefs and
- intentions to make the partners act in specific ways straight away or later on.

This approach is to be discussed and elaborated upon in what follows.
1.3 The relation between semiotics and intensional logic

Before beginning this discussion, however, it is necessary to point out a further obstacle to an adequate reconstruction of the processes of communication in A.I. research - an obstacle created by cultural traditions that are entrenched in our various natural languages.

Since the days of Plato and Aristotle, two separate terminologies have been used to describe what happens in communication between organisms. On the one hand there seem to be extraorganismic objects: sign vehicles, signals, symbols, words, pictures, sounds etc. They appear to be endowed with magic powers that somehow make them carry messages, contain content, have sense. What can someone do who wants to study such extraorganismic objects? He must find criteria for classifying them: according to the medium in which they occur, the channel through which they are transmitted, the relation that exists between the sign vehicle and the message carried by it, etc.

In this paradigm, semioticians (cf. Eco, 1976 and Nöth, 1990) and linguists (cf. Lyons, 1977) have set up taxonomies opposing
- human versus animal signs,
- visual versus auditory, tactile, olfactory and gustatory signs,
- natural versus nonnatural signs,
- indexes versus icons versus symbols,
- nouns versus verbs, adjectives, adverbs and sentences.

Summarizing the results, we can say that this object-oriented approach has given access to an enormously rich realm of sign types but is now approaching stagnation due to the taxonomic methodology and the algebraic apparatus used in its description. Moreover, what happens when an intelligent system uses signs of the various types in communication has not been grasped.

On the other hand all European languages offer a rich terminology for the description of intraorganismic attitudes and processes such as thinking and knowing; believing, assuming and hypothesizing; wanting, wishing and intending; inferring, concluding and proving. These appear to happen internally without a material basis. Someone who wants to study them seems bound to investigate the so-called "inner life" of a person or animal. Psychological introspection and logical analysis of rules of inference are the methodological procedures usually applied in this subject-oriented approach (cf. Finocchiaro, 1989, who develops an alternative empirical methodology).

As a result, elaborate theories were developed, e.g., about cognitive dissonance or about proof procedures in 2-, 3- and n-valued logics. However, what happens when an intelligent system thinks, believes, intends and infers during a communication process has not really been grasped.
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And a psychology and a logic that cut themselves off from analyzing actual communication are bound to stagnate and become marginal, too.

In the subject-oriented paradigm it is often said that one thinks, believes, assumes, hypothesizes, infers, concludes and proves on the basis of "evidence". But what the status of that evidence is, remains generally unasked (however, cf. Chisholm, 1966: ch. 4). Logicians and psychologists have to realize that what they call evidence is exactly what is analyzed as sign, index, icon and symbol in semiotics. And semioticians and linguists have to realize that what they call a message does not exist without
- someone conceiving of it,
- someone wanting someone else to receive, believe, infer it and
- someone making someone else do something by producing it.

It so happens that English has a word which bridges the gap between objectified external signs and messages on the one hand and subjectified internal beliefs, intentions and inferences on the other. It is the word "meaning", which can occur in both contexts (cf. Grice, 1957 and 1982; as well as Schiffer, 1972 and 1987). We use it to denote the mysterious semantic force of an external object, this being either a symbol or symbol complex as in "word meaning" and in "the meaning of this text, picture, symphony"; or an artifact as in "the meaning of the Berlin wall" and "the meaning of the tunnel under the Channel"; or a natural phenomenon as in "the meaning of the dark cloud in the sky" and "the meaning of the high waves on this lake". And we use it to denote the mysterious pragmatic force of a personal act as in "Peter means Mary", "the hooligan meant to hit you" and "John meant that you are mistaken".

It is my contention that the two correlative mysteries will disappear once we start seeing the meanings of external objects and the internal acts of meaning as two sides of the same coin.

In what follows I will therefore engage you in the actual analysis of sign processes occurring in various types of human interaction, including what can be called communication. My aim will be to present a semiotic framework for the analysis of all possible sign processes. I will introduce semiotic concepts for each sign type and will define these semiotic concepts on the basis of three central concepts of intensional logic, namely 'believe', 'cause' and 'intend'. For the purpose of this presentation I will take it for granted that 'believe', 'cause' and 'intend' can be characterized in a sound way within intensional logic (cf. Kutschera, 1976; for the logic of 'believe' cf. Lenzen, 1978 and 1980, Stalnaker, 1984, Mudersbach, 1984 and Gärdenfors, 1988; for the logic of 'cause' cf. Beckermann, 1979, Kutschera, 1980, Meixner, 1987 and Aqvist & Mullock, 1989; for the logic of 'intend' cf. Wright, 1963, 1968: ch. 2 and 1977, Meggle, 1981, Bealer, 1982: ch. 10 and Cohen, Morgan and Pollack, 1990).
My conceptual apparatus provides a set of definitions for infinitely many types of sign processes, covering all possibilities of semiosis. It is offered as a first step towards both the reconstruction of what happens in human communication and the construction of communication behaviour in artificial intelligent systems.

2. A hierarchy of sign types

2.1 Basic sign types: signal, indicator, expression, gesture

(I) Let me proceed from the assumption that sign processes are special types of causal processes. A causal process can be characterized as a process connecting the occurrence of an event \( f \) with the occurrence of an event \( e \), where (the occurrence of) \( f \) is called a cause and (the occurrence of) \( e \) is called its effect. Think of yourself sitting in a room where a sudden loud noise makes the window rattle: we say that the occurrence of the noise \( f \) is a cause for the occurrence of the rattling \( e \) in the windowpanes, the latter being its effect. Think of a mountain slope covered with snow where an increase in the weight of the snow load sets off an avalanche: we say that the occurring increase of the snow's weight is a cause for the avalanche \( e \), which is its effect. Think of a lake where the water temperature falling below 0 degrees centigrade makes the water freeze: we say that the occurring decrease of the water temperature is a cause for the freezing of the water, which is its effect.

In these processes no organs of perception are needed; there is no representation necessary for the event \( e \) and no memory required that can store this representation; there is no program involved (e.g., a 'rattling program') that produces the effect \( e \) in these circumstances; nor do we have to assume any intention (e.g., by the noise to make the window rattle). Instead we have a direct causal relationship \( \rightarrow \) which connects the occurrence of the event \( f \) with the occurrence of the effect \( e \) without a third system intervening.

Causal processes can be described by the formula \( E(f) \rightarrow E(e) \), where \( f \) and \( e \) are terms denoting events, \( \rightarrow \) is a two-place sentence operator denoting the cause- and-effect relation and \( E \) is a one-place predicator denoting the property that the event denoted by its argument term occurs (at a certain time and place). \( E(f) \rightarrow E(e) \) is to be read: "the fact that \( f \) occurs causes the fact that \( e \) occurs"; or shorter: "the occurrence of \( f \) causes the occurrence of \( e \)".

(II) The scenario becomes different, when we have a bird \((a)\) sitting on a tree and a loud noise \((f)\) makes this bird fly off \((r)\). Here the occurrence
of the noise \( f \) is a cause for the flying off \( r \) of the bird, and we say that this cause functions as a signal for the bird \( a \) to fly off \( r \). The signal process is only possible because the bird has organs of perception which register the noise, and a program of reaction which makes it respond with flight behaviour. The bird \( a \) is a behavioural system intervening between the occurrence of the cause \( E(f) \) and the occurrence of the effect \( E(e) \). The effect consists in \( a \) performing the flight behaviour \( r_T(a,r) \).

If the bird’s response is a simple physiological reflex, we do not require the bird’s memory coming into action by storing an internal representation of the noise: the bird need not believe anything when flying off. Nor do we, of course, assume any intention on the part of the noise to make the bird fly off.

Signal processes can be described by the formula \( E(f) \rightarrow T(a,r) \), where "\( a \)" is a term denoting a behavioural system, "\( r \)" is a term denoting its behaviour and "\( T \)" is a two-place predicator denoting the relation of performance that holds between the behavioural system (denoted by its first argument term) and the behaviour (denoted by its second argument term). In this constellation, \( a \) is called a reacting system, \( T(a,r) \) is called its response or interpretant, and \( f \) is called a signal for \( a \) to do \( r \).

Now think of a scenario with a skier \( a \) standing on a snowy mountain slope when a sudden grumbling noise \( f \) comes from below that makes him believe that the snow under him might start sliding downhill \( p \). Here the occurrence of the noise \( f \) is a cause for the occurrence of a belief by \( a \) in a proposition \( p \), and we say that this cause functions as an indicator of \( p \) for the skier \( a \).

The indicator process can occur because the skier has not only organs of perception, which register the noise, and a program of reaction, which makes him perform a response, but also an internal representation system that enables him to have an internal response such as a belief. However, we still do not have to assume the involvement of intentions (e.g., on the part of the rocks wanting to warn the skier of the coming avalanche).

Indicator processes can be described by the formula \( E(f) \rightarrow G(a,p) \), where "\( p \)" is a sentence denoting a proposition and "\( G \)" is a two-place operator having a behavioural system as its first argument and a proposition as its second, and denoting the relation of belief that holds between the behavioural system and the proposition. In this constellation, \( a \) is again called a reacting system, \( G(a,p) \) is called its response or interpretant, \( p \) is called the message of \( f \) for \( a \), and \( f \) is called an indicator of \( p \).

The next scenario we take as an example is the apartment next door where a door is banged \( f \), which makes the neighbour \( a \) believe that the tenant \( b \) is angry \( Z \). Here the occurrence of the noise \( f \) is a cause for the occurrence of a special type of belief in \( a \), namely the assumption that
there is someone \( b \) who caused the bang and that this person \( b \) is in a certain state \( Z \). In this case we say that the noise functions as an expression, for the neighbour \( a \), of the state of anger \( Z \) in its producer \( b \). The expression process can occur because the reacting system \( a \) not only perceives the noise but also assumes the existence of an acting system \( b \) and infers that it is in a certain state.

Note that we do not have to presuppose that the acting system assumed by \( a \) exists in reality nor if it exists, that it really is in the state in question. For the noise to function as an expression, it suffices that the reacting system assumes it to have been produced by someone in a certain state. Expressions thus are indicators of special types of propositions. Being indicators, expressions do not require the involvement of intentions on the part of the reacting system, nor on the part of the acting system: the alleged tenant might have banged the door without wanting to and without intending to make someone aware of the fact that he was angry.

Expressions thus are indicators of special types of propositions. Being indicators, expressions do not require the involvement of intentions on the part of the reacting system, nor on the part of the acting system: the alleged tenant might have banged the door without wanting to and without intending to make someone aware of the fact that he was angry.

Expression processes can be described by the formula \( E(f) \rightarrow G(a, Z(b)) \), where everything is as in the formula for indicator processes except that \( p \) is replaced by \( Z(b) \); "\( b \)" is a term denoting a behavioural system and "\( Z \)" is a one-place predicator denoting the property of its argument being in a certain state. In this constellation, \( b \) is called an acting system, \( a \) is called a reacting system, \( G(a, Z(b)) \) is called \( a \)'s response or interpretant, \( Z(b) \) is called the message, and \( f \) is called an expression of \( b \)'s state for \( a \).

(V) The last scenario to be considered on this level of our exposition is that of a person \( a \) walking through a parking lot and suddenly hearing the noise \( f \) of a car engine being started nearby. When the occurrence of the noise \( f \) is a cause for \( a \) to believe that the person \( b \) who started the engine intends \( I \) to drive away \( g \), then we say that \( f \) functions as a gesture, for \( a \), of the intention \( I \) of \( b \) to drive away \( g \). A gesture is an expression where the expressed state of the sign producer is an intention to produce another event.

Again, the assumption of a sign producer and of his intention may be mistaken, so that a noise can be taken by someone as a gesture without having in fact been produced by anyone. This is why the acting system involved is called a virtual system. The difference between simple expressions and gestures is rather important. Imagine yourself walking through a construction site when a giant bulldozer approaches you: what horror, when the machine continues to follow you wherever you turn to get out of its way! Taking the course of the machine as an expression of its general work task constitutes no problem for you. But the situation becomes alarming if you find yourself forced to attribute a more abstract intention to the machine, particularly the intention of running over you.
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Gesture processes can be described by the formula $E(f) \rightarrow G(a, I(b, T(b,g)))$, where everything is as in the formula for indicator processes except that $p$ is replaced by $I(b, T(b,g))$. Here "I" is a two-place operator having a behavioural system as its first argument and a proposition as its second, and denoting the property of the behavioural system having the intention to realize the proposition. "T(b,g)" is to be interpreted in a way analogous to "I(a,r)", with "T" as a two-place predicator, and "g" as a term denoting the behaviour of the first argument of T. In this constellation, $b$ is called an acting system, $a$ is called a reacting system, $G(a, I(b, T(b,g)))$ is called $a$'s response or interpretant, $I(b, T(b,g))$ is called the message, $T(b,g)$ is called the gestured behaviour, and $f$ is called a gesture of $b$'s intention for $a$.

Figure 1 shows a synopsis of the concepts introduced so far. It should have become clear that they constitute a series, such that each following concept is a specialization of the preceding one; the specific differences can be seen by comparing the structure of the effects given in the response formulas of figure 1:

(I) If there are no behavioural systems involved, we have to do with a simple causal process; $f$ is a cause and the occurrence of $f$ causes the occurrence of $e: E(e)$.

(II) If there is a reacting system $a$ intervening between cause $f$ and effect $e$, $f$ functions as a signal for $a$ to do $r$; this is because the occurrence of $f$ causes $a$ to do $r: T(a,r)$.

(III) If the response of $a$ to the occurrence of $f$ is not just any event, but consists in $a$ believing that $p$, then $f$ functions as an indicator of $p$ for $a$; the occurrence of $f$ causes $a$ to believe $p: G(a,p)$.

(IV) If what $a$ believes upon registering $f$ is that there is a $b$ that produced $f$ and that is in state $Z$, then $f$ is an expression of $Z$ for $a$; the occurrence of $f$ causes $a$ to believe in state $Z$ of $b: G(a, Z(b))$.

(V) If the state $Z$ of the acting system $b$ assumed by the reacting system $a$ is an intention to produce a further event $g$, then $f$ is a gesture of $b$ to do $g$ for $a$; the occurrence of $f$ causes $a$ to believe in the intention $I$ of $b$ to do $g: G(a, I(b, T(b,g)))$.

Thus we can summarize: every gesture is an expression (of its producer's intention), every expression is an indicator (of its producer's state), every indicator is a signal (for the recipient to believe something), and every signal is a cause (of some response in a behavioural system). But of course, the reverse is not true: only certain causes are signals, only certain indicators are expressions, and only certain expressions are gestures.

Now the question arises, which of these types of events should be regarded as signs. The answer is straightforward: everything that causes a response in a behavioural system can be called a sign. This criterion
I CAUSE

\[ \text{event } E(i) \rightarrow \text{effect } E(e) \]

II SIGNAL

\[ \text{event } E(i) \rightarrow \text{reacting system } a \rightarrow \text{response } T(a,r) \]

III INDICATOR

\[ \text{event } E(i) \rightarrow \text{reacting system } a \rightarrow \text{response } G(a,p) \]

IV EXPRESSION

\[ \text{acting system } b \rightarrow \text{event } E(i) \rightarrow \text{reacting system } a \rightarrow \text{response } G(a,Z(b)) \]

V GESTURE

\[ \text{acting system } b \rightarrow \text{event } E(i) \rightarrow \text{reacting system } a \rightarrow \text{response } G(a,1,(b,T(b,g))) \]

- O event
- □ system (machine organism institution)
- ● virtual system
- O → O causal process
- □ → □ input process
- □ → O output process
- □ → O virtual output process

Figure 1: Basic sign types: signal, indicator, expression, gesture
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enables us to treat gestures (V), expressions (IV), indicators (III), and signals (II) as types of signs and to exclude simple causes (I) from the realm of signs. Another consequence of this criterion is that f, which is a simple cause in the case of I, becomes a sign (a sign vehicle) in the cases of II through V.

When we speak of a behavioural system in this context, we have in mind any organism, such as a plant, an animal, or a human individual. A behavioural system is characterized by a program which determines its response to an event registered by it. In terms of computer science, we can also say that a behavioural system is any system that accepts an input and responds with an output according to its program. Taken in this general sense, behavioural systems can also be social institutions such as a national state, a city council, a corporation, a university or a publishing house. And, of course, we also consider artificially constructed systems such as computational information processing systems as behavioural systems since they take events of a certain type as input and respond with an appropriate output. If an information processing system is designed for tasks that experts are understood to carry out, we refer to it as an expert system. Our task is to study the conditions under which the behaviour of any such system can be called "intelligent behaviour" and "communicative behaviour".

Neither the question whether an event is a sign nor the question which type of sign it is can be answered by studying the event in isolation: simple causes, signals, indicators, expressions and gestures all have the same simple structure \( E(f) \). An event becomes a sign event only through the fact that it is taken as input by some behavioural system, which then responds to it with some internal or external interpretant. A sign event can be said to function as a signal, indicator, expression or gesture only on the basis of the effect it has on the reacting system: a signal causes any type of response; an indicator causes a belief; an expression causes the assumption of the existence of an acting system and a belief as to its state; a gesture causes the assumption of the existence of an acting system and a belief in that system having a certain intention. This is why signals are said to be signs of the simplest type.

Taking the response to a given event into consideration may help to decide the question whether it is a sign event of one of the four basic types, but on the level of analysis given so far, there is no way of distinguishing a natural event (that becomes a sign only by way of causing a certain behaviour in a reacting system) from an intentionally produced sign. Even expressions and gestures are defined only on the basis of the reacting system believing in the existence of some acting system whose state or intention is indicated; the question whether they are really produced by such an acting system or not is left open. Therefore also the distinction
between an attempt at signaling, indicating, expressing or gesturing something and the successful achievement of such an attempt is beyond the conceptual apparatus introduced so far (but cf. § 3.1).

A related point concerns the widely used distinction between sign events and sign types. On the present level of analysis, we are only dealing with concrete events that either function as signs or that are not signs at all. An event which does not cause some behavioral system to react in one of the four ways specified is not a sign, even if it is of a type which characterizes events that function as signs in other contexts. We are therefore not yet in a position to distinguish between instances of coded signs (which might or might not function as signs in concrete circumstances) and uncoded signs. However, the present approach is open for the introduction of such a distinction on a higher level of analysis (cf. § 5).

A question often raised by semioticians pertains to the relationship in indicators between the sign vehicle \( f \) and the message \( p \). In indexical signs, the occurrence of \( f \) is said to either cause or be caused by the message \( p \): 
\[
E(f) \rightarrow p \quad \text{or} \quad p \rightarrow E(f)
\]
Thus, the occurrence of a shadow \( E(f) \) under a tree may be said to cause coolness and thus become an indexical sign, for some reacting system, of it being cool under the tree \( (p) \). Indexical signs in this sense, however, must not be confused with indicators: while indexical signs require a causal relationship to hold between the occurrence of the sign vehicle and the message, indicators require a causal relationship to hold between the occurrence of the sign vehicle and the interpretant (which consists in a belief, in this case): 
\[
E(f) \rightarrow G(a,p).
\]
How exactly the reacting system \( a \) arrives at this belief is left open. Thus, our concept of an "indicator" is wider than the notion of an "indexical sign" in Peirce (cf. Peirce, 1931-1966: II, § 283-291). It more resembles the notion of an "Anzeichen" in Husserl (1901: II 1, § 12) and of "indication" in Prieto (1966: ch. 12). This is why one can find indexical as well as iconic and symbolic indicators, depending on the relationship between \( f \) and \( p \) being either a cause-and-effect relation, a resemblance or neither of these. While the relationship between \( f \) and \( p \) need not be causal, the relationship between \( f \) and \( G(a,p) \) always is.

These special questions should not, however, turn the reader's attention away from the central idea of the series of basic sign concepts introduced so far. Apart from the predications \( E(...) \) and \( T(...,--). \), which play a primarily technical role, only three concepts of intensional logic are necessary to define these sign concepts: causing \( ... \rightarrow --), \) believing \( G(...,--\) and intending \( I(...,--\). \) What counts is the configuration of these attitudes and processes. This is what determines the differences between the sign types. Signs of the basic types discussed turn out to be extraorganismic correlates of attitudes and processes. In what follows, we will demonstrate that signs of all types...
have that property. The correlation between the terminologies of semiotics and intensional logic will therefore continue to be of concern to us.

2.2 Levels of reflection: iteration of intention and belief

The distinction of sign types so far was entirely dependent on the behaviour of a reacting system $a$. This lowest level in the hierarchy of sign types to be set out is therefore named "1a". In the present section, we will not only have to do with a virtual acting system assumed by $a$, but include a real acting system $b$, and analyze various simple interactions which are possible between the two systems $a$ and $b$.

When an acting system $b$ comes into play, $b$ can produce an event $f$ because $b$ intends this event to cause $a$ to do or believe something. $a$ can then believe that a certain event $f$ was produced by $b$ because $b$ intended $f$ to cause $a$ to do or believe something. $b$ can even intend this, i.e., intend $a$ to believe that a certain event $f$ was produced by $b$ because $b$ intended it to cause $a$ to do or believe something. And $a$ can in turn have reason to believe in that complex intention of $b$, etc.

This describes a series of intentions with embedded beliefs of increasingly complex structure on the part of the acting system $b$ and a series of beliefs with embedded intentions of increasingly complex structure on the part of the reacting system $a$. The resulting ordered set of increasingly complex beliefs and intentions will be called levels of reflection:

<table>
<thead>
<tr>
<th>Level</th>
<th>Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>$G(a,p)$</td>
</tr>
<tr>
<td>1b</td>
<td>$I(b, G(a,p))$</td>
</tr>
<tr>
<td>2a</td>
<td>$G(a, I(b, G(a,p)))$</td>
</tr>
<tr>
<td>2b</td>
<td>$I(b, G(a, I(b, G(a,p))))$</td>
</tr>
</tbody>
</table>

On level 1, $a$ believes something, and $b$ intends something. On level 2, $a$ believes that $b$ intends $a$ to believe something, and $b$ intends $a$ to believe that $b$ intends something. The iterated beliefs and intentions could also be attributed to one and the same individual, or to more than two individuals; but for reasons of exposition, we base our description on two different individuals $a$ and $b$ that play complementary roles in the sign processes studied. This enables us to refer to the levels as 1a, 1b, 2a, 2b, ... respectively.

Proceeding from the basic sign processes introduced in § 2.1, we will now use the series of levels of reflection to build up more complex sign
Figure 2: Levels of reflection up to communicating
processes that will eventually lead to what is generally called communication (in the strong sense of the word). Compare the table in figure 2, where the defining characteristics of the five basic concepts I through V are given on the bottom line, which presents level Ia: a cause is defined by the formula in area I1a, a signal is defined by the formula in area IIIa, etc. The following chapter (§ 3) presents illustrations and discussions of various formulas on the higher lines of figure 2, such as I1b, I2a, and IIIb, II2a.

3. The reconstruction of communication

3.1 Acting and indicating an action

Consider the following set of culinary examples.

(I1a) In the kitchen, a cup of yogurt accidentally falls into the deep freezer: \( E(f) \). The yogurt gets frozen: \( E(e) \). The latter event is caused, under the given circumstances, by the former one: \( E(f) \rightarrow E(e) \). What we have here is a simple causal process in the sense of § 2.1. Now imagine that Bernie, the son of the family, discovers the frozen yogurt in the deep freezer, tries it and likes the taste. In consequence:

(I1b) Bernie deliberately takes another cup of yogurt out of the refrigerator and puts it in the deep freezer: \( T(b,f) \). He intends that the fact that the yogurt got into the deep freezer will again lead to the yogurt freezing: \( I(b, E(f) \rightarrow E(e)) \). Doing something with the intention that it will cause something else to happen is an action. Actions are described with reference to their intended effects. This is why we say that Bernie freezes the yogurt when he does nothing more than put the yogurt in the deep freezer. If the intended effect does not occur, then the action is unsuccessful. But let us assume that the deep freezer is working, and putting the yogurt in it really makes it freeze: \( E(f) \rightarrow E(e) \). Under these circumstances Bernie can regard his action as successful.

Generalizing the example, we can say: if \( b \) produces an event \( f \) and intends that the occurrence of \( f \) will cause the occurrence of a further event \( e \), then \( f \) is an action. Every action can be described by the formula: \( T(b,f) \land I(b, E(f) \rightarrow E(e)) \). The action \( f \) is successful if the occurrence of \( f \) causes the occurrence of \( e \), as intended by the acting system \( b \). Thus \( E(f) \rightarrow E(e) \) is called the condition of success of the action \( f \).

(I2a) Imagine now that, some days later, Bernie puts a cup of yogurt in the deep freezer again. But this time, he is not alone. His sister Astrid happens to see what he does, without being noticed by him. She wonders why on earth he should do so. Then she remembers that Bernie has been praising the culinary delights of frozen yogurt lately, and she reaches the
conclusion that Bernie does so because he intends the fact of the yogurt getting into the deep freezer to lead to the yogurt freezing: $G(a, T(b,f) \land I(b, E(f) \rightarrow E(e)))$.

In semiotic terms, for Astrid the event of the yogurt getting into the deep freezer is an indicator of Bernie's action directed at having the yogurt frozen: $E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow E(e)))$. The event of the yogurt getting into the deep freezer is the sign vehicle; the proposition that Bernie puts it there to have it frozen is the message; Astrid is a recipient of the message; Astrid's belief in the message is the interpretant.

If we compare the present example of an indicator process with that given in § 2.1 (I), we see that the only difference lies in the complex structure of the message $p$. An indicator $f$, where $p$ has the structure $T(b,f) \land I(b, E(f) \rightarrow E(e))$ is called an indicator of an action. Note that an event can be an indicator of an action even if the system producing this event does not intend it to function as an indicator.

Indicators of actions can occur without intervening codes. An event becomes an indicator of an action simply if it causes some behavioural system to conclude that its producer intended it to cause some other event.

Now, the case where an event is unknowingly taken to be an indicator of something can be compared with another case where such an event is intentionally produced to serve as an indicator of something for another person. Imagine: Bernie and Astrid both are in the kitchen, Bernie makes sure that Astrid notices what he does and then ceremoniously opens the deep freezer and puts a cup of yogurt in it. Here Bernie produces an event $f$ and intends the occurrence of this event to cause Astrid to believe that Bernie produces this event with the intention for it to lead to another event $e$: $T(b,f) \land I(b, E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow E(e))))$. In other words, Bernie acts with the intention that what he does be an indicator for Astrid that he attempts to bring about a certain effect.

In semiotic terms, if $b$ produces an event $f$ with the intention that $f$ serve as an indicator of $p$ for $a$, then $b$ indicates $p$ to $a$. Thus what Bernie does here is indicating to Astrid his action of making the yogurt freeze. We are dealing with someone indicating an action. This becomes especially clear when we compare the present example with the formula that defines indicating in area IIIb of figure 2: $T(b,f) \land I(b, E(f) \rightarrow G(a,p))$. It differs from the complex formula above only in having $p$ instead of: $T(b,f) \land I(b, E(f) \rightarrow E(e))$, which is the formula for action (cf. figure 2, 11b).

When someone $b$ produces an event $f$ with the intention that $f$ serve as an indicator of some $p$ for some other person $a$, then $b$ cannot count on being successful: $f$ may or may not be received as indicator of $p$ by $a$; i.e., $f$ may or may not cause $a$ to believe $p$ (as intended by $b$). This raises the question whether an $f$, occurring under these circumstances, may be called a sign in
the sense of § 2.1: when the indicating is successful, $f$ functions as an indicator of $p$ for $a$ and therefore is a sign; however, when the indicating is unsuccessful, no indicator process takes place, and $f$ cannot therefore be regarded as a sign in the sense of § 2.1. The best way to circumvent this awkward situation is to extend our criteria for the sign concept: we now call an event not only a sign

(1) when it causes a behavioural system to respond by doing or believing something, but also

(2) when there is a behavioural system which produces this event with the intention for it to be a sign in the first sense.

A sign in the first sense we call a *recipient sign*, a sign in the second sense a *sender sign*. On the basis of this stipulation, an event produced in order to indicate, whether or not the indicating is successful, is a sign.

If an indicating of an action takes place: $T(b,f) \land I(b, E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow E(e))))$, the acting system $b$ is called a sender; the event $f$ is called an indicating sign; $a$ is its intended recipient or addressee; $G(a, T(b,f) \land I(b, E(f) \rightarrow E(e))$ is the intended interpretant; $T(b,f) \land I(b, E(f) \rightarrow E(e))$ is the intended message.

Returning to the example, let us assume that Bernie’s behaviour really leads Astrid to believe that Bernie is making the yogurt freeze. In this case Bernie’s indicating of this action is said to be successful. It would even be called successful if there were an electric energy breakdown and the yogurt did not in fact get frozen. It would also be so if Bernie did not really want the yogurt to freeze this time and took it out of the deep freezer immediately after Astrid left the kitchen. These eventualities should make it clear beyond doubt that the condition of success in indicating lies in the occurrence of $f$ making the reacting system $a$ believe a certain proposition $p$: $E(f) \rightarrow G(a,p)$, and not in the proposition $p$ itself or one of its components being true. If we replace $p$ in the above formula by the formula for an action, we obtain the fully explicit condition of success for the indicating of an action: $E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow E(e)))$.

This case concludes a series of examples for four different but related processes having to do with simple cause-and-effect sequences (cf. column I of figure 2). On level 1a we have a simple cause-and-effect sequence without any intervening systems. On level 1b we have an acting system’s attempt to bring about such a cause-and-effect sequence, i.e., we have to do with an action. On level 2a the initial cause of the cause-and-effect sequence leads to a belief about this attempt to bring about the cause-and-effect sequence, i.e., the actor causes a belief about this action. This is a constellation which makes the causing event a sign: it becomes an indicator of the action. On level 2b we have an acting system’s deliberate attempt to make the initial cause produce this belief about the attempt to bring
about a cause-and-effect sequence. This is a constellation which makes the action coincide with an attempt to indicate the action. Only the last two processes are sign processes. And there is no communication in the strong sense yet.

In order to reach the stage of complexity at which one can adequately talk of communication, let us now follow another series of example cases on levels 1a through 2b, this time in column II of figure 2: signals, signalings, indicators of signaling and indicating of signaling.

3.2 Signaling and indicating a signaling

(I11a) Imagine we are in a noisy kindergarten, where the teacher Britta (b) has to look after a number of small children (a) of age 3 to 5. All of a sudden there occurs a loud bang: \( E(f) \), which causes the children to interrupt their play and look up at the origin of the noise: \( T(a,r) \). This is a causal process with an intervening behavioural system \( a: E(f) \rightarrow T(a,r) \). It is a response called orientation reflex by biologists, and it can happen without any beliefs intervening.

In semiotic terms, an event that causes a behavioural system to react in a certain way is defined as a signal (cf. § 2.1); the reaction of the behavioural system is called its interpretant. This is why we say that the sudden noise is a signal for the children to look up in the direction of its origin. Signals such as these are signs of the simplest type.

(I11b) Now think of Britta and what she did when the bang occurred in her noisy kindergarten. She was amazed at the moment of silence, which was its effect. Next time she wants to produce a moment of silent attention, she produces a sudden noise herself by loudly clapping her hands. Experienced parents know how well this method works, when the children are young enough and the clapping is loud enough. How should we analyze Britta’s behaviour? Well, it is an action because Britta produces an event and intends the event to cause another event: \( T(b,f) \land I(b, E(f) \rightarrow E(e)) \). But it is a special type of action since the event produced by Britta is intended to bring about the other event by way of being a signal: \( f \) is intended by Britta to cause the children to look up, be silent and pay attention: \( E(f) \rightarrow T(a,r) \). Thus, Britta’s handclapping is the action of producing a signal: \( T(b,f) \land I(b, E(f) \rightarrow T(a,r)) \).

In semiotic terms, a behavioural system \( b \) that produces an event \( f \) with the intention of it functioning as a signal for \( a \) to do \( r \) is said to perform a signaling. The event \( f \) is the signaling, \( a \) is the intended recipient or addressee of \( f \) and \( a \) doing \( r \) is its intended interpretant. Signaling is often nothing more than pure manipulation: the youngest children have no
choice; in their case, the teacher’s action is nearly always successful: \( E(f) \rightarrow T(a,r) \). However, signaling can be as unsuccessful as any other type of action: what is necessary for behaviour to be an action is only that a certain effect is intended to happen, not that it really happens.

**(II2a:c)** Now let us introduce a third party into the scenario. There is a visitor - her name is Cynthia - who observes what goes on in the kindergarten without interfering herself. Cynthia hears Britta clap, and this handclapping is an indicator for her of Britta intending the children to look up, be silent and pay attention. Formulated more explicitly, the handclapping \( f \) causes \( c \) to believe that \( b \) does \( f \) because \( b \) intends the children \( a \) to do \( r \): \( E(f) \rightarrow G(c, T(b,f) \land I(b, E(f) \rightarrow T(a,r))) \); in short, \( c \) believes because of \( f \) that \( b \) does \( f \) so that \( a \) will do \( r \) because of \( f \). This formulation shows that, on this level of reflection, the handclapping \( f \) has two different signal functions:

1. \( f \) causes the visitor \( c \) to believe something (i.e., \( f \) becomes an indicator for \( c \)).
2. \( f \) causes the children \( a \) to look up (i.e., \( f \) is a signal for \( a \) to do \( r \)).

For the visitor \( c \), the handclapping is an *indicator of signaling*; for the children involved, it is a signal. Under these circumstances we can say that the visitor \( c \) understands the action of the teacher \( b \) as signaling.

**(II2a:a)** Back to the kindergarten without a visitor. Even young children are capable of making hypotheses about what happens around them. The more often the handclapping occurs, the less easily they let it interrupt their activities. They become aware of what Britta wants to bring about by her handclapping: they now believe each time when she claps her hands that she wants to make them look up, be silent and pay attention at that moment. Even if they do not react by really looking up, being silent, paying attention, they have a direct reaction; it does not consist in an external response but in an internal process: the children’s interpretant of Britta’s handclapping is their believing, at that moment, that Britta intends them to look up, be silent and pay attention. Just like the visitor Cynthia in the preceding example, they take the handclapping as an *indicator of signaling*. This case differs from the preceding one only in that there is personal identity between the recipient of the signal and the recipient of the indicator of signaling. The children \( a \) are recipients of an indicator of signaling since \( f \) causes \( a \) to believe that \( b \) does \( f \) because \( b \) intends the occurrence of \( f \) to lead to \( a \) doing \( r \): \( E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow T(a,r))) \). And the children \( a \) are also recipients of a signal if the occurrence of \( f \) causes \( a \) to do \( r \): \( E(f) \rightarrow T(a,r) \). We can say that the children *understand* the teacher’s action as signaling, even if they do not *follow* it.

**(II2b:c)** In order to reach the next higher level 2b, let us return to the example with Cynthia, the visitor. Imagine that Britta knows Cynthia is
observing what she is doing, and she wants to make Cynthia aware that she will signal to the children that, say, the play time is over and they must look up, be silent and pay attention. She can achieve this by modifying her signal \( f \): instead of clapping her hands loudly, she might give Cynthia a meaningful look and move them only in such a way as to visually simulate handclapping for Cynthia. In such a case, \( b \) produces a silent handclapping \( f \), because \( b \) intends the occurrence of \( f \), to make \( c \) believe that \( b \) will soon produce a loud handclapping \( f \); since \( b \) intends the occurrence of \( f \), to make \( a \) do \( r \): \( T(b, f) \land I(b, E(f)) \rightarrow G(c, T(b,f) \land I(b, E(f)) \rightarrow T(a,r)) \); in short, \( b \) does \( f \), with the intention that \( c \) believe that \( b \) will soon do \( f \), with the intention that \( a \) do \( r \).

In semiotic terms, we can say, using previous definitions: \( b \) produces for \( c \) an indicator of \( b \) producing a signal for \( a \) to do \( r \). As in § 3.1, the production of an indicator is called indicating (cf. Fig. 2, III1b) and the production of a signal is called signaling (cf. Fig. 2, II1b). Thus what the teacher does here is indicating a signaling. She intends the visitor to understand that she is going to signal something to the children.

(II2b:a) The next case to be discussed is still on level 2b, but dispenses with Cynthia, the visitor: Britta, the teacher, has in the meantime become aware that some children no longer follow her handclapping automatically, although there is no doubt that they hear it perfectly well. Being an experienced pedagogue, she also changes her own behaviour and stops trying to manipulate the children. She no longer intends her handclapping to cause an immediate external reaction; she only wants the children to notice - like the visitor - that she intends them to be silent and pay attention. This she can achieve without suddenly clapping her hands loudly. Instead, she waits for a sufficient number of children to glance at her, gives them a meaningful look and simulates handclapping. What she produces is an allusion to signaling. This again is what is called indicating a signaling; however, the strength of real signaling connected with it has become variable: to the extent that Britta diminishes the loudness of her handclapping, its signal effect decreases, but to the same extent the indicator effect increases.

The difference between this example and the preceding one involving Cynthia as a third party is again that there is personal identity between the addressee of the indicating of a signaling and the addressee of the signaling. In addition, the sign vehicle produced to be an indicator of a signaling is identical with the sign vehicle produced to be a signal.

In terms of intensional logic, indicating a signaling involves the following: \( b \) produces \( f \) because \( b \) intends the occurrence of \( f \) to make \( a \) believe that \( b \) produces \( f \) because \( b \) intends the occurrence of \( f \) to make \( a \) do \( r \): \( T(b,f) \land I(b, E(f)) \rightarrow G(a, T(b,f) \land I(b, E(f)) \rightarrow T(a,r)) \); in short, \( b \) does \( f \) with the
intention for $a$ to believe (because of $f$) that $b$ intends $a$ to do $r$ (because of $f$). That is, $b$ does $f$ with the intention for $a$ to understand that $b$ intends $a$ to do $r$.

Indicating a signaling has conditions of success that are very different from those of genuine signaling. This can be seen when we compare area IIIb with areas III1b and II2b in figure 2: successful signaling requires that the occurrence of $f$ causes $a$ to do something: $E(f) \rightarrow T(a,r)$; successful indicating only requires that the occurrence of $f$ causes $a$ to believe something: $E(f) \rightarrow G(a,p)$; and successful indicating of a signaling requires that the occurrence of $f$ causes $a$ to believe in the intention of $b$ for $a$ to do something: $E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow T(a,r)))$. Successful indicating of signaling is possible without successful signaling.

3.3 Communicating

Now imagine that the pure-signal aspect of the handclapping $f$ in the last example becomes zero. The result is that $f$ turns into a genuine higher level indicator. By producing $f$, Britta now indicates a signaling, but no longer performs the signaling itself. She informs the children of a wish, but no longer utters it. She indicates to the children that she wants them to do something, and if she is successful, the children will understand that she wants them to do something, but they will not necessarily feel moved to do it.

How can Britta nevertheless reach her goal of making the children who glance at her be silent and pay attention? Strictly speaking, she has no behavioural resources of her own that she could utilize for that purpose. She depends entirely on the insight and good will of the children. She can only wait for the children to become 'understanding' and 'sensible', as she likes to say.

What happens when the children become 'understanding' and 'sensible'? Well, they understand that Britta intends them to do $r$ and this understanding suffices to make them actually do $r$. Semiotically speaking, they respond to the indicator of a signal produced by Britta, as if it were the signal itself. The indicator that $b$ intends them to do $r$ is taken by them as a signal to do $r$. This is what happens in a successful request. A successful request consists in a signal process (I11a) achieved through an indicator of signaling (II2a). A successful request is thus composed of two sign processes, a signal process and an indicator process, where the one causes the other to occur. The indicator process $E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow T(a,r)))$ causes the signal process $E(f) \rightarrow T(a,r)$. Thus the condition of success in requesting is the following: $(E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow T(a,r)))) \rightarrow (E(f) \rightarrow T(a,r))$.
This formula shows that requesting is successful if it makes the addressee do something on the basis of his belief in the sender's intention for him to do it. If we compare the indicator formula with the signal formula, it differs from it precisely in having a belief and intention component: \( G(a, T(b, f) \land I(b, E(f) \rightarrow \cdots)) \). When we delete this component, the indicator formula merges with the signal formula.

Now, if the teacher is still of good cheer and has not given up all hope that the children will become serious communication partners, then she will try to reinforce the positive behaviour just described, by repeating interaction of this type as often as possible. Put in semiotic terms, she will produce a signal by producing an indicator of herself producing a signal; i.e., she will signal by indicating a signaling. Formulated in terms of intensional logic: \( b \) produces \( f \), intending the occurrence of \( f \) to make \( a \) believe that \( b \) produces \( f \) with the intention for the occurrence of \( f \) to make \( a \) do \( r \), and \( b \) believes that if the occurrence of \( f \) will lead to \( a \)'s belief that \( b \) produced \( f \) with the intention for the occurrence of \( f \) to make \( a \) do \( r \), then the occurrence of \( f \) really will make \( a \) do \( r \):

\[
T(b, f) \land I(b, E(f) \rightarrow G(a, T(b, f) \land I(b, E(f) \rightarrow T(a, r)))) \land G(b, (E(f) \rightarrow G(a, T(b, f) \land I(b, E(f) \rightarrow T(a, r))))) \rightarrow (E(f) \rightarrow T(a, r)).
\]

This is the definition of a directive act of communicating. In it, \( f \) is called a directive sign event or simply a directive; \( b \) is the sender and \( a \) the addressee; \( G(a, T(b, f) \land I(b, E(f) \rightarrow T(a, r))) \) is the intended secondary interpretant, and \( T(a, r) \) is the intended primary interpretant; \( T(b, f) \land I(b, E(f) \rightarrow T(a, r)) \) is the secondary message. There is no primary message, because the intended primary interpretant does not consist in a belief.

If the occurrence of \( f \) makes \( a \) (perform the secondary interpretant, i.e.) believe that \( b \) wants \( a \) to do \( r \), then \( a \) has understood \( f \) as a request and the act of communicating is felicitous. Thus the felicity condition of a directive is identical with the condition of success of its indicating component: \( E(f) \rightarrow G(a, T(b, f) \land I(b, E(f) \rightarrow T(a, r)))) \).

If in addition to making \( a \) believe that \( b \) wants \( a \) to do \( r \), the occurrence of \( f \) makes \( a \) do \( r \) because of this belief, then \( a \) has followed the request, and the communication attempt is successful. Thus the condition of success of a directive includes its felicity: \( (E(f) \rightarrow G(a, T(b, f) \land I(b, E(f) \rightarrow T(a, r)))) \rightarrow (E(f) \rightarrow T(a, r)) \).

What turns indicating a signaling into directive communicating is the sender's belief that this condition of success is going to be realized by the addressee: \( G(b, (E(f) \rightarrow G(a, T(b, f) \land I(b, E(f) \rightarrow T(a, r)))) \rightarrow (E(f) \rightarrow T(a, r))) \).

The defining formula of directive communicating can be read in the top area of column II in figure 2. On the same line, the reader finds analogous formulas for
declarational communicating, which consists in acting by indicating that action,
- assertive communicating, which consists in indicating by indicating that indicating,
- expressive communicating, which consists in expressing by indicating that expressing, and
- commissive communicating, which consists in gesturing by indicating that gesturing.

These formulas claim that non-directive acts of communicating have the same structure as directive ones; the only difference between them is supposed to lie in the effect of the basic process on which they rely: it is a simple event in the case of declarations, a behaviour of $a$ in the case of directives, a belief of $a$ in a message $p$ in the case of assertives, a belief of $a$ in a state of $b$ in the case of expressives, and a belief of $a$ in an intention of $b$ to do $g$ in the case of commissives.

In order to test the validity of this generalization from the structure of directive communicating to the structure of other types of communicating, let us examine a case of declarational communicating (cf. column I in figure 2). When somewhere in the world, a shaman $b$ declares a man and a woman husband and wife by quietly laying his hands on their joined right hands under the appropriate circumstances, he performs laying on of hands $f$ because he intends the occurrence of $f$ to turn his followers $a$ into a married couple: $E(f) \rightarrow E(e)$. In other words, he produces $f$ with the intention for the occurrence of $f$ to make the required status change come about. But how does he think this status change will be achieved? Well, in laying on his hands, he also has the intention that the occurrence of $f$ will make his followers $a$ believe that he intends the occurrence of $f$ to turn them into a married couple: $E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow E(e)))$. In other words, he produces $f$ with the intention for the occurrence of $f$ to be an indicator of the action of making the required status change come about. And he believes that when the occurrence of $f$ makes his followers $a$ believe that he intends the occurrence of $f$ to turn them into a married couple, then the occurrence of $f$ will in fact turn them into a married couple: $(E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow E(e)))) \rightarrow (E(f) \rightarrow E(e))$. In other words, he believes that the indicator process itself will be what causes the occurrence of $f$ to bring about the status change in his addressees under the given circumstances.

This is what is described by the formula in the top area of column I in figure 2 (area I2becom). As in the other formulas of figure 2, its structure is indicated by boxes enclosing the relevant constituents. The two large boxes contain occurrences of the same formula, which describe an indicator of an action (cf. the identical formula appearing in area I2a). The
occurrence of this formula in the upper box is embedded as second argument in the intention operator \( I(b, ...) \). The occurrence of this formula in the lower box is the antecedent of a formula which represents a complex causal proposition and has as its consequent \( E(f) \rightarrow E(e) \), the latter describing the process intended to happen in the action indicated. The complex causal proposition is embedded as second argument in the belief operator \( G(b, ...) \). The belief of \( b \) thus described authorizes us to replace the occurrence of the indicator formula in the large box above by \( E(f) \rightarrow E(e) \). As a result, the formula in 12bcom is transformed into \( T(b, f) \land I(b, E(f) \rightarrow E(e)) \), which describes precisely the basic action that \( b \) is trying to perform (cf. the formula in area 11b).

This formula-based reasoning demonstrates how the sender succeeds in performing an action in declarational communicating. He produces an indicator of himself performing this action, and he believes that the indicator process will cause the process which is intended to happen in the action: \( E(f) \rightarrow E(e) \). This was shown to be equivalent with the sender performing the action indicated. Herein lies the justification for our statement that declarational communicating is acting by indicating that action.

Again it must be emphasized that the indicating of an action has conditions of success different from those of the action indicated. The indicating is successful if the addressees believe that the action is performed (condition of success of the indicating component or felicity condition). The action itself is successful if its intended effect comes about (condition of success of the action component). And the declarational act as a whole is successful only if the fulfilment of the condition of success of its indicating component (its felicity condition) brings about the fulfilment of the condition of success of its action component. As in directive acts of communicating, what turns indicating an action into declarational communicating is the belief of the sender that its complex condition of success will be realized by the addressees.

The formula-based reasoning above led us to the conclusion that every declarational act of communicating is an action performed by indicating that action. On this basis, it can be argued that also every other act of communicating (as defined on line 2bcom in figure 2) is an action performed by indicating that action. Let us again proceed from levels 1a and 1b in figure 2 in order to show this. As demonstrated in § 2.1, every gesture is an expression, every expression is an indicating, every indicating is a signaling, and every signaling is an action; thus all sign processes defined on level 1a are causal processes. Now it also holds that every gesturing is an expressing, every expressing is an indicating, every indicating is a signaling, and every signaling is an action; thus all sign processes defined
on level 1b are actions. The same is true of all indicating processes described on level 2b: they are all indicatings of an action (of one of the types defined on level 1b). Since signaling, indicating, expressing and gesturing are all actions, and the indicating of a signaling, of an indicating, of an expressing and of a gesturing is always the indicating of an action, the formula in 12bcom, which claims that a declarational act of communicating is an action performed by indicating that action, carries over to each of the other types of communicating.

In conclusion, we are justified in claiming that

(1) all commissives, expressives, assertives and directives are declarations and

(2) all communicating consists in an action performed by indicating that action.

For this reason we need only think in terms of declarational communicating when we discuss general properties of communicating in what follows.

The two results of this section are highly relevant for two central tenets of traditional speech act theory. Declarational, directive, assertive, expressive and commissive acts of communicating are counterparts of the five types of speech acts postulated in Searle (1979). As Searle claims, all human speech acts belong to one of these types, but he cannot prove this claim because he does not lay open its analytical basis. If one accepts our definitions of declarations, directives, assertives, expressives and commissives as explications of Searle's speech act types, one can use our conceptual system to deduce the universality and completeness of Searle's typology. The fact that our conceptual system, which is based on an independently motivated system of simple sign processes and a general set of levels of reflection, includes Searle's typology as a special case, can be considered as a confirmation both of Searle's philosophical account and of our semiotic approach.

As with the basic sign processes, the acts of communicating defined above constitute a series of increasingly specialized sign processes. This makes it possible to consider all of them as special cases of declarations, thus confirming a position which John Austin reached late in his life (cf. 1958 and 1962), i.e., that the distinction of performative versus constative utterances is misguided when used as a general typology of verbal communicating, since all communicating is performing an action.

In addition, our approach has the advantage that it provides systematic access to kinds of sign processes other than speech acts and thus bridges the gap between speech acts and all sorts of non-communicative sign behaviour, be it verbal or non-verbal.
3.4 Felicity, openness and success in communicating

As pointed out in § 3.3, a communicating is performed in order for the addressee
- to understand what the sender wants to happen (felicity condition of communicating) and
- to accomplish that on the basis of this understanding (condition of success of communicating).

This leads to the following two questions:
1. Under what circumstances does the addressee understand what the sender wants to happen?
2. Under what circumstances does the addressee accomplish what the sender wants to happen?

In order to see how these two questions are to be answered, let us review the series of kindergarten examples once more.

Ad 1: On level 1a, the sign event was a signal to do something, which was automatically followed. On level 2a, it became an indicator of a signaling, which was only believed.

What made the addressees believe, on level 2a, that the teacher wanted the children to look up, be silent and pay attention? In the visitor Cynthia's case, the real handclapping served as an indicator of Britta's intention, and Cynthia could have reasoned: handclapping normally has such an effect; Britta must know that and she would not do something if she did not also approve of its anticipated main effect; this effect must therefore have been intended. In the case of the older children, we can assume the capability of a similar reasoning.

But what made Cynthia also believe, on level 2b, that Britta intended her to believe she would soon clap her hands loudly? Well, Britta produced an iconic indicator of the handclapping signal and at the same time divested it of its signal force by going from the acoustic to the optic channel. Cynthia could have reasoned: Britta performs handclapping in a way that prevents it from having the effect it usually has on the children; at the same time Britta gives me a meaningful look, from which I conclude that she intends to indicate something to me; what can it be? The most probable guess is that by clapping her hands silently she intends to make me believe that she will soon perform a similar act for the children which is to have its usual effect on them, i.e., she will soon clap her hands loudly.

The children's understanding of Britta's indicating of a signaling can be explained on similar lines. The children could have reasoned: Britta performs handclapping in a way that prevents it from having the compulsive effect it used to have on us; at the same time Britta gives us a meaningful look, from which we conclude that she intends to indicate something to us;
what can it be? The most probable guess is that by clapping her hands silently she intends to make us believe that she wants us to react in the way we used to, by being silent and paying attention.

This explanation relies on the history of sender-recipient contacts in each case. When two people have successfully solved a coordination problem in a certain way, they tend to solve it in a similar way when it occurs again. Thus, a convention develops, which is based on the memory that the interaction partners have of previous problem solutions (cf. Lewis 1969: ch. 13 and II1). This convention of letting a certain sign type correspond to a certain type of intended interpretant can often be based on assumed causal relations (indexes) or relations of resemblance (icons), but that it is so based is not a necessary condition for its development.

Linguistic conventions are a case in point. Even if they were once based on iconic and indexical sign relations, these relations became less and less binding in the history of language. Learning from his own communication history, each communication partner lets his memory take over and help where there is no sufficient iconic or indexical sign relation. In this way, eventually the impression has arisen in some semioticians (cf. Saussure 1916: part I, ch. 12) that such signs are not iconically or indexically motivated at all. However that may be, recourse to the history of sender-recipient contacts is necessary for an explanation of the development from non-linguistic signaling by way of indicating a signaling to full-grown linguistic utterances such as "Regardez!", "Aufgepasst!", "Look here!" The latter are produced as genuine requests, i.e., as signaling by means of indicating a signaling. An intermediate step in the development from non-linguistic to linguistic requests of that kind may be seen in handclapping accompanied by verbal utterances which then gradually turns into verbal utterances accompanied by handclapping until the handclapping is entirely omitted in the end.

Ad 2: If we can assume that this is how the children learn to understand signaling acts of the various kinds, why should they follow them and do what the sign producer wants them to do? Here again, the history of sender-recipient contacts plays an important role. Being used to having many of their own wishes fulfilled by Britta, the children also tend to fulfil what they think are her wishes. And they generally do so without Britta actively trying to influence them. When Britta now performs her silent handclapping for the first time, she can profit from these habits. If the handclapping is felicitous, the children understand that she wants them to do r, and since this is a wish of hers, they tend in fact to do r: their understanding of her wish makes them fulfil the wish. In this way, Britta’s silent handclapping, which is only an indicator of her signaling, becomes a signal for them to do r.
What happens, when Britta tries to reinforce this behaviour by performing other requests? The children start understanding not only that she wants them to do 🎅 but also that she believes they will do 🎅 when they understand that she wants them to do 🎅. Her silent handclapping now causes them not only to believe that she is signaling but also that she is communicating. It turns into an indicator of a directive act of communicating. The sender's directive act of communicating as a whole becomes the content of the addressee's belief and thus occurs on a higher level of reflection. The indicator process leading to this belief has to be located on level 3a in the hierarchy of sign types. The higher level of understanding reached in this way is not counterproductive; on the contrary, it may enhance the motivation of the children to do 🎅: the children's belief that 📺 wants them to do 🎅 (level 2a) and their belief that 📺 wants them to know that 📺 wants them to do 🎅 (and that 📺 wants them to do 🎅 because of this knowledge; level 3a) work together in making them really do 🎅.

Being a good teacher, Britta is, of course, bound to notice the children's increasing ability to understand; and she reacts by making her intentions and beliefs in communicating as transparent as possible. This can lead to even higher levels of understanding and indicating: Britta may now perform a directive (i.e., she may signal by indicating this signaling) simply by means of indicating the performance of this directive (i.e., she may signal by indicating this signaling and do that through indicating that she is signaling by indicating this signaling). It is left to the reader to try and reformulate this configuration of sign processes on level 3b in the terminology of intensional logic as a configuration of attitudes and internal processes in the persons involved.

What is required of Britta in the course of mutual adaptation with the children is an increasing openness to higher levels of reflection and the will to use these levels more and more for the accomplishment of her intentions in communicating. Unrestricted reflective openness in communicating would consist in the sender 📺 being able not only
(2b) to intend that $a$ believes that $b$ does $f$ because $b$ intends the occurrence of $f$ to bring about some effect; but also

(3b) to intend that $a$ believes that $b$ intends that $a$ believes that $b$ does $f$ because $b$ intends the occurrence of $f$ to bring about some effect; and

(4b) to intend that $a$ believes that $b$ intends that $a$ believes that $b$ intends that $a$ believes that $b$ does $f$ because $b$ intends the occurrence of $f$ to bring about some effect; etc.

Put in formulas, unrestricted reflective openness of the sender $b$ in an act of communicating is the ability of $b$ such that

(2b) $I(b, G(a, T(b,f) \land I(b, E(f) \rightarrow E(e))))$
(3b) $I(b, G(a, \neg \neg \neg ))$
(4b) $I(b, G(a, \neg \neg \neg ))$

The corresponding openness on the side of the addressee $a$ in an act of communicating can be defined in a parallel way:

(2a) $G(a, T(b,f) \land I(b, E(f) \rightarrow E(e)))$
(3a) $G(a, I(b, \neg \neg \neg ))$
(4a) $G(a, I(b, \neg \neg \neg ))$
Of course, in real-time communication, reflective openness is never realized in an unrestricted way. Due to the finite character of human and artificial brains, an infinite number of intentions (on the part of the sender) and beliefs (on the part of the addressee) can never be activated. However, even if this were possible, it is unnecessary. Felicitous communicating requires intentions and beliefs to occur on levels 1 and 2. Reflective openness thus consists simply in being prepared to additionally activate levels 3 and 4, etc. according to the levels anticipated to be activated by the communication partner. This account has the advantage of sparing us the unrealistic assumption implicitly or explicitly made by many another theorist that communicating requires the occurrence of infinitely many propositional attitudes (cf. Schiffer, 1972; Meggle, 1981; Sperber & Wilson, 1986; and Barwise, 1989).

In addition to mutually-adapted reflective openness, there are further circumstances that contribute to the success of an act of communicating. They have already been comprehensively discussed in the relevant literature (cf. Searle, 1969, 1979 and 1983; Bennett, 1976; Kasher, 1976, 1979 and 1988; Bach & Harnish, 1979; Recanati, 1981; Savigny, 1983; Searle & Vanderveken, 1985; Sperber & Wilson, 1986; Grandy & Warner, 1986; Burkhardt, 1990; Hall et al., 1990; as well as Searle et al., 1992) and it may therefore suffice to summarize them in our own terms here:

a. If the addressee is to do what he understands the sender intends him to do, he must assume that the sender is serious. In the kindergarten case, this implies that the teacher really wants the children to be silent and pay attention when she produces a directive to that effect. In the shaman case, this implies that the shaman really wants the man and woman to become husband and wife when he performs the declarational laying on of hands: \( I(b, E(f) \rightarrow E(e)) \). This formula describes the primary communicative intention of the sender and can be called the seriousness condition of communicating.

b. The addressee must assume that doing what the sender intends him to do is not a mistake. This implies in the case of directives that it lies in the addressee's (short or long term) interest (cf. Posner, 1980: ch. 5). In the case of assertives, expressives and commissives, what the sender wants the addressee to do is to believe something, and this is not a mistake if what is supposed to be believed is true. This condition can be called the unmistakenness condition of assertive communicating.

c. In the case of assertives, expressives and commissives, the sender's own psychological state is a relevant circumstance in the addressee's decision whether he can believe what the sender wants him to believe. In an assertive, the sender himself must appear to believe
the proposition he intends the addressee to believe: $G(b,p)$. In an expressive, this proposition specifies a certain state of the sender, and so the sender must appear to be in that state: $Z(b)$. In a commissive, that state consists in the sender's intention to do something, and so the sender must appear to have that intention: $I(b, T(b,g))$. This condition is sometimes called the sincerity condition of communicating.

These circumstances are important enough to justify our considering them in relation to the constituents of the complex formula that defines the act of communicating.

4. The anatomy of communication

In § 2 and § 3 we introduced a hierarchy of sign types based on complex configurations of believing, causing and intending. We started on level 1a with signals, indicators, expressions and gestures and showed that they are all causes with effects of increasing complexity. We then introduced signaling, indicating, expressing and gesturing on level 1b and showed that they are all actions with intended effects of corresponding complexity. We then demonstrated how signs of higher levels are constructed by combining the concepts of levels 1a and 1b. This led us to the definition of five types of communicating. Communicating occurs in the form of a declaration, a directive, an assertive, an expressive or a commissive, and it consists in acting by indicating that action, signaling by indicating that signaling, indicating by indicating that indicating, expressing by indicating that expressing and gesturing by indicating that gesturing. All communicating thus has the same structure: it is an action performed by means of indicating that action. Since communicating is a sign process of high complexity, there are many conditions determining its performance, and the time has now come to give a systematic account of them.

4.1 Conditions of communicating

As a result of the analysis in the preceding paragraphs we know that when someone $b$ performs an act of communicating, $b$ produces a certain event $f$ and intends (primary intention) the occurrence of $f$ to cause a certain effect $e$ (primary effect); $b$ also intends (secondary intention) the occurrence of $f$ to cause (secondary effect) someone else $a$ to understand his primary intention; and $b$ believes that this understanding will bring about a process leading to the primary effect. We also know what is
required of the addressee \( a \) to make \( b \)'s act of communicating a success on the various levels: \( a \) must accomplish the primary effect (condition of primary success); \( a \) must accomplish the secondary effect (condition of secondary success or felicity condition); and the accomplishment of the secondary effect must cause the accomplishment of the primary effect (communication condition). And we know that this complex response is enhanced if \( a \) has the reflective openness to become aware of intentions of \( b \) on still higher levels and if \( a \) believes in the sender's seriousness and unmistakensness and assumes his sincerity.

Let us now look at the various conditions in detail (cf. figure 3).

1. **The sincerity condition.** If someone asserts some proposition \( p \) which he does not believe in himself, or expresses some state which he is not in, or promises to do something without intending to do it, he is called insincere. The sincerity condition of an assertive is therefore \( G(b,p) \), that of an expressive is \( Z(b) \), and that of a commissive is \( I(b,T(b,g)) \). These formulas are written on the bottom line of the list of conditions of communicating given in figure 3. They all describe psychological states of the sender with respect to the proposition which is the primary message of the act of communicating. The latter consists in \( p \) for assertives, \( Z(b) \) for expressives and \( I(b,T(b,g)) \) for commissives. If the sender wants to convince the addressee of the primary message, he must give him the impression that it is true or at least that he is convinced of it himself. In the case of declarations and directives there is nothing the sender wants to convince the addressee of on this level of reflection; instead he wants the addressee to bring about some external effect (possibly in cooperation with himself, as in many declarations). Therefore declarations and directives have no sincerity conditions (Searle, 1979: 19, acknowledges that there is no sincerity condition for declarations, but for directives he postulates a sincerity condition of the type: \( b \) wants \( a \) to do \( r \), cf. also 1979: 14 and 44. As our systematic account shows, this requirement lies on a level that is different from the sincerity conditions for assertives, expressives and commissives: it is one of the seriousness conditions treated in point 6; cf. also Falkenberg, 1990).

2. **The minimal propositional content.** When someone performs an act of communicating, he wants to achieve a certain primary effect by indicating that he wants to achieve that effect. A natural way of verbal communicating therefore is the utterance of a verbal expression which refers to the intended primary effect by means of its coded content. The propositional content of a verbal declaration can be expected to be simply \( E(e) \), of a verbal directive \( T(a,r) \), of
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a verbal assertive $G(a,p)$, of a verbal expressive $G(a, Z(b))$ and of a verbal commissive $G(a, l(b, T(b,g)))$. So the shaman might simply say to his marriage couple "You are now husband and wife"; and the teacher might say "Keep silent and pay attention" ("Silence and attention, please!"). However, in the case of assertives, expressives and commissives, where the intended primary effect involves a propositional attitude of the addressee (his belief), it is also possible to omit the verbalization of that attitude and just to specify its intended content. Thus in an assertive act of communicating one simply says "The door is closed" instead of "Believe that the door is closed". In an expressive one says "How happy I am!" instead of "Believe how happy I am". And a commissive may be reduced even further so that one says "I will bring you the book" instead of "Believe that I intend to bring you the book!". This simplification is made possible by the fact that communicating is acting by indicating the action concerned. It is often enough to utter a minimal proposition in order to bring about the intended indicator process in the addressee (cf. line 2 in figure 3).

3. The primary message (unmistakenness condition). In an assertive, expressive and commissive, the sender tries to make the addressee believe a certain proposition $p$, $Z(b)$, and $l(b, T(b,g))$ respectively. This proposition is called the primary message of the act of communicating. A message is something the sender intends the addressee to believe. In declarations, however, the sender intends some change to come about on the social level, and in directives, the sender intends the addressee to respond with some behaviour other than belief. Therefore, declarations and directives have no primary messages. When the addressee really believes what the sender intends him to believe, he is not mistaken if the respective proposition holds. The unmistakenness condition for the response to an act of communicating is therefore identical with its primary message. One could construct a similar argument for directives (cf. circumstance b in § 3.4), requiring that the behaviour the sender tries to make the addressee perform is in the addressee's interest. However, the formula describing this behaviour, $T(a,r)$, is not embedded in a belief operator and therefore specifies no message in the sense given above. This is why an unmistakenness condition is specified only for assertives, expressives and commissives on line 3 in figure 3.

4. The primary interpretant (intended primary effect). The primary interpretant of an act of communicating is what the addressee must do, if the act of communicating is to be successful. The primary
interpretant is thus identical with the intended primary effect of the act of communicating. It consists in $E(e)$ for declarations, $T(a,r)$ for directives, $G(a,p)$ for assertives, $G(a, Z(b))$ for expressives and $G(a, I(b, T(b,g)))$ for commissives. The primary interpretant of an act of communicating is constituted by something happening (on the social level) in declarations, the addressee doing something in directives, and the addressee believing something in assertives, expressives and commissives. What the addressee is to believe can itself be a complex attitude of the sender as in the case of $I(b, T(b,g))$ for commissives.

5. The primary process (condition of primary success). The occurrence of the intended effect alone is not sufficient for an act of communicating to be successful. Closing a door before being requested to do so cannot be regarded as fulfilment of that request. Communicating by producing a sign event $f$ is successful only if the occurrence of the intended effect is caused by the occurrence of $f$. Causal processes of this kind were described as basic sign processes in § 2.1 above. They are what we call the primary processes of acts of communicating, and their occurrence is the condition of primary success for these acts of communicating. As pointed out in § 3.3, it is important to note that an act of communicating can be performed without the corresponding primary process occurring. In this case we say that it is unsuccessful with respect to its condition of primary success. It can still be felicitous (cf. point 9).

6. The primary intention (seriousness condition). When someone produces a sign event $f$ in an act of communicating, he intends the respective primary process (which is the condition of primary success of this act of communicating) to occur. This intention is called the primary intention of the sender. It is $I(b, E(f) \rightarrow E(e))$ in the case of declarations, $I(b, E(f) \rightarrow T(a,r))$ in the case of directives, $I(b, E(f) \rightarrow G(a,p))$ in the case of assertives, $I(b, E(f) \rightarrow G(a, Z(b)))$ in the case of expressives, and $I(b, E(f) \rightarrow G(a, I(b, T(b,g))))$ in the case of commissives. If the sign producer does not have one of these intentions, his production of $f$ is not a serious act of communicating. Our definitions of the five types of communicating do not directly require the primary intention to occur, but they do specify that the sign producer intends the addressee to believe in it and that the sign producer assumes that this belief will cause the content of the primary belief to be realized.

7. The secondary message (primary action). As was established in point 3 above, a message is what the sender tries to make the addressee believe in an act of communicating. The definitions of all types of
communicating require that the sender tries to achieve the intended primary effect by making his addressee believe that he is trying to achieve it. Thus all communicating involves a message on this secondary level. The secondary message is what the addressee must be made to understand (by means of the occurrence of \( f \)), if the act of communicating is to be felicitous. What the addressee understands in a felicitous declaration is that the sender performs an action, in a felicitous directive it is that the sender performs a signaling, in a felicitous assertive it is that the sender performs an indicating, in a felicitous expressive it is that the sender performs an expressing, and in a felicitous commissive it is that the sender performs a gesturing. The formulas for the secondary messages on line 7 of figure 3 are identical with the formulas specifying the respective actions on level 1b in figure 2. These actions can be called primary actions.

8. *The secondary interpretant (intended secondary effect)*. When someone produces a sign event \( f \) in order to communicate something, he performs a primary action by indicating that action. The intended effect of the primary action is the primary interpretant of the act of communicating, the intended effect of the indicating is the secondary interpretant. It consists in the addressee believing that the sender is performing the primary action. The formulas for the secondary interpretants in line 8 of figure 3 therefore all start with \( G(a, ...) \), where the second argument consists in the primary action performed. The secondary interpretant of an act of communicating is a belief on the part of the addressee in the sender's intention to bring about the occurrence of the primary interpretant by producing the sign event \( f \). The secondary interpretant includes the belief of the addressee that the sender's production of \( f \) is a serious act of communicating (cf. point 6).

9. *The secondary process (felicity condition, condition of secondary success)*. When the occurrence of the sign event \( f \) in an act of communicating leads to the addressee understanding that the sender is performing a certain primary action, then the act of communicating is felicitous. The felicity condition thus requires the occurrence of \( f \) to be an indicator of the primary action performed. This indicator process (cf. level 2a in figure 2) is called the secondary process of the act of communicating concerned. It is directly intended by the sender, as can be seen in the formulas defining communicating of the various types (upper box on level 2bcom in figure 2). Therefore the felicity condition of an act of communicating can be said to be its condition of secondary success. The
conditions of primary (cf. point 5) and secondary success must both be fulfilled if an act of communicating is to be successful.

10. The secondary intention. When producing an event $f$ in order to communicate, the sign producer has the intention that the occurrence of $f$ will make the addressee understand that he is performing a certain primary action. This intention is called the sender's secondary intention in communicating. It is characterized by the formulas on line 10 in figure 3. They show that the sender's secondary intention can be understood as his intention to have the felicity condition fulfilled by the addressee. The secondary intention is the intention involved in indicating the performance of the primary action to the addressee (cf. level 2b in figure 2).

11. The secondary action. Producing an event $f$ with the intention to make the addressee understand that one is performing a certain primary action is the secondary action involved in communicating. The secondary action thus consists in the production of $f$ connected with the secondary intention. It aims at bringing about the secondary process (fulfilment of the felicity condition), and its intended effect is the secondary interpretant. The secondary action in an act of communicating is the action of indicating the primary action. The formulas for the secondary action on line 11 of figure 3 are therefore identical with the formulas specifying the indicating of an action on level 2b in figure 2.

12. The communication condition. The essential feature of communicating lies in the sender producing a secondary sign process (of level 2a) (i.e., performing a secondary action of level 2b) with the belief that it will bring about a primary process (of level 1a): he uses an indicator of himself producing a causal process in order to bring about that causal process (in declarations); he uses an indicator of himself producing a signal process in order to bring about that signal process (in directives); he uses an indicator of himself producing an expression process in order to bring about that expression process (in expressives); and he uses an indicator of a gesture process in order to bring about that gesture process (in commissives). This is described by the formulas for the communication condition on line 12 in figure 3. They have a peculiar structure, which becomes evident when one compares the effect of the secondary process with the effect of the primary process caused by it: while the effect of the secondary process is $G(a, T(b,f) \land I(b, E(f) \rightarrow E(e)))$, the effect of the primary process is simply $E(e)$. The difference between the
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formulas of these two effects consists in \( G(a, \ldots I(b, \ldots )) \), which characterizes one step down in the hierarchy of levels of reflection. Thus one is justified in claiming that the whole point of communicating lies in reducing a higher level process to a corresponding process on the next lower level of reflection. The sender of an act of communicating believes that this reduction will be carried out by the addressee, and whenever this is the case, the act of communicating is successful in the full sense (including the fulfilment of the conditions of both secondary and primary success). The condition of communication implies that behavioural systems not reaching at least the second level of reflection are incapable of performing acts of communicating or of appropriately responding to them: communication is impossible without a certain degree of intelligence.

Let us now compare the various formulas that specify attitudes and processes connected with communicating. The following conclusions emerge.

(i) With the exception of the formulas for the sincerity condition, the minimal propositional content and the communication condition, the formulas in each column of figure 3 constitute a sequence where each formula contains an occurrence of the preceding one as its constituent.

(ii) The formulas for the primary process (the condition of primary success) are identical with those of level 1a in figure 2; the formulas for the primary action (secondary message) are identical with those of level 1b; the formulas for the secondary process (the felicity condition, condition of secondary success) are identical with those of level 2a; and the formulas for the secondary action are identical with the formulas of level 2b.

(iii) Even the circumstances which enhance primary and secondary success in communicating find a place in this system of formulas: when the primary message is true, the addressee is *unmistaken* in believing it (as intended by the sender). When the sender himself believes the primary message or is in the corresponding state, he is *sincere*. When the sender has the primary intention necessary for the act of communicating, he is communicating *seriously*.

Since the formulas in each column from line 3 to 11 in figure 3 are embedded in one another and the formula on line 11 is a constituent of the formula defining the respective act of communicating, all these formulas can be said to describe aspects of communicating. However, this does not imply that they are all true when an act of communicating of the respective type takes place: when an act of communicating is unsuccessful on the
primary level, the primary message (3) is not believed and the primary interpretant (4) does not occur, nor does the primary process (5). When an act of communicating is not serious, the primary intention (6) does not occur. When an act of communicating is not felicitous, the secondary message (7) is not believed and the secondary interpretant (8) does not occur, nor does the secondary process (9). Of all the attitudes and processes noted in figure 3, only the secondary intention (10) and the secondary action (11) are necessary components of an act of communicating; this follows from the upper section of the definitions on line 2bcom in figure 2. The second necessary feature of communicating is the sender's belief in the validity of the communication condition (12) under the given circumstances, which follows from the lower section of the definitions on line 2bcom in figure 2.

The conclusions (i) and (ii) above confirm our claim that communicating is a complex sign process that requires at least the level of reflection 2, and is constructed on the basis of sign processes of level 1a and 2a.

4.2 Action, understanding and communicating

In § 4.1 we studied the conditions of communicating in relation to the components of the belief-and-intention configuration involved in communicating. Let us now analyze the components of the belief-and-intention configurations involved in other kinds of sign processes. Above, communicating was repeatedly characterized as a primary action performed by means of a secondary action aimed at making the addressee understand the sender’s intention to perform the primary action. Felicitous communicating thus involves two kinds of action on the part of the sender and (at least) one kind of understanding on the part of the addressee. What role do action and understanding play in the other kinds of sign processes of the hierarchy given in figure 2?

On level 1a there is no action defined yet, nor does any understanding occur in simple causal processes and in signal processes. However, when a sign event $f$ is an indicator, its occurrence causes a belief in a reacting system: $E(f) \rightarrow G(a,p)$, and this in itself justifies speaking of understanding, if only in a very rudimentary sense. Indicator processes turn out to be central building blocks of communicating: they not only occur in expression and gesture processes, which are both special cases of indicator processes; they also reoccur on level 2a, as can be seen from the structure of the respective formulas: $E(f) \rightarrow G(a,...)$.

The simplest type of action specified in our hierarchy occurs on level 1b in column I. Someone is said to perform an action by doing $f$ if he intends
the occurrence of \( f \) to cause a certain effect. Performing an action is thus characterized as doing something with a certain intention: \( T(b,f) \land I(b,...) \).

All other processes on level 1b are special cases of actions, and action processes also reoccur on a higher level in 2b, as can be seen from the structure of the respective formulas: \( T(b,f) \land I(b,...) \).

From these observations it follows that, with the exception of simple causal and signal processes, all processes specified in our hierarchy up to level 2b are configurations of indicator processes and actions. In principle, the construction of complex sign processes by combining indicator processes and actions can be continued beyond the second level of reflection. The discussion of interactive openness in § 3.4 made it clear that such higher-level sign processes exist. But the higher one gets the more they tend to lose their point, since they are not systematically connected with responses on the lower levels of reflection. This is, however, what communicating is supposed to achieve through the communication condition.

If we stay with the apparatus of intensional logic in constructing higher-level sign processes, the resulting formulas soon become too complicated to be handled easily. Let us therefore make use of the semiotic terminology, which was introduced in § 2 and § 3, and synoptically presented in figure 2, in order to abbreviate the higher-level formulas. This is possible if we allow the area codes of figure 2 to be substituted for the formulas occurring in these areas:

- the formula for an action in area 11b, which contains the formula for a causal process \( E(f) \rightarrow E(e) \) as specified in area 11a, can thus be replaced by \( T(b,f) \land I(b,11a) \);
- the formula for an indicator of an action in area 12a can be replaced by \( E(f) \rightarrow G(a,11b) \), as well as by \( E(f) \rightarrow G(a, T(b,f) \land I(b,11a)) \);
- the formula for an indicating of an action in area 12b can be replaced by \( T(b,f) \land I(b,12a) \) and by \( T(b,f) \land I(b, E(f) \rightarrow G(a,11b)) \) as well as by \( T(b,f) \land I(b, E(f) \rightarrow G(a, T(b,f) \land I(b,11a))) \);
- the formula for a declarational act of communicating in area 12bcom can be replaced by \( T(b,f) \land I(b,12a) \land G(b,12a \rightarrow 11a) \) as well as by what can be obtained by spelling out 12a and 11a as in the other example cases.

The abbreviated formulas are a convenient instrument for showing that:

- \( f \) is an action if it is produced with the intention of bringing about a certain effect,
- \( f \) is an indicator of an action if its occurrence causes a recipient to believe that it is an action,
- \( f \) is an indicating of an action if it is produced with the intention for it to be an indicator of an action, and
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f is a declaration if it is produced with the intention for it to be an indicator of an action and with the belief that this indicator of an action will cause the primary process intended in the action.

Abbreviated formulas of this kind can be used not only to describe the relations among the levels in column I, but also in the other columns of figure 2. If one omits the column signs, the formulas characterize the general relations among the sign processes on the various levels of reflection in all columns, that is for all types of sign processes. This procedure has been used in the presentation of sign structures in figure 4.

Figure 4 shows the general principles of construction of the hierarchy of sign processes. In the horizontal dimension, it is based on a series of causal processes with increasingly complex effects. These processes are characterized on level 1a in the same way as in figure 2.

In the vertical dimension, we also have a series of increasingly complex processes, but the principles of construction here are different from those in the horizontal dimension:

- on level 1a, we have a formula for a simple causal process $E(f) \rightarrow E(e)$;
- on level 1b, this formula reoccurs as a constituent of the formula $T(b,f) \land I(a,...)$; the latter characterizes b’s intention to bring about ... by producing f, i.e., it characterizes an action;
- on level 2a the formula 1b reoccurs as a constituent of the formula $E(f) \rightarrow G(a,...)$; the latter characterizes an indicator process, i.e., it characterizes a’s understanding of 1b;

The construction procedures for formula 1b out of 1a and for formula 2a out of 1b are then repeated on the higher levels:

- level 2b is reached from level 2a in the same way as level 1b is reached from level 1a by embedding the respective formula into $T(b,f) \land I(b,...)$; i.e., on level 2b we are dealing with an action;
- level 3a is reached from level 2b in the same way as level 2a is reached from level 1b by embedding the respective formula into $E(f) \rightarrow G(a,...)$; i.e., on level 3a we are dealing with an indicator process, that is, an understanding.

This dual progression of action and understanding can be continued without end. However, there is a complication on level 2b, which lies in the special way communicating is constructed on the basis of action and understanding: communicating is performing a first-level action by making the addressee understand that one is performing that action. Communicating is the indicating of an action, combined with the sender’s belief that the level-reducing communication condition holds. Thus the first part of the formula for communicating is identical with the formula 2b for indicating an action: $T(b,f) \land I(b,2a)$; its second part represents the level-reduction:
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\[ G(b,2a \rightarrow 1a) \]. As the configuration of belief and intention operators shows, the level-reducing formula belongs to the same level of reflection as the formula for indicating an action. This is why the reflection level of communicating is characterized as 2bcom.

In figure 4, the formulas on level 3a etc. take the formula for communicating, 2bcom, as constituent. As pointed out above, an alternative progression could simply take the formula for indicating an action, 2b, as constituent.

The addition of the sender’s belief in the communication condition, which constituted an act of communicating on level 2bcom, is also constitutive of communicating on higher levels of reflection. One must, however, add to this as many level-reducing beliefs as are necessary to reach the basic level of reflection. On level 3bcom, the formula 3b, which represents the indicating of a declaration, has to be conjoined not only with the formula \( G(b,3a \rightarrow 2a) \), which reduces the indicator of a declaration to the indicator of an action, but also with the formula \( G(b,2a \rightarrow 1a) \), which reduces the indicator of an action to the primary process intended in the action. The higher the level of reflection of an act of communicating, the more level-reducing operations must be assumed by the sender to be performed by the addressee.

It is not difficult to find examples for higher-level communicating on level 3: take a chairperson trying to reopen a formal session when the intermission is over. Instead of formally reopening the session by saying “I hereby reopen the meeting”, which would be a standard declaration, he can indicate this declaration by producing a noticeable cough \( f \), and believe that the occurrence of \( f \) will be accepted as a declaration to the same effect as the standard reopening declaration. Another example of higher-level communicating was outlined in our discussion of communicative openness in the kindergarten (cf. § 3.4). When the teacher \( b \) tries to have the children be silent and pay attention without uttering an explicit verbal request to that effect, she can just hint at herself uttering an explicit verbal request by producing a noticeable cough \( f \). In both cases, \( f \) can take over the function of indicating since it is indexically connected with the verbal utterance indicated (coughing is a preparatory step to a verbal utterance). The acts of communicating indicated, however, are different in the two cases; their type and content have to be inferred from the circumstances.

These examples may suffice to provide evidence for the wealth of complex higher-level sign processes that result from combinations of the three procedures described. Taking into account reflective openness in the sender and the addressee, they can be recapitulated as

(1) action: producing an event \( f \) with the intention that the occurrence of \( f \) be a cause for a certain lower-level process: \( T(b,f) \land I(b,\ldots) \),
| 3bcom | f is a declaration through an indicating of this declaration | f is a directive through an indicating of this directive | f is an assertive through an indicating of this assertive | f is an expressive through an indicating of this expressive | f is a commissive through an indicating of this commissive |
| 3b   | f is an indicating of a declaration | f is a directive | f is an assertive | f is an expressive | f is a commissive |
| 3a   | f is an indicator of a declaration | f is a directive | f is an assertive | f is an expressive | f is a commissive |
| 2bcom | f is a declaration, i.e., f is an action through an indicating of this action | f is a directive, i.e., f is a signaling through an indicating of this signaling | f is an assertive, i.e., f is an indicating through an indicating of this indicating | f is an expressive, i.e., f is an expressing through an indicating of this expressing | f is a commissive, i.e., f is a gesturing through an indicating of this gesturing |
| 2b   | f is an indicating of an action | f is a signaling through an indicating | f is an indicating of an expressing | f is an indicating of a gesturing | f is an indicating of a gesturing |
| 2a   | f is an indicator of an action | f is a signaling | f is an indicating | f is an expressing | f is a gesturing |
| 1b   | f is an action | f is a signaling | f is an indicating | f is an expressing | f is a gesturing |
| 1a   | f is a cause | f is a signal | f is an indicator | f is an expression | f is a gesture |

Figure 4: The hierarchy of sign types and its principles of construction
understanding: being made to believe something by the occurrence of $f$: $E(f) \rightarrow G(a,...)$, and

(3) communicating: producing an indicator of an action with the belief that it will cause the process intended in the action: $T(b,f) \wedge I(b,na) \wedge G(b,na \rightarrow n-1a)$, where $n$ is any natural number above 1.

When higher-level communicating is performed to achieve the effect of one of the five types of communicating defined on level 2bcom, it has the form:

$$T(b,f) \wedge I(b,na)$$
$$\wedge G(b,na \rightarrow n-1a)$$
$$\wedge G(b,n-1a \rightarrow n-2a)$$
$$\vdots$$
$$\wedge G(b,n-(n-2)a \rightarrow n-(n-1)a),$$

where $n$ is any natural number above 1.

4.3 Sign use and type-switching

If a sender $b$ produces an event $f$ with the intention that $f$ serve as a sign, we can say that $b$ uses $f$ as a sign, as already pointed out in point 12 of § 4.1. Thus $b$ uses $f$ as a signal when $b$ performs the action of signaling: $T(b,f) \land I(b, IIIa)$; $b$ uses $f$ as an indicator when $b$ performs the action of indicating: $T(b,f) \land I(b, II1a)$; etc. And $b$ uses $f$ as an indicator of signaling, when $b$ performs an indicating of signaling: $T(b,f) \land I(b, II2a)$; etc.

In the case of communicating, $b$ produces an indicator of an action and believes it to cause the process intended in that action. Here again we can formulate that $b$ uses an indicator of an action as a cause for the process intended in that action. In directives, for instance, we can say that $b$ uses an indicator of signaling as a signal: $T(b,f) \land I(b, II2a) \land G(b, II2a \rightarrow IIIa)$.

The concept of sign use enables us to analyze the composition of more complex sign processes obtained by combining selected sign processes from our hierarchy. Let us study them on the basis of a final series of examples connected with expressions, expressings and expressive acts of communicating (cf. column IV in figure 2 and figure 4). In area IV1b, $b$ expresses some state $Z$: $T(b,f) \land I(b, E(f) \rightarrow G(a, Z(b)))$; i.e., $b$ uses $f$ as an expression of that state: $T(b,f) \land I(b, IV1a)$. In area IV2b, $b$ indicates expressing; i.e., $b$ uses $f$ as an indicator of expressing: $T(b,f) \land I(b, IV2a)$. In area IV2bcom, $b$ performs an expressive act of communicating, i.e., $b$ uses an indicator of himself expressing some state as an expression of that state: $T(b,f) \land I(b, IV2a) \land G(b, IV2a \rightarrow IV1a)$. 
Imagine an apartment where Brenda (b) is in the kitchen, preparing supper, while Amanda (a), who shares the apartment with Brenda, is sitting at her writing desk in the room next to the kitchen. The kitchen door is open and the radio is not on, since Amanda wishes not to be disturbed while working.

(IV1a) One evening, while Amanda is concentrating on her work, she suddenly hears a cry of pain from the kitchen: E(f), which makes her believe that Brenda has hurt herself (Z) while preparing the supper: E(f) → G(a, Z(b)). Let us assume that Brenda has in fact hurt herself and in the process did not think of any other person present. She cried out involuntarily. Amanda hears the cry, believes that Brenda is in pain and, as a consequence, jumps up from her writing desk and runs into the kitchen to see if she can help. This is to have more consequences.

(IV1b) One evening, Brenda is preparing supper again and she has another mishap, which is slightly less serious than the first one. There is no involuntary cry. But after a short reaction time, Brenda intentionally produces a cry of pain that resembles the one she would have produced involuntarily if the pain had been severe enough. She produces a cry with the intention that its occurrence cause Amanda to believe she is in pain: T(b,f) ∧ I(b, E(f) → G(a, Z(b))). This is what we call expressing pain. The difference between an expression of pain and an expressing of pain is that the latter, but not necessarily the former, is an action: T(b,f) ∧ I(b, IV1a); cf. § 3.1 and area IV1b in figures 2 and 4.

(IV1b → IIIb) Now it may well be that Amanda cannot tell the difference and takes Brenda's cry as an expression of pain in the same way as in the first case. In consequence, she may run to help Brenda, bandage her finger etc. And this may be what Brenda wanted to achieve. If so, Brenda manipulated Amanda: she produced an event with the intention that it be taken as an expression of a bodily state (independent of what her bodily state actually was) and she believed that this expression would serve as a signal for Amanda to come to help; in other words, Brenda used an expression as a signal: T(b,f) ∧ I(b,IV1a) ∧ G(b, IV1a → IIIa). Manipulation always takes place when one tries to make someone else do or believe something without indicating that intention to him. The difference between manipulation and communication lies in the communication condition. When the latter is fulfilled, the addressee is intended to understand what the sender wants him to do or believe, and this understanding is even supposed to cause the addressee to do or believe that.

(IV2a) Back to the kitchen: if Brenda repeats her manipulation too often, Amanda may become aware of it. In this case, Brenda's cry makes Amanda believe that Brenda produced it with the intention for the cry to make Amanda believe that Brenda is in pain: E(f) → G(a, T(b,f) ∧ I(b, E(f) →
$G(a, Z(b)))$. Semiotically speaking, Amanda takes Brenda’s cry as an indicator of Brenda expressing pain: $E(f) \rightarrow G(a, IV1b)$. The discovery that Brenda sometimes voluntarily cries in order to make Amanda believe she is in pain when in fact she is not may make Amanda less eager to run to help. Amanda may even accuse Brenda of misleading her and simulating pain by producing fake pain behaviour.

(II2a) However, if Amanda is very fond of Brenda, she might eventually accept Brenda’s simulated cry $f$ as a direct signal for her to come into the kitchen and help. In this case, $f$ serves as an indicator of signaling for Amanda, and it is no longer relevant whether she has any specific belief about Brenda’s bodily state: $E(f) \rightarrow G(a, T(b, f) \land I(b, E(f) \rightarrow T(a, r)))$; in semiotic terms: $E(f) \rightarrow G(a, II1b)$.

(IV2b) Amanda’s way of responding might influence Brenda’s habits of interaction in such a way that she now tries to avoid giving any reasons for being accused of simulating. So the next time Brenda hurts herself, she does not dare to produce her pseudo-natural pain cry but simply utters the word "ouch", in a tone that indicates that she has not lost control of herself. In this case, Brenda produces a conventional sound, intending its occurrence to make Amanda believe that she produces this sound with the intention of making Amanda assume she is in pain: $T(b, f) \land I(b, E(f) \rightarrow G(a, T(b, f) \land I(b, E(f) \rightarrow G(a, Z(b))))$. Semiotically speaking, Brenda indicates to Amanda that she is expressing pain: $T(b, f) \land I(b, IV2a)$.

(IV2b \rightarrow IIIb) Of course, Brenda indicates expressing pain only in order to make Amanda come into the kitchen again. Thus Brenda produces an indicator of expressing pain with the belief that it will serve as a signal for Amanda to come; in other words, Brenda uses an indicator of expressing as a signal: $T(b, f) \land I(b, IV2a) \land G(b, IV2a \rightarrow IIIa)$. However, when using an indicator of expressing as a signal, Brenda manipulates Amanda in a way similar to herself using an expression as a signal. In either case, Amanda may or may not be aware of the manipulation.

(IV2bcm) When Brenda uses $f$ as an indicator of expressing her state, Amanda is relieved that Brenda is no longer simulating. She therefore takes Brenda’s indicating of expressing pain more seriously than the previous pseudo-natural pain behaviour. However, indicating that one expresses something is not the same as expressing something, and so Brenda cannot count on Amanda automatically believing that she is really in pain. She rather counts on an intermediate process taking place in Amanda. She believes that when her utterance of "ouch" makes Amanda understand that she wants her to believe she is in pain, then it will also make Amanda believe that she really is in pain. This corresponds to the communication condition. By applying it, Brenda makes Amanda’s belief in Brenda’s pain dependent on her understanding of Brenda’s utterance; i.e., Brenda
performs an expressive act of communicating: $T(b,f) \land I(b,IV^2a) \land G(b, IV^2a \rightarrow IV^1a)$.

(IV^2com \rightarrow III^1b) Of course, Brenda has not given up her hope that Amanda will come to her when she believes that Brenda is in pain. She performs the expressive act of communicating in the belief that it will serve as a signal for Amanda to come; in other words, she uses the expressive as a signal: $T(b,f) \land I(b,IV^2a) \land G(b,IV^2a \rightarrow IV^1a) \land G(b,IV^1a \rightarrow III^1a)$. What Brenda achieves in this way is signaling by expressively communicating. Her primary expressive intention is conveyed communicatively, but her primary directive intention is still supposed to be satisfiable by manipulation. In Austin's terminology (cf. 1962: 121ff), she uses an act of communicating to perform a perlocutionary act. She uses an expressive as a signal without intending her addressee to be aware of that; she does not indicate to Amanda that she believes a successful act of expressive communicating will serve as a cause for her to come into the kitchen. If this is her aim, she cannot achieve it by simply using a communicatively produced expression as a signal.

(IV^2com \rightarrow II^2b) When Brenda performs an expressive act of communicating with the additional belief that communication success will make Amanda something. Alternatively, Brenda can perform an expressive act of communicating and believe that communication success will make Amanda understand that she wants her to come into the kitchen. In this case she indicates signaling by expressively communicating; she uses an expressive as an indicator of signaling: $T(b,f) \land I(b,IV^2a) \land G(b,IV^2a \rightarrow IV^1a) \land G(b,IV^1a \rightarrow II^2a)$; in short: $IV^2com \land G(b,IV^1a \rightarrow II^2a)$. However, even if Brenda is successful, Amanda will only believe that Brenda is in pain and that she wants her to come. Amanda will not feel she is being asked to come into the kitchen because of Brenda's pain. Amanda can again accuse Brenda of manipulating her, since Brenda does not openly request her to come. In order to circumvent this objection, let us try the following version.

(IV^2com \rightarrow II^2bcom) Brenda produces an expressive $f$ in the belief that communication success will make Amanda receive $f$ as a directive. In this case, Brenda uses an expressive sign $f$ as a directive sign. Spelled out in a little more detail, Brenda signals to Amanda to come (by indicating this signaling) through expressing her pain (by indicating this expressing): $T(b,f) \land I(b,IV^2a) \land G(b,IV^2a \rightarrow IV^1a) \land G(b,IV^1a \rightarrow II^2bcom)$; put more explicitly: $T(b,f) \land I(b,IV^2a) \land G(b,IV^2a \rightarrow IV^1a) \land G(b,IV^1a \rightarrow II^2a) \land G(b,II^2a \rightarrow III^1a)$; and in the shortest version: $IV^2bcom \rightarrow II^2bcom$. 
However, even this complicated configuration of beliefs and intentions is not appropriate as a communicative attitude geared to making Amanda aware of Brenda's dual intention. Although Brenda tries to perform two acts of communicating (based on the same sign event $f$), the connection between the two acts is manipulative. Amanda can still accuse her of using communication for the purpose of manipulation. Brenda is still involved in what we can call manipulative indirectness. In order to achieve communicative indirectness, Brenda must indicate to Amanda that she produces the $f$ with the intention to use it as a signal. A possible way of doing this is the following.

$$(\text{com } (IV2bcom \rightarrow II1a)) \quad b \text{ produces } f \text{ with the intention that the occurrence of } f \text{ make } a \text{ understand that } b \text{ intends } a \text{ to believe in } b\text{'s state; and } b \text{ believes that when this understanding occurs, the belief in } b\text{'s state will occur (expressive). In addition, } b \text{ intends that the occurrence of } f \text{ make } a \text{ understand } b\text{'s intention that when the occurrence of } f \text{ leads to } a\text{'s belief in } b\text{'s state then the occurrence of } f \text{ will also lead to } a \text{ doing } r; \text{ and } b \text{ believes: when the occurrence of } f \text{ makes } a \text{ understand } b\text{'s intention (that when the occurrence of } f \text{ will lead to } a\text{'s belief in } b\text{'s state, the occurrence of } f \text{ will also lead to } a \text{ doing } r), \text{ then the occurrence of } f \text{ will really lead to } a \text{ doing } r \text{ (communicative indirectness). Spelled out in a formula, this amounts to:}

$$T(b,f) \land I(b, E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow G(a, Z(b))))))$$

$$\land G(b, (E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow G(a, Z(b))))))$$

$$\rightarrow (E(f) \rightarrow G(a, Z(b))))$$

(expressive)

$$T(b,f) \land I(b, E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow G(a, Z(b))))))$$

$$\land G(b, (E(f) \rightarrow G(a, T(b,f) \land I(b, E(f) \rightarrow G(a, Z(b)))) \rightarrow (E(f) \rightarrow T(a,r))))))$$

$$\rightarrow (E(f) \rightarrow T(a,r)))$$

(communicative indirectness)

In semiotic terms, $b$ produces an indicator of herself producing an expression of her state, and $b$ believes that this indicator will serve as an expression of her state:

$$T(b,f) \land I(b, IV2a)$$

$$\land G(b, IV2a \rightarrow IV1a)$$

(expressive)

In addition, $b$ produces an indicator of herself intending the expression of her state to serve as a signal for $a$ to do $r$, and $b$ believes that this indicator will in fact serve as that signal:

$$T(b,f) \land I(b, E(f) \rightarrow G(a, T(b,f) \land I(b, IV1a \rightarrow II1a)) \land G(b, (E(f) \rightarrow G(a, T(b,f) \land I(b, IV1a \rightarrow II1a)))) \rightarrow II1a)$$

(indirectness)

In other words, $b$ produces $f$ as an indicator of expressing and uses that indicator as an expression; in addition, $b$ produces $f$ as an indicator of $b$'s intention for this expression to serve as a signal and uses that indicator as a signal. In short, $b$ uses an expressive as an indirect directive.

A complex sign process thus structured satisfies the communication condition in two different ways. On the one hand, $b$ performs an expressive
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The act of communicating; on the other hand, b utilizes this expressive act of communicating in a communicative way for the purpose of signaling. b no longer manipulates a to do r by means of the expressive, but indicates to a b's wish for the expressive to serve as a signal for a to do r and believes that this indicating will bring about the signaling. In other words, by communicatively expressing her bodily state, b indirectly requests a to do r. If a really does r, then this no longer constitutes the intended effect of a covert perlocutionary act of b, but the satisfaction of an indirectly communicated wish of b.

The examples we are considering in this section differ from the ones discussed earlier in that they combine basic processes of two different types: an expression (column IV in figure 2) serves as a signal (column II in figure 2) for the addressee to do something. As was pointed out, there are various ways in which this can be achieved. In the example IV1b → II1b there is double manipulation: b manipulates a into doing something by manipulating a into believing something. The example IV2b → II1b is not essentially different: here b manipulates a into doing something by indicating that b wants to manipulate a into believing something. In IV2bcom → II1b, there is only simple manipulation: b manipulates a into doing something by communicating b's state to a. Here we are dealing with manipulation by means of communication. This is also the case in IV2bcom → II2bcom, where we have two acts of communicating of different types linked through the same sign event f. This link itself is produced uncommunicatively. Thus b produces f as an expressive act of communicating and manipulates a into taking it as a directive act of communicating.

Only in the last example is the change from one type of basic process to the other performed communicatively. In com (IV2bcom → II1a) b not only performs an expressive act of communicating but also communicates the intention for this act of communicating to serve as a signal for a to do r. This is typical of what is called an indirect speech act in Searle, 1979 (cf. also Morgan, 1978). Indirect acts of communicating satisfy the communication condition in at least two ways: they are based on an act of communicating of type x and they communicate its utilization to achieve the result of an act of communicating of type y. Such type-switching can take an act of communicating of any type as basis and lead to an act of communicating of any other type.

This may be illustrated by a final example. When, in concluding this chapter, I say to you "I am sorry about the complexity of my formulas", I communicatively intend you to take that as an apology for the complexity of my formulas: I perform a declaration by means of an expressive. This indirect declaration is a felicitous act of communicating only if you understand my intention for you to take my expressive as a declaration.
And it is successful if you do take the expressive as a declaration because you understand my intention for you to do so.

5. Consequences for Artificial Intelligence research

With the analysis of type-switching sign processes, our trip through the realm of semiosis has come to a provisional end. This gives us an opportunity to assess the advantages and disadvantages which our approach to communication has in A.I. research.

The leading concern of this article was the question what happens in communication between humans. It was asked with the aim of giving an answer to the question what should happen in communication between information processing systems in A.I. The reconstruction of basic processes in human communication was carried out with a view to the construction of such processes in human-machine communication and in machine-machine communication. It was done on the basis of the claim that machines lacking the capacity to communicate cannot be called intelligent in any adequate sense of the word.

In reconstructing communication, we proceeded from the claims (made in § 1) that communicating is a sign process and that in sign processes external objects or events are registered or produced in connection with attitudes and processes internal to recipients and senders. We then introduced (in § 2) five elementary concepts of intensional logic that can be used to describe occurrences of external events and internal attitudes and processes. We used two event-predicators, one of them denoting the occurrence of an event: $E(\ldots)$, and the other denoting the production of an event by a behavioural system: $T(\ldots, \ldots)$; and we applied three sentence operators, one of them denoting the cause-and-effect relation: $\ldots \rightarrow \ldots$, the second denoting the belief by a behavioural system in a proposition: $G(\ldots, \ldots)$, and the third denoting the intention of a behavioural system to realize a proposition: $I(\ldots, \ldots)$. These few concepts were all we needed to define (in § 2 and § 3) a hierarchically structured set of infinitely many sign concepts. As was pointed out in § 3, the sign concepts defined on this basis are characterized by the fact that the type of a sign event is always dependent on the type of sign process in which it occurs, the latter being determined by the belief-and-intention configuration of the recipient or the sender. In § 4 the sign concepts on the various levels of the hierarchy were shown to be reached in a dual way by alternatively applying an action and an indicator concept to lower-level sign concepts and by using a device for level-reduction, which we called the communication condition. The sign hierarchy includes, as a sub-hierarchy, a set of (infinitely many) concepts...
of communicating on the various levels of reflection. Among them are five types of communicating which correspond to the five types of speech acts defined in Searle, 1979. To round off the conceptual apparatus, a type-switching device was introduced in § 4.3, which makes it possible to combine a sign process of a given type with a sign process of another type, thereby creating indirect sign processes and, particularly, indirect communicating.

The concepts of an action and an indicator, together with the communication condition and the type-switching device, constitute a powerful set of tools for providing the structure of all kinds of sign processes that occur in human life. At the same time, the fact that all these devices are, by definition, based on the five elementary concepts of intensional logic mentioned above, gives this formal apparatus an explicitness and a transparency that allows its application in computer programming.

The present reconstruction of human communication processes as a sub-hierarchy within the hierarchy of sign processes can therefore function as a basis for the construction of intelligent systems that develop the capacity to communicate. At the same time the implementation of the present hierarchy of sign processes in a computer can serve as a test procedure for the consistency of our approach. In addition, this implementation can be the first step towards further elaboration of special communication tasks to be carried out by expert systems of various kinds.

Presupposing that these applications of our hierarchy of sign processes will prove successful, what consequences do we foresee concerning the role which sign processes of the various types and, in particular, communication can play in A.I.?

1. What type of sign is realized by a given event depends largely on the internal belief-and-intention configurations of the sign producer and the recipient. Thus the key to constructing communication in artificial information processing systems lies not so much in the syntactic and semantic structures of the external sign events, but in the capacity of the systems to activate appropriate internal states, i.e., belief-and-intention configurations.

2. When a system capable of decoding its sign input also has the capacity to form hypotheses about the beliefs and intentions of the sign producer,

- it can increase the number of inferences from the sign input and thus intensify its information processing,
- it can check the decoded information against the hypothetical communication intentions of the sign producer, and thus detect errors (and correct them according to its hypotheses or change its hypotheses),
it can understand signs of one type as indirectly conveying messages normally carried by signs of other types, i.e., it can understand acts of indirect communicating.

- it can decide to respond in a way not directly determined by the sign input but based on the results of its own intensified information processing, error correcting and indirect understanding.

3. Analogous points can be made about the sign producer: when a system capable of producing signs by encoding information selected from its data base also has the capacity to form hypotheses about the beliefs and intentions of the addressee,

- it can more adequately chose the appropriate information to be encoded,

- it can decide about the possibility of abbreviations or the necessity of redundancies,

- it can make use of coded meanings to convey other messages by way of indirect communicating,

- it can leave to the addressee the decision of how to respond in the light of a shared goal, thus relying on the addressee's capacity for rational behaviour.

These modes of behaviour in the sign producer and the addressee offer enormous advantages over systems whose capacities are restricted to decoding and encoding information. Information processing systems endowed with belief-and-intention configurations will approximate the efficiency and flexibility of human information exchange. The possible increase in misunderstanding can be counteracted in the same way as in human communication, i.e., by allowing the interacting systems to thematize any puzzling behaviour of their communication partners straight away.

4. Previous approaches to the interaction between information processing systems only had available either the simple code model or the highly refined speech act analysis of Searlian provenance. The code model is too rigid to be of use in the flexible interaction required in the application of expert systems. Speech act theory provides five highly specialized types of sign processes. But when one looks at human interaction, it seldom consists merely of simple decoding or encoding activities, nor does it always involve acts of communicating that correspond to Searlian speech acts. There is a vast field of interaction lying between these two extremes which has never been sufficiently studied and systematically analyzed up to now. Our conceptual approach can be of help in filling this gap. We started with a set of basic sign processes and increased their
complexity step by step until we reached ones corresponding to speech acts. However, we did not stop there, but provided means for the (re)construction of sign processes that are slightly more complex and slightly less complex than speech acts. This makes our approach comprehensive enough to grasp what goes on in actual human interaction: the majority of sign processes occurring between humans are below the threshold of communication, and when there is communication it never occurs without accompanying lower-level sign processes (involving contextual indicators) and higher-level sign processes (involving the reflectional integration of the communicated messages with the messages of previous communication and of contextual indicators). Only a comprehensive semiotic approach such as ours can do justice to human interaction, and it follows that only this kind of approach can lead to a successful modeling of human interaction in A.I.

5. The structure of codes in general, and of natural and machine languages in particular, was given little attention in the present essay. This was deliberately done in order to use the available space for an analysis of the complex mutual relations between sender and addressee in human interaction. However, it is clear that communication would not be very efficient without conventional codes that provide a potentially infinite set of types of sign events and assign them fixed meanings. Nevertheless, the possibility of solving the complicated tasks of advanced expert systems simply on the basis of the generative power of such codes has been highly overestimated in the history of A.I. It seems that humans use linguistic expressions with conventional meanings largely as instruments to convey messages that differ from those meanings, as in metaphors, ellipses and indirect speech acts. Indirect communicating is a way of constructing new messages on the basis of given meanings. The more complex the meanings given by our conventional codes, the more elaborate the messages can be that we construct by relying on mutual belief-and-intention configurations. This argument confirms the traditional assumption that language and thinking must have developed in close relation to each other. The point made in the present article is that this would have been impossible without communicating. From this it is merely a small step to the claim that artificial information processing systems will develop intelligence only if they are programmed so that they can communicate.

6. One of the important consequences of our approach is the claim that communicative competence in the strict sense discussed here cannot be programmed as such into an information processing
system. It must rather be trained. The history of sender-recipient
contacts between two information processing systems must be
arranged in such a way that system \(a\) starts expecting the complex
belief-and-intention configurations in system \(b\) that are required for
\(b\)'s sign to function as a communicative sign. Only when systemati­
cally confronted with increasingly complex sign processes and when
guided by reinforcing responses, can an information processing
system develop the habit of presupposing communicative belief-and­
intention configurations in the sign producer. And only under such
circumstances can it develop the habit of presupposing such internal
configurations in the addressee of a self-generated sign process. This
implies that communication-oriented behaviour cannot be acquired
by the addressee independently of the sender and vice versa; i.e.,
role change between systems is a necessary component in the
training of communicative competence.

7. The training approach to the introduction of communicative
competence in information processing systems has a further
consequence concerning the roles a system should take in communi­
cative interaction. Full communicative competence cannot be
reached by training the pairwise exchange of information within
simple dialogue constellations. Communicative competence includes
the ability to distinguish ratified communication partners from non­
ratified participants, addressed ratified communication partners from
non-addressed ones, eavesdropping non-ratified participants from
bystanders, etc., and this ability can only be trained by putting the
information processing system into each of these roles vis-a-vis a
given sender (and vice versa). Similar differentiations must be
learned concerning the roles of author, principal and animator in
the function of a sender. An information processing system that
cannot make adequate hypotheses about these various roles and
cannot switch quickly from one to the other will not have the
flexibility necessary for appropriate behaviour as an advanced expert
system. In learning to assess its momentary role in an ongoing
communication, the system must rely on the ability to respond to the
contextual signals, indicators, expressions and gestures that
accompany the acts of communicating performed by the sender.

8. Of course, the necessary training programs for computers cannot be
developed on the basis of armchair analyses of the processes to be
trained. The appropriate belief-and-intention configurations of the
participants in communication have to be known in principle on the
basis of empirical research. Two fields of study are promising in this
respect. One of them includes the complex communication
constellations presented on the stage in theatrical plays, where the plot (a special version of the history of sender-recipient contacts) determines the hypotheses of the actors and actresses and of the audience about their mutual belief-and-intention configurations. Another promising object for empirical research is the pathology of human interaction, where the belief-and-intention configurations mutually projected onto one another are again results of the history of sender-recipient contacts within the group of humans concerned. This is not the place to go into the methods to be used in such research. Its results, however, must make it possible
- to predict the level of reflection necessary and sufficient for a given task of interaction,
- to diagnose situations where interaction partners take either too high levels of reflection (as in certain types of paranoia) or too low ones (as in certain types of bureaucracy),
- to find ways for therapeutic treatment that is level-reducing in one case and level-raising in the other.

From a semiotic point of view, communication training for computers will eventually differ very little from therapeutic training for paranoid persons and management reorganization in bureaucratic institutions, thus confirming our approach that the sign users we are studying can be (human) organisms as well as information processing machines and social organizations.

Acknowledgment

I am grateful to Arnold Günther, René Jorna, Sabine Kowal, John Orman and Klaus Robering for extensive comments on earlier drafts of this paper.

References


Believing, causing, intending: A hierarchy of sign concepts


