

# Attributes of Language Use Explained by Activities of Neurons

Shinji Karasawa

Miyagi National College of Technology

Nodayama 48, Shiote, Medeshima, Natori-shi, Miyagi-ken, 981-1239 Japan

Email: shinji-karasawa@cup.ocn.ne.jp, <http://www17.ocn.ne.jp/~shinji-k/index.htm>

**Abstract** A creature is not able to live without interacting with surroundings. The creature makes action in order to continue activities. The network of neurons in a brain is a tool to replay and it is created through the activity. A language is a tool that expresses activities of a brain. Fundamentals of language use are explained by means of activities of cell level. Since every nerve cell unifies many activities into one activity, a subset of activities forms a hierarchical linkage of neurons. There are linkages between the representative and the content that is expressed, and there are linked overlaps in a layered structure. The branch processes of language use are operated by means of the intermittent activities.

**Key words** Mind, Brain, Neuron, Behavior, Activity, Knowledge, Language, Universal grammar

## 1. Introduction

A motivation of behavior is essentials of intelligence. But, there has not been the formal theory that deals with objectives of activities. The paradigm of activity is able to explain about the general motivation of human activity, because the activities of cell level possess generalities. Up to now, the traditional science stays away from affairs on individual mind. It is considered that the mind is activities of a brain, and essentials of brain mechanism depend on attributes of creature.

Generally speaking, biochemical reactions a creature change its surroundings. The creature adapts its behavior to the renewing surroundings. Similar activities are found in a body. Each cell does suitable activity in order to continue activity. It acts as a member of cell society. The instinct is a verbal expression on the general motivation of activities. Every activity in a creature is considered as a tool for living. Information is the tool to express activities of a brain. The language is the most important tool to express the activities of brain i.e. the mind. Human being has developed the world of information in a brain by means of the language use.

The behavior of animal was researched as “sensory-

motor coupling” in the field of cybernetics [1]. It has been programmed as “subroutine-call hierarchy” in the field of behavior-based robotics [2]. Winner-take-all architecture is considered for a selection dynamics as a competitive coordination on actions. However, the traditional science does not deal with spirits [3]. According to a traditional concept of so-called dualism [4], a human have physical body and non-physical spirits.

The activities of a living creature are composed of biochemical reactions [5]. Every action in a body is unified at each section and each moment. The intermittent operations are similar to operations of a digital computer. The activities of a human and those of a digital computer are controlled by a time-sharing operating system.

N. Chomsky proposed so-called universal grammar [6], and he argued that the universal grammar was an innate function. But the language use is acquired together with acquisition of natural intelligence through experiences in the real world. Then the characteristics common to all language are explained by means of attributes of (1) real world, (2) brain-mechanism, and (3) vocal organ.

In this paper, the mind as activities of brain is described in order to understand essentials of language use.

## 2. A definition of mind as the activity of a brain

Human being has developed a world of information in its brain. The information is a tool to interact with the outer world. The primitives of interactive activities can be traced back to a first life. If every individual reaction in a group does the action that is matching properly to demands of the group, the group behaves as a system. If each cell in a group makes the action that is matching properly to the demands of its surroundings, the whole activity functions as an organized body.

The biochemical reaction of a creature forms a part of body concurrently. Elements for the activity are created through the activities. The gene expression depends on the activity. The creature continues activity in order to adapt itself to the changing surroundings. The creatures have continued to evolve such biochemical reactions about four billion years.

There are many phenomena attributed to activities of a human brain such as intention, planning, thought, imagination, knowledge, and communicate [7]. Up to now, many peoples believe that a mind stays in a brain. The mind is not a thing. Although the activity of a brain depends on its surroundings, the main function of a brain is replay. There are individualities and generalities.

Here, we define that the mind is activity of a brain, and we describe the phenomena attributed to mind by knowledge on activities of cell level. Every creature possesses a reproduction system of itself. The reproduction system has developed through experiences on four billion years in the real world.

The evolution of a species is a history of the species. The history is a record of the experiences. The paradigm of activity makes clear processes of the evolution [8]. The system of gene composed of DNA with RNA was acquired by two billion years of trial and error. The system of gene is the tool for reproduction of protein. Those proteins include enzyme. The protein and the enzyme are used as tools for the biochemical reaction. The gene expression

depends on the activities. The process of molecular level on gene expression is very complicated [9].

Now, the evolution on creature is promoted by the variation of genes through exchange of genes during the processes of reproduction as indicated by the genetics. Even so, the natural selection in the real world functions on the progress of evolution. The activity in the real world is the essential factors in the evolution of creature.

## 3. Human brain that plays a drama without a scenario

If every speaker in a conference makes the speech that is adjusted in order to adapt the demands of its surroundings, the whole speech becomes a unified story. The attendants at the conference are able to join with such story. The audiences are able to experience a part of those activities. To attend a meeting is a participation of the community. The meeting is effective means to get from the other person.

But a human in the real world does not hold the same position at the same time. The nerve circuit in a brain is formed through individual experiences. Those facts induce differences in individual brain. Moreover, the molecular level of mechanism on natural living is very complicated. Although there are facts beyond scientific treatments, we can find many generalities on activities of creature.

Every creature communicates to changing surroundings in order to live. When trees are beginning to bud, it is the sign of early spring. When those leaves fall from the tree, it is the sign of early winter. Flowers must communicate with bees in order for pollination to be successful. A male bird must communicate with females, if they mate, and rear young birds [10].

Although there are differences between species due to the results of evolution, every creature possesses so-called natural intelligence. The human being also works today in order to be active in tomorrow. The essentials of human behavior in the real world are not so different from the other animals. The animal does not use language. The real

world is different from a model of world. Although the information does not change, the real world at a real time will change. The world model is a tool for the activity. We can discuss about fundamentals of mind from the paradigm of activity, because activity exists in a real world.

#### 4. Signal of timing on activity in a nerve system

Although it is difficult to consider that the energy forms circuits for the reaction, we can consider that the activity forms circuits for the reaction. A difference between the proposing paradigm of activity and the traditional concept of activity is inclusion of the attributes those exist in a real world.

Every activity of a creature is carried out by means of biochemical reactions. Although the biochemical reaction returns to original state after the action, the body causes a little change by the experience. The nerve circuit changes a little after transmission of impulses.

The operation of activity transfer system is a time-sharing operation. Only concurrent activities are able to interact with each other. The shape of an action potential in nerve circuit shows an impulse. The impulse indicates the timing of a reaction in a real world. Although each action is nonlinear and it is always moving, we can express the agent by means of transference of timing on activity by using transference of electric charge.

Each unit of activity possesses beginning and end. The resultant state is provided by the integration of activities. The most simple activity is expressed by means of a delta function  $\delta(t)$ . Here, the gauss type of impulse is expressed as  $f(t)=A \exp(-kt^2)$ . The resultant of impulsive activity is represented by the unit step function  $u(t)$  that indicates the state as 1 or 0. That is, the integral of delta function gives unit step function. Derivative of unit step function with respect to time gives a delta function.

Electric circuit functions at static state, and it also functions at the transition of state. But every operation of

a neuron is impulsive [11]. Each neuron operates a rule of reaction. The rule indicates a continuous aspect.

The activity of a neuron indicates a relationship among activities. The function of neuron is expressed as an impulse driven combinational logic circuit. Here, a logic function specifies an activity. The figure separation through grouping of perceptual components is expressed by a combinational logic such as sum of products canonical form. AND logic circuit decreases constituents of an action. OR logic circuit increases the constituents of an action.

The activities in a body are linked to a nerve circuit in order to unify the reactions of parts. The trace on transference of activities in a nerve network makes possible to replay the same behavior. The transition of activities will be described by two sets of data. One set is the data on present activities obtained before the change. Another set is the data on outputs obtained from monitors on actuators. In a digital computer, these data are used as follows. The activated address data are transferred from an address register to address of memory through control bus. The outputs of data from the memory are transferred into data register via data bus. The intelligence can be implemented in a programmable logic device (PLD). The circuit is able to unify concurrent activities into one action. The subset of decision-making forms a layered structure.

#### 5. The language for representation of activities

A set of activities stays in a circuit during the transmission. The delay line for temporary memory is materialized by means of a series of delay elements. The temporary memory of serial-in/parallel-out register is used to decode a subset of serially arranged signals.

There are various impulsive reactions of neuron in a brain. Input of impulses is compared with all connected neurons in order to select reaction, and the appropriate subset of activities is ignited. Since growth of intelligence is achieved by adding new circuit, the nerve circuit forms a layered structure. Each neuron unifies concurrent

activities and it selects the pattern of activities. If there are plural ignitions of decoder, the state of those ignitions is decoded by means of a neuron in the next stage. A network of decoders functions as a linked overlapping. The overlapping is not independent.

Finally, an affair is recognized by one neuron in a brain. For, the behavior of body must be unified at every moment. Since a common characteristic is recognized frequently, an individual analysis is carried out by means of a tree structure of neurons. If we want to know pattern, we ignore the time dependencies. If we want to know time dependencies of a phenomenon, we must ignore changes of the shape. Moreover, there are plural characteristics on a real thing. The common attributes are able to link by means of an additional neuron. Then, a nerve circuit for an agent forms a network. Linkages of such activities depend on the attributes of real thing or real affair. Those activities are carried out by time-sharing operations.

The nerve system is organized by means of existing circuits, and growth of intelligence is achieved by adding new circuits. The layered structure of decoders makes possible to represent a great number of things and affairs. As for rate of ignition, conditions for an operation on one component are less than those on whole. There are a great number of combinations in a system of many components. This principle of extension economizes circuits.

As for language use, there are two kinds of linkages. Contents of intelligence are memorized in a nerve circuit where there are parallel connections. On the other hand, the speech is carried out serially through the activities of one vocal organ.

A word is defined in the circuit of hierarchy, and one sentence corresponds to an activity in a real world. The knowledge is the information that represents activities of the brain. The human communicates via language, and the language is used as an element of thinking. The brain mechanism of a human incorporates the language use.

An activity of a neuron is intermittent and it makes

time-sharing operation possible. The transference from parallel arrangement of activities to serial arrangement of activities is carried out by transmission of activities on a nerve line.

## 6. Attributes of one word utterance

There are plural decoders in a system of recognition. So, the choice of activation is carried out by means of decoder for subroutine-call. Meaning of an activity is the results those depend on connected elements.

The circuit shown in Fig.1 decodes a set of serial activities. Here, an arrow ( ) indicates the connection that transfers activity. A circle indicates an element of activity. Activity in input side of circle is delayed for activities of output side.

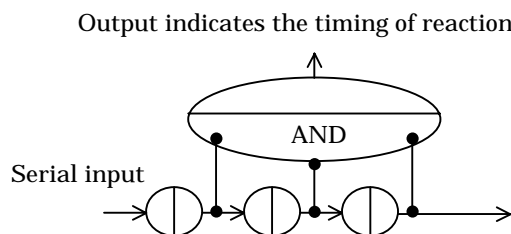


Fig.1 A decoder for a set of serial activities

A voice is uttered serially. But, a subset of activities is recognized at a time in a nerve circuit as shown in Fig.2.

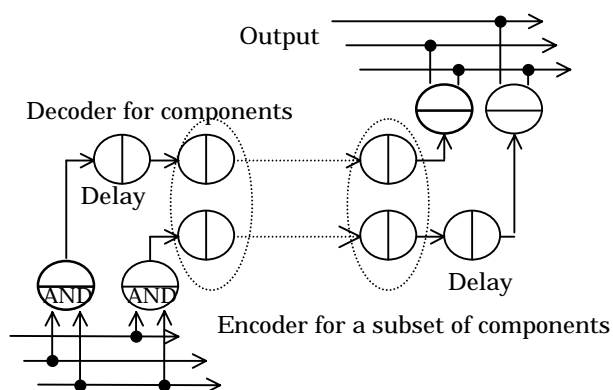


Fig.2 Timing control circuit for a unification of serial actions

The subset of activities is decoded by means of the

neuron where the later part of sentence is delayed on an occasion of utterance. On the other hand, the earlier part of the sentence is delayed on an occasion of recognition. A network of delay lines makes possible to unify the activities on phonemes for a word. As for the insertion of delay elements for the unification of subset of activities, the positions of inserted delay elements in a network for recognition are opposite in a network for utterance.

### 7. Grammar in a linguistic expression

When two words are used for a communication, the utterance of the more important word is stressed. If there is not stressed word in two-word utterance, the later word is important. That is so-called end-focus. This word order in a speech is affected by the mechanism of brain.

The signal on segmentation is inserted in a set of serial activities of the structured language. Since the period of utterance on each word in a sentence is decided individually, the segmentation of recognition is controlled by individual word. Moreover, it is difficult to detect the speed of an utterance at first. So, grammatical information is inserted into end of utterance. As for Japanese grammar, grammatical information is expressed by means of postpositional particle. There is inflection such as conjugation, declension, and comparison for grammatical information at ending of a word.

The information of speech voice to be decoded includes the punctuation, word order, inflection, and grammatical affix. A layered structure of activities for the speech understanding is constructed by using such information. These processes of understanding are carried out in an individual brain.

The systematic operation of layered activities needs two kinds of mechanisms. One kind of mechanisms is concerned with linkages among constituents. Those connections are memorized in a form of logic circuit. The other mechanism is concerned with the timing control of operations. The period of activity for each element on

language is not the same. Since the delay time on word for a sentence is long and various, timing control on activity of plural word in a sentence is achieved by means of looped delay elements.

An activity is held in a loop through circulation. The activation of this type of memory is controlled by the signals for ignition and signal for the extinction. As shown in Fig.3, the timing of subroutine-call must be controlled by each word. The output ignites the subroutine connected. The network of subroutine possesses the meaning.

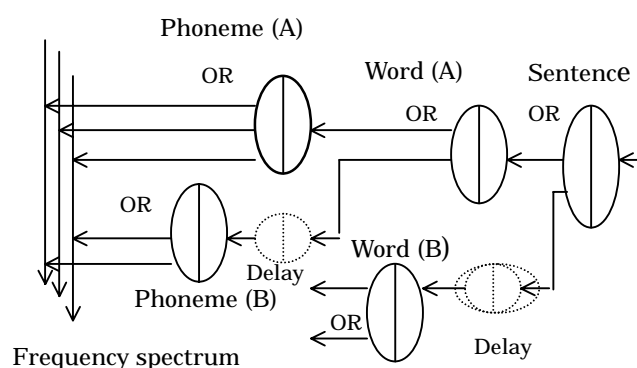


Fig.3. Timing control of subroutine-call for a speech

### 8. Attributes of verb due to the activity of real world

The most important word in a sentence is verb. The type of verb corresponds to that of activity. The verb has meaning of an activity. The speech has to include a verb in order to have independent effects. The informational representative of activity has plural attributes due to the activity of a real world. That is, the verb has the plural attributes due to the activity of the real world.

The language is developed through experiences of language use. There are common attributes among similar activities in the real world. The same format of activity is represented by the same format of language. The linguistic rules economize efforts of language use. Most of common attributes on language come from the real world, because every language is implemented in the real world.

Each activity has special attributes. So, each verb has special attributes. A word of complement in a sentence

must possess the attributes assigned by the verb. A word of subject in a sentence must possess the attributes assigned by the verb. A word for object in a sentence must possess the attributes assigned by the verb.

There are 5 type of sentence in English. The tense of a sentence is a form taken by a verb to show the time of action. Moreover, there is the voice that shows the relation of the subject to the action. In active voice, the subject is active. In passive voice, the subject is passive. The voice affects the verb.

Meaning of the linguistic expression of human being is independent from media of transmission. A sentence provides information of an agent. Such language affects the other person independent from person. The role of each word is a representative of information abstracted.

## 10. Conclusion

The paradigm of activity is a new promising approach that bridges between information world and the real world. The information is a representative and it is a tool for an activity in the real world. The language is the most important tool to express the activities in a brain. Human has developed its intelligence by using the language.

As for general motivation of the activity, a creature makes action in order to continue activities. The activity is a tool for the next activity. Each creature or each neuron or each cell is not able to continue living without interacting with its surroundings. Every creature has to adapt its behavior to the surroundings. The activity of creature is flexible.

The activity of cell level is based on the biochemical reaction. The biochemical reaction forms the system concurrently. The activities in a body accompany with activities of the brain. The concept of activity is able to cover such linked reactions.

As for the communication, if every speaker in a conference makes the speech that is adjusted in order to adapt the demands of its surroundings, the whole speech

becomes a unified story automatically. The phenomenon indicates that the audiences are able to experience a part of those activities. The meeting is effective means of knowledge communication.

But if a human stays in a world of information, he will become the existence that loses individualities. The actual human could not live always in a world of information. So essentials of brain mechanism are attributes of the nerve network and that of the real world.

Although the brain mechanism is realized by means of activity of a neuron, the wisdom is affected by experiences in the real world. Although the activities of a brain are individual, we investigated generalities of the brain mechanism from the viewpoint of activities of neurons.

Essentials of language use have been described by the concept of activity. The paradigm of activity is promising approach to understand the human being.

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