A Description of Core Concepts for Basic Verbs in Japanese and English based on their Recognition Primitives

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This paper will report on how a new system of semantic processing could generate a breakthrough in concepts free from the limitations of conventional semantic processing based on existing case patterns in existing thesauri. We will also discuss, in order to realize a more advanced system of semantic processing, what kind of linguistic knowledge is needed. Finally, we will examine how to collect and structuralize this knowledge.

Our assumptions are as follows: 1. A polysemy has one basic semantic core and many meanings are derived from this semantic core, depending on how it is interpreted. 2. When dealing with abstract concepts, we replace them with more concrete entities that can be directly felt with five senses. Within the framework of basic Japanese and English verbs from which basic words are derived and through which we recognize external objects, their core concepts will be analyzed. We will analyze "recognition primitives," from which we acquire meanings and usages for concrete objects. We will try to describe perceptible notions of these core concepts by analyzing a number of important polysemous verbs.

Keywords: semantic attribute, case element, selectional restriction (of nouns, etc.), recognition primitives, polysemies, Core Theory

1 Introduction

In the semantic analysis of natural language, we have often utilized case patterns (Ikehara, Miyazaki, and Yokoo 1993), (Ikehara, Miyazaki, Shirai, and Hayashi 1987) such as the sort of semantic attribute that nouns possess with specific case elements in the verbs, the central element of linguistic structures. During such processes, we also used a thesaurus (Ikehara et al. 1993), (Ikehara et al. 1987) that systematically classifies words and concepts listing their relations. However, the selectional restrictions of nouns in some case patterns could not be adequately satisfied in a thesaurus with even a sufficient number of nodes and these restrictions could not be supported by their semantic attributes. In any case, the comprehensibility of the thesaurus is not guaranteed. For example, the difference in case patterns between "iru" and "aru" (iru and aru both mean "to exist") generally depends on whether the semantic

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features in the 'ga' case ("ga" in Japanese is a sentence connector or a case marking post-
position) are animate or not; however, there are many examples in violation of these sorts of 
selectional restrictions. The examples are: "He has two children. (aru)" (kare niha futarino 
kodomo ga aru) "There is a person opposing -. (aru)" (ni hantai suru hito ga aru) "There is a car in front of the house (iru)" (ie no mae ni kuruma ga iru). Further, we cannot precisely 
describe differences among synonyms with nuances such as in "agaru" and "noboru" (both 
of them meaning “to rise”, or “to climb”) within the rules from the views of selectional re-
strictions. Trope expressions like metaphors and metonymies are in violation with the rules 
of selectional restrictions. Moreover, although even the selectional restrictions are qualified, 
we cannot obtain semantically correct interpretations for the following examples in Japanese: 
"furo ga afureru" translated into English as “*The bath is overflowing” or “kokuban wo kesu” 
translated into English as “*The blackboard is erased.” These sentences should be correctly 
written in Japanese and translated into English as: “The water of the bath is overflowing” 
and “That which is written on the black-board is erased.” so we can analyze these expressions 
within the framework of usual case patterns. Moreover, these expressions before rewriting 
can often be used not as trope expressions in everyday language but used unconsciously as 
conventional expressions.

This paper will report on how a new system of semantic processing could generate a break-
through in concepts free from the limitations of semantic processing based on existing case 
patterns and existing thesauri. We will also discuss, in order to realize a more advanced system 
of semantic processing, what kind of linguistic knowledge is needed. Finally, we will explore 
how to collect and structuralize this knowledge.

Our assumptions are as follows: 1. A polysemy has one basic semantic core and many sub-
cores derived from this semantic core, depending on how it is interpreted. 2. When dealing 
with abstract concepts, we replace them with more concrete entities that can be directly felt 
with five senses. Within the framework of basic Japanese and English verbs from which basic 
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be analyzed. We will analyze “recognition primitives,” from which we acquire meanings and 
usages for concrete objects. We will try to describe perceptible notions of these core concepts 
by analyzing a number of important polysemous verbs.

At the beginning of our inquiry, by consulting references to selectional restrictions in choos-
ing suitable sentence patterns, we will collect and make abstractions for the meanings and 
usages of applicable verbs in existing dictionaries (Ikehara et al. 1993), (Koizumi, Funaki, 
Honda, Nitta, and Tsukamoto 1989). We will shed some light on polysemous verbs. Then, we
will explore the meanings and usages for some basic Japanese and English verbs by exploiting their core concepts. We will analyze the differences in the usages among synonymous verbs that do not fit into conventional case patterns. Various kinds of recognition primitives of verbs are utilized by subjects when trying to comprehend the objects that they are observing. These meaning primitives refer to concrete concepts that, in turn, reflect recognizable shapes of objects observed optically. Subjects conceptualize abstract notions by replacing them with concrete objects in the manner that suits the certain particular incidences in the process of abstraction.

2 Treatment of multi-meanings and their meaning primitives

In Japanese and English, we have verbs that we here call the “default” verbs. One example in Japanese is “iru” and its translation into English is “to exist”. One example in English is “to take.” This kind of basic or “default” verbs that cover wide ranges of semantic fields in Japanese and English are very common in the actual usage, and they feature prominently in both languages. When we translate “iru” into English, a variety of curious linguistic phenomena occur.

As we had conducted a pilot study, prior to the experiments of Chapter 5, one interesting fact has emerged; that is, 72% of the translations of “iru” in our pilot study were idiomatic or collocational that they could not be literally translated into English. One example would be “sonomama inasai” in Japanese that is translated as “You stay right there.” These 72% of the incidences are not under discussion here because the number of such specific instances in English, translated from Japanese is virtually infinite. On the other hand, the other 28% of “iru” are of theoretical interest to us because in our pilot study they closely matched what we call here the default or semantically literal translations of the English equivalent; in this context, they are successfully translated without many usual metaphorical restrictions.

Among English verbs “to take” is such an example. In our pilot study, 58% of the incidences in “take” did not come under the two default usages. In other words, 58% of them didn’t come under the selectional restrictions of “transfer of possession” or “elimination” in Chapter 4. An example sentence that is not default is: “She took his statement as insulting”.

Our categorization was fairly accurate, however, and on the average, more than half the number of sample sentences came to be under our sorting system, which turned out to be the case and which will be shown in the experiments described in Chapter 5. In some instances
such as for "afureru", all the samples came to be under our categorization of its translations of "to overflow" or "to fill up".

In Chapter 2, we will be offering a unique perspective, the so-called "point-of-observation" for 5 Japanese and 5 English default verbs. In Chapter 3, the notion of Recognition Primitive in connection with these verbs will be studied in detail. Then, in Chapter 4, the Recognition Primitives with the help of Selectional Restrictions are applied to analyze those 5 Japanese and 5 English verbs that were discussed in Chapter 2. In Chapter 5, all the verbs mentioned in Chapters 2 and 4 will be experimented using 100 sample sentences for each of those 10 verbs, testing if the hypothetical categorizations described in the two previous chapters (Chapter 2 and Chapter 4) were sound.

Generally speaking, many basic but linguistically significant words are polysemies. A polysemous word has one basic semantic core, and many meanings are derived from this semantic core. According to the Core Theory (Tanaka 1987), (Tanaka 1990), words have sub-cores with high abstractions whose polysemous features are not dependent on the context. On the other hand, when a word is actually used in a sentence, the abstract core is, depending on the context, defined and specified, so that many polysemous meanings are fixed on the spot, with the help of that particular context.

(Kunihiro 1997) classified words into those that are concept-driven and those that are phenomenon-driven. According to him, these concept-driven abstract cores refer to concepts in the brains that we cannot directly feel with five senses. When concept-driven words are used concretely, they manifest themselves in many varied forms, controlled by the context. Thus, it is hard to grasp their core concepts tangibly. For example, particles, conjunctions, and auxiliary verbs are in this category. We usually have a hard time directly conceptualizing the concrete knowledge associated with them. As a rule, these words are not conjugated.

On the other hand, phenomenon-driven words or descriptive words are represented in the external world, whose referents we can feel with our senses. Words referring to things, actions, events, and characteristics are in this category. We refer to them as "descriptive elements," and humans recognize these elements in tangible ways. If there is only one element to perceive but if there are different ways of perceiving it, the results would be different kinds of recognition events. Also, differences occur when the context is different. In other words, differences can be classified into two broad ways: one is dependent on the context and the other is dependent on the way the concept is being perceived. This view has also been expressed by Kunihiro. An example of the descriptive elements is shown in Figure 1. In this example, the hand is picking up an object. In order to pick it up, the hand must grip it first. After gripping
According to the Core Theory, there is one core for each word. But if we try to understand a polysemy with multi-meanings, the level of abstraction becomes very high. So, if the way of perceiving the core is different, we expect to come up with a set of different "sub cores". This process is comparatively difficult to be accomplished in the computing environment. We define an external object and its properties (descriptive elements, as Kunihiro puts it) by our senses. Then, we define these properties with one fundamental concept as the basis for the polysemy. In order to derive sub-cores of various basic words, we must define one core concept for each word. The difference in structures is caused by the different perception mechanisms. Figure 2 shows a polysemous word. A polysemy has a semantic core with a range of meanings; here, meanings within a core are sub-cores. Each core concept in this prospect is divided into its sub-cores.

When humans cannot recognize an object by senses, we replace abstract concepts existing
in the brains with the things we are able to feel with our senses but at this stage those entities are not conceptually concrete yet. Then, they would become fully concrete as soon as we ascribe a term to them. Based on this assumption, we replace abstract words and their core concepts with more concrete ones. When we comprehend these basic words and core concepts, we are trying to discern the essence of them. These ideas are derived by considering a deeper interpretation of the meanings of a word and by considering the generative manipulation of meanings (Koizumi et al. 1989). This whole theorizing is thought to have a link with the theory of Generative Lexicon (Putejovskey 1995).

Below, we will set forth examples in which we will depict basic notions and core concepts for polysemous verbs in Japanese and in English. For data analysis and sampling of the patterns, articles by (Ikehara et al. 1987), (Koizumi et al. 1989), (Kunihiro 1997), (Miyajima 1972), and (Shinmura 1998) in the reference can be consulted for the details of their original ideas, being utilized in this current theorizing process.

Examples of Japanese Verbs

Example 1

Verb: afureru (To Overflow) is the “default” verb for the concept/notion in this example:

“Liquid is filled in a container, and goes out of the container.” is the fundamental notion of the verb; however, there are two primarily different sub-cores for this verb.

1. The liquid is not containable anymore, so it goes out from the container >> physical movement

Point of observation: The Outside of the object that contains the liquid

Usage 1: The Verb is the central factor in the sentence, not the “Liquid” or the “Container”, because the main focus in this instance is the phenomenon of “flowing out”. In other words, the speaker is interested in the fact that the container cannot contain, but not in the fact that the liquid can no longer stay. So, “oil” or any other liquid can readily be substituted for water and the sentence still makes sense, because of the semantic focus of this verbal expression.

“Water is overflowing from the tank.” (mizu ga suisou kara afureru)

Semantic formulas of this example

(For the first example in this and the following entries, two semantic formulas for each example will be provided: the first formula (1) will be based on the perception from each Point of observation; the second formula (2) will be based on the perception from each notification incidence)
1) Water (inside) is (Aux) overflowing (to Outside) from the tank.
2) Water (liquid) is (Aux) overflowing (physical movement) from the tank.

“The tank is overflowing.” (suisou kara afureru)

**Usage 2:**

The central factor in the sentence is either the “Liquid” or “The thing that contains the liquid”, not the Verb; in contrast to Usage 1, the main topic in this instance is “the sand” (as in the example) and the speaker’s interest is what goes out of the container. In other words, “The sand cannot stay in the container.” So, in contrast to Usage 1, the focus is not on the verb; other verbs can be substituted to mean “to be going out”, and it still makes sense. In sum, the difference between Usage 1 and Usage 2 is on what the focus of attention is. In Usage 1, water is not the focus. In Usage 2, sand (in place of water, in Usage 1) is the focus.

“The sand is going out of the container.” (suna ga iremono kara afureru)

- **Semantic formulas of this example**

1) The sand (inside) is (Aux) going out (to Outside) of the container.
2) The sand (grain) is (Aux) going out (physical movement) of the container.

2. The container is filled with liquid >> change of state

**Point of observation:** The Inside of the thing that contains something

**Usage 1:** The Verb is the central factor in the sentence, not the “Liquid” or “The thing that contains it”.

“Water is filling the tank.” (mizu ga suisou ni afureru)

- **Semantic formulas of this example**

1) Water (outside) is (Aux) filling (to Inside) the tank.
2) Water (liquid) is (Aux) filling (change of state (condition)) the tank.

“The tank is filled with water.”

**Usage 2:** The central factor in the sentence is either the “Liquid” or “The thing that contains it”, not the Verb.

“The audience fills the hall.” (kaijou ni choushuu ga afureru)

- **Semantic formulas of this example**

1) The audience (outside) fills (to Inside) the hall.
2) The audience (countable (humans)) fills (change of state (condition)) the hall.

“A pleasant mood appears on his face.”

“The department store is filled with merchandise.”

“He is filled with confidence.”
Example 2

Verb: *agaru* (To Rise) is the “default” verb for the concept/notion in this example:

> “An object moves from a lower to a higher physical space. The focus is not on the process of moving, but it is on the result of moving, so the recognition time of movement is equal to zero”

is the fundamental notion of the verb; however, there are three primarily different subcores for the core concept for this verb. Here, an “entity” means an “object”. “Entities other than concrete objects and properties” like “abstract things, events, and properties” are in this context substituted as concrete objects.

1. A thing moves from a lower to higher place >> physical movement, a change of state

   **Point of observation:** a good view that overlooks the entire movement

   **Usage 1:** A thing moves from a lower to higher place (physical movement)

   “A cat moves up to the roof.” (*neko ga yane ni agaru*)

   - **Semantic formulas of this example**
     1) A cat (moving object) moves up (a view) to the roof.
     2) A cat (a thing) moves up (physical movement) to the roof.

   “A man moves upstairs.” “The sun rises.”

   “The fireworks go up.” “The crossing gate rises.”

   **Usage 2:** A thing rises to face a being of a higher status (physical movement)

   “Everyone rose when the judge entered the courtroom.”

   - **Semantic formulas of this example**
     1) Everyone (countable (humans)) rose (a view) when ...
     2) Everyone (countable (humans)) rose (physical movement) when ...

   “The preacher stood on the podium, rising above the congregation.”

   **Usage 3:** A State/condition that rises.

   “The price of goods is rising.” (*bukka ga agaru*)

   - **Semantic formulas of this example**
     1) The price (a view) of goods (countable (things)) is (Aux) rising (value).
     2) The price (condition) of goods (countable (things)) is (Aux) rising (value).

   “The value of gold has risen.” “The singer’s popularity rose.”

2. A thing moves from a lower place and comes into the view >> suddenly appearing

   **Point of observation:** movement to a destination

   **Usages:** “The evidence came up at the trial.” (*shouko ga saiban de agaru*)

   - **Semantic formulas of this example**
1) The evidence (matter) came up (movement to a destination) at the trial.
2) The evidence (matter) came up (appear) at the trial.
   "His name came up during the conversation."
   "The medicine took effect immediately."

3. A thing moves higher, and goes out of view >> completion in the act of disappearing
   Point of observation: movement from a starting point
   Usage:
   "The rain stops (going out of the way)." (ame ga agaru)
   - Semantic formulas of this example
     1) The rain (weather) stops ((halt) movement)
     2) The rain (weather) stops (complete)
        "The work is done (complete)."
        "The exercise is complete." "The manuscript is complete."

Example 3
Verb: noboru (To Climb) is the “default” verb for the concept/notion in this example:
   "The whole thing moves upward from a lower to a higher physical space. The importance
of this particular expression lies in the way of movement; the movement is continual, so the
recognition time of movement is not equal to zero” is the fundamental notion of the verb.
Depending on where one looks at the movement, alternate points of view may come up.
   Here, “abstract entities, events, and properties” are perceived in the mind of the observer
as concrete objects (‘objectified things’ and thus viewed as concrete). Therefore, the basic
notions or sub-core concepts can be applied to either abstract entities or concrete objects.
1. A thing moves from a lower to higher place >> physical movement, change of state
   Point of observation: the course or route of the movement
   Usage 1: a thing moves from a lower to higher place (physical movement)
   "A man climbs along the mountain route." (otoko ga yamamichi wo noboru)
   - Semantic formulas of this example
     1) A man (human) climbs (V) along the mountain route (the route of the movement)
     2) A man (human) climbs (V) along the mountain route (physical movement)
        "A man climbs a mountain."
        "A man climbs up the stairs." "The train climbed up the steep slope."
        "The sun rises."
   Usage 2: A thing figuratively moves up to the place of higher status (physical movement,
change of state)
“The Congressman moved up to the Senate.” (giin ha jouin ni noboru)

- **Semantic formulas of this example**
  1) The Congressman (human) moved up (V) to the Senate (the course of the movement).
  2) The Congressman (human) moved up (V) to the Senate (change of state(condition))

“The man rapidly climbed up the ladder of success.”

**Usage 3:** The property moves up (change of state)

“The number of participants went up to 500 people.” (sankasha ga 500 nin ni noboru)

- **Semantic formulas of this example**
  1) The number (unit) of participants (humans(countable)) went up (the course of the movement) to 500 people.
  2) The number (unit) of participants (humans(countable)) went up (change of state) to 500 people.

“The financial damage can go up to 100 billion yen.”

“The price will probably go up to one million yen.”

“The mercury goes up in the summer.”

2. **An entity comes up from lower place, appearing in view >> through various paths, appearing**

**Point of observation:** movement to a destination

**Usage:**

“The matsutake appears on the table.” (matsutake ga zen ni noboru)

- **Semantic formulas of this example**
  1) The matsutake (object) appears (movement to a destination) on the table.
  2) The matsutake (object) appears (appearance) on the table.

“The person becomes a candidate.”

**Example 4**

Verb: iru/aru (To Be) is the “default” verb for the concept/notion in this example:

An entity is in existence. The focus for both of these Japanese verbs is “being in existence”.

There are three primarily different sub-cores for the two verbs.

1. **There is a thing >> as a being**

**Point of observation:** existence

**Usage:**

“There is a chair.” (isu ga aru)

- **Semantic formulas of this example**
1) There (position) is (existential) a chair (thing)
2) There (position) is (being) a chair (thing)

2. In this instance, “have” is used in English instead of “Be”
   
   **Point of observation:** possession
   **Usage:** (One has . . .)

3. In this instance, “Come” is used in English instead of “Be”
   
   **Point of observation:** genesis
   **Usage:** (One came into existence)

**Examples of English Verbs**

**Example 1**

*Verb:* “Go” is the “default” verb for the concept/notion in this example:

“A reaches a place, as A has covered a distance.” is the fundamental notion of the verb; there are three primarily different sub-cores for this particular verb.

1. *A is no longer here, because he left here >> departure*
   
   **Point of observation:** Starting Point
   **Usage:**
   “I’m going now.”

   - **Semantic formulas of this example**
     1) I (subject) am (Aux) going (Starting Point) now.
     2) I (subject) am (Aux) going (departure) now.
     “We went from the dormitory to the school.”
     “He is going away for the summer.”
     “Can I go now? I’m tired.”
     “The batter hit a homerun, and the ball was gone.”

2. *A is going now, as I see him walking down the street from the window >> progression*
   
   **The point of observation:** Mid-way
   **Usage:**
   “Where are you going?”

   - **Semantic formulas of this example**
     1) Where (Mid-way) are (Aux) you(subject) going?(V)
     2) Where (progression) are (Aux) you(subject) going?(V)
     “I’m going to the theater.”
     “They are going from the station to the stadium.”

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“He was running as he went to the bus stop.”
“The manager goes to the mound, as he wants to have a conversation with the pitcher.”

3. A went to John’s house >> arrival

**Point of observation:** Destination

**Usage:**

“His hand went to his pocket.”

- *Semantic formulas of this example*

  1) His hand (body part) went (V) to his pocket (Destination).
  2) His hand (body part) went (V) to his pocket (arrival)

“Where do the books go?”
“I went to court in order to sue them.”
“All my savings will go to pay for the school tuition.”
“Recognition doesn’t always go to the most deserving.”

**Example 2**

*Verb:* “Come” is the “default” verb for the concept/notion in this example:

“One has walked to reach this place.” is the fundamental notion of the verb; however, there are three primarily different sub-cores for this particular verb.

1. A has come here >> arrival.

**Point of observation:** Destination

**Usage:** “Peter came here last night.”

- *Semantic formulas of this example*

  1) Peter (subject) came (V) here (Destination) last night.
  2) Peter (subject) came (V) here (arrival) last night.

“Come to me, and I’ll give you a rest.”
“Let’s come back some other time.”

2. A is coming now, as I see him walking on the street from the window >> progression

**Point of observation:** Mid-way

**Usage:**

“Is John coming now?”

- *Semantic formulas of this example*

  1) Is(Aux) John(subject) coming (Mid-way) now?
  2) Is(Aux) John(subject) coming (progression) now?

“Yes, I see him coming over the hill.”
“He is coming to save us, in the midst of this crisis.”
3. Nobody is here anymore, because he left this place yesterday >> departure  

Point of observation: Starting Point  

Usage:  
“He came from the United States.”  

Semantic formulas of this example  
1) He (subject) came (V) from the United States (Starting Point).  
2) He (subject) came (V) from the United States (departure)  

“Nobody knows how humans have come about.”

Example 3  

Verb: “Get” is the “default” verb for the concept/notion in this example:  

“One has a hold on a matter, as he contained the situation or the matter.” is the fundamental notion of the verb; however, there are four primarily different sub-cores for this particular verb.  

1. I gained possession of this >> the concept of earning.  

Point of observation: acquisition  

Usage:  
“I got this computer from my cousin.”  

Semantic formulas of this example  
1) I (subject) got (acquire) this computer from my cousin.  
2) I (subject) got (earn) this computer from my cousin.  

“I’m getting a teaching certificate in mathematics.”

2. I covered the distance >> reaching.  

Point of observation: distance  

Usage:  
“I got here, after three days drive.”  

Semantic formulas of this example  
1) I (subject) got (V) here (distance), after . . .  
2) I (subject) got (V) here (reaching), after . . .  

“He will get there in 5 hours.”

3. I begot a child >> conception.  

Point of observation: generation  

4. With an adjective complement, the verb indicates some change effected in the position or state of the object. >> impact  

Point of observation: change
Usage:
“I got you curious.”

Semantic formulas of this example
1) I (subject) got (V) you (object) curious (change)
2) I (subject) got (V) you (object) curious (impact)

Example 4
Verb: “Take” is the “default” verb for the concept/notion in this example:
“One touched a thing to mark possession.” is the fundamental notion of the verb; however, there are two primarily different sub-cores for this particular verb.
1. A took possession of something >> seize.
   Point of observation: acquisition
   Usage:
   “They took the territory, after a week-long military campaign.”
   Semantic formulas of this example
   1) They (subjects) took (acquire) the territory, after ...
   2) They (subjects) took (seize) the territory, after ...
   “The bank took her car because she couldn’t make her loan payments.”
2. One removed something >> elimination.
   Point of observation: deprive
   Usage: “The waiter took away the empty dishes.”
   Semantic formulas of this example
   1) The waiter (subject) took away (deprive) the empty dishes.
   2) The waiter (subject) took away (eliminate) the empty dishes.
   “The mother took the toy from the child, because he was naughty.”

Example 5
Verb: “Give” is the “default” verb for the concept/notion in this example:
“One brings the change of possession to someone else.” is the fundamental notion of the verb; however, there are three primarily different sub-cores for this particular verb.
1. A hands over a thing >> delivery
   Point of observation: provision
   Usage:
   “John gives money to his workers.”
   Semantic formulas of this example
1) John (subject) gives money (provide) to his workers.
2) John (subject) gives money (deliver) to his workers.
   “The doctor gave them an immunization shot for smallpox.”

2. A made a sacrifice >> surrender

   Point of observation: commitment

   Usage:
   “She gave her life to the church as a nun.”

   - Semantic formulas of this example
     1) She (subject) gave her life (commitment) to ...
     2) She (subject) gave her life (surrender) to ...

3. A puts forth from oneself >> expulsion

   Point of observation: generation

   Usage:
   “Mary gave a loud belch.”

   - Semantic formulas of this example
     1) Mary (subject) gave a loud belch (generate)
     2) Mary (subject) gave a loud belch (expel)
   “The pot of water gave off steam.”

   - *A note about the “Point of observation”.

   The Point of Observation is the “guide post” for the whole range of meanings within the “Core”. When we look at each point of observation, it should be the central notion for each sub-core. We have noted that one core exists for one verb (word), and that several sub-cores exist within the core. So, the fundamental and “default” meaning primitive for each sub-core is to become the point of observation. In order to contrive a new point of observation for a particular sub-core, we should choose the most “pivotal” notion for that sub-core, not necessarily the most characteristic notion. The pivotal notion is something from which all other notions in the sub-core could be derived: like the “head node” from which all the branches ramify. This pivot is contrasted with the “most characteristic label” that is the most convenient description for setting up the sub-core, but nevertheless, that is only an illustration for that particular sub-core. A “label” illustrates and describes; on the other hand, the “pivot” or “head node” signifies and points out the essence of the particular sub-core.
3 The Recognition Primitive

As we discussed in Chapter 2, when we notice a phenomenon, a polysemy may be used to describe the phenomenon. The way of describing depends on how we recognize the phenomenon. We might utilize a variety of usages among synonyms some of which cannot adequately be explained by the usual case patterns. We utilize selectional restrictions of nouns that their semantic attributes or even the words of those attributes cannot sufficiently describe their semantic structures. Then, the final resort is the use of Recognition primitives. The various viewpoints that a subject may use to understand various phenomena are referred to as the recognition primitives. When perceiving a specific concrete object, we first notice the shape of that object. We also notice how the object is utilized. We notice the function of an artificial object that humans have made for a specific purpose. We notice the various uses for even a natural object. For abstract entities that we cannot see optically, we try to match them with appropriate concrete objects. After that, we can recognize such concrete objects in place of abstract entities with five senses. Here, as we describe the selectional restrictions of nouns for a certain phenomenon, we try to examine various language phenomena from the viewpoints of recognition primitives for the shapes of physical objects.

3.1 Recognition Primitives regarding Shapes

There are two ways of observing the shape of an object: one is to see its physical shape and the other is to perceive its cognitive shape. The physical shape can be described visually; e.g. as a “sphere” or “circle”. Three-dimensional figures come in an infinite variety of shapes from the simple to complex. However, because information about a geometric shape is, to a certain degree, free of the selectional restrictions of verbs that describe it, information of relatively simple shape can suffice for the purpose of its description. On the other hand, information of more complicated shapes might overwhelm naturally restricted data when forcing it to adapt to a simple physical shape. Cognitive shape exists in information accompanied by a hypothetical understanding of corresponding physical shape. It is information that we conceptually “abstractify” from a physical shape. For example, there is a physical shape: a container. The attributes for its cognitive shape are, for instance: “There is a hole” or “There is an empty space that can contain something in it.” As in this example, whatever shapes “the hole” takes, the fact that “There is a hole” would not change. Information in which a complex shape is abstractified is the cognitive shape. Accordingly, it is thought that the expression, “There is an empty space that can contain something in it” follows how this particular thing is mentally
perceived. Figure 3 shows the representation of this perception, appropriately expressed as “Within a container, there is an empty space that can contain something that is either liquid or solid in it.”

The cognitive shape exemplifies its concept for a specified verb. For example, the cognitive shape “sphere” corresponds to the verb concept “$to roll”. (In this paper, the dollar sign ($) is the mark for the general concept of a mental picture typical or representative of that concept following the sign.) The cognitive shape “There is a hole” corresponds to the verb concept “$to fill” or “$to move out of”. For the sentence “A ball rolls”, it is not that the verb “to roll” and the noun “a ball” has a corresponding relation to each other. Instead, a cognitive shape “a sphere” is given to the notion “a ball”. We therefore infer that “A ball is a sphere, so it can roll”; we can thus conclude that the selectional restrictions of nouns in this case pattern are satisfied. Expressions of cognitive shapes like “A sphere” or “There is a hole.” are called the “recognition primitives” for shapes. Accordingly, those primitives are represented by the followings notions:

**Recognition Primitives:** taking notice of how concrete objects are visually observed

**spatial dimensions:**

+0D  zero dimension: a spot  
+1D  one dimension: a line  
+2D  two dimensions: a surface  
+3D  three dimensions: a mass

**space domain:** whether a space (from one to three dimensions) is open or closed

+open  empty space (sky, etc.)  
+half open  closed in one direction, open in another direction  
+closed  closed space (default value)
penetrability: indication for the penetrability of a surface

+ penetrable  passing through a “hole”, a penetrable surface
+ penetrable  like a “door”, a possible switch between passable/impassable
- penetrable  like a “wall”, impassable

obstacle: indication of an obstacle in the movement of an object

+ obstacle (a height)  like a “mountain” or a “trench”
+ obstacle (a depth)  like a “valley”, “pit”, “ocean”, “river”, “lake”
+ obstacle (water)  like an “ocean”, “river”, “lake”
+ obstacle (psychology)  like a “road”, “railroad”

degree of a slope: indication of a slope in a space (from one to three dimensions)

+ horizontal/ + gentle slope/ + slope/ + steep slope/ + vertical

degree of a curve/bump

+ curve/ - curve + round/ - round  the degree of curved line
+ bump/+ bulge/- fissure/- bump  the roughness/smoothness of a surface

characteristic shape (single object):

+ spot  /
+ line  /
+ surface  /
    + circle  + ring + wheel
    + semicircle |
    + square  + board + book + net + fragment + frame
+ mass  /
    + sphere
    + hemisphere
    + cube
    + column
    + gimlet

characteristic shape (collective):

- procession/ + bundle/ + herd

Recognition Primitives: taking notice of how things exist

containable: whether the space can/cannot contain things
Using recognition primitives for shapes, examples of their concepts can be described as follows.

**Example 1**

We are arbitrarily choosing the “tunnel” for our analysis. As a descriptive example, we will use the conceptual framework of the tunnel for representing how its 3-dimensional features are understood, as a guiding standard for any concrete object. The reason why a tunnel’s 3-dimensional and 2-dimensional aspects are looked at is because, for its 3-dimensional aspect, its concept is useful to typify the understanding of anything we conceive in our minds when we imagine an object; whatever the shape a particular tunnel takes, we have certain features in our mind whenever we think of any tunnel. On the other hand, the 2-dimensional aspect can be imagined when we slice/cut a long tunnel along its course. In other words, when you think of a vertical slice of an elongated empty space in the middle of a particular tunnel, you would envisage an open-air circle that is in the passage of the tunnel; at the brink of that flat circle, a solid circle with cement or rock encircles that empty space/body of air.

“+3D” and “+2D” are the marks preceding the particular perceptible characteristics. The feature of a 3-dimensional tunnel is either flat or ascending or descending. Its shape is pipe-like; it has a passage or a course. It can contain things and various objects. It contains air.

In a 2-dimensional interpretation of a tunnel, we can penetrate the “vertical slice” of air.
If there are no visual obstacles in the tunnel, we can observe the imaginary slice of air as a circle.

\[ \text{tunnel}(+3D(\text{+flat surface/}+\text{gentle slope}, +\text{cylinder}, +\text{course}, +\text{containable}(+\text{vapor}), \text{+2D}(+\text{penetrable}, +\text{vertical}, -\text{obstacle}, +\text{circle})) \text{+2D}(+\text{penetrable}, +\text{vertical}, -\text{obstacle}, +\text{circle}))) \]

placed on flat surface/gentle slope, inside cylinder-shaped empty space, an elongated empty course in 3 dimensions; both ends having penetrable and vertical circles

In figure 4, one can enter a tunnel, and thus the tunnel has been penetrable. The tunnel has an empty space inside. One can go through the tunnel; and as one is going through it, one is figuratively being contained in it. One then exits, going out of the tunnel; in this way, the tunnel has been penetrated.

*Example 2*

\[ \text{mountain}(+3D(\text{+obstacle(height)}, +\text{horizontal}, +\text{cone}, -\text{containable}(+\text{solid}), \text{+2D}(\text{-penetrable}, +\text{gentle slope}/+\text{slope}/+\text{steep slope}, +\text{bump}))) \]

placed on horizontal surface, cone-like 3 dimensional shape without space inside (+obstacle(a height)), having bumps and (gentle to steep) slopes

*Example 3*

\[ \text{river}(+3D(\text{+obstacle(water)}, +\text{obstacle(a depth)}, +\text{horizontal}/+\text{gentle slope}, \text{+band}, +\text{course}, +\text{containable}(+\text{liquid}), \text{+}}) \]

Fig. 4 Imaginary Description of the "tunnel"
placed on horizontal/gentle slope; pipe, space inside filled with liquid; course-like three dimensions (obstacle of movement with water and depth); having a penetrable horizontal band above

Example 4
$\text{cup}(+3D($
  $+\text{container}, +\text{containable}(+\text{vapor}),$
  $+2D(+\text{penetrable}, +\text{horizontal}, -\text{bump}, +\text{circle})))$
a 3-dimensional container with a space inside, having a circular, penetrable upper edge surface

Example 5
$\text{house}(+3D($
  $+\text{horizontal}, +\text{container}, +\text{containable}(+\text{vapor}),$
  $+2D(+\text{penetrable}, +\text{vertical}, -\text{bump}, +\text{square})))$
placed on horizontal surface, a 3-dimensional container with space inside, having penetrable/impenetrable (possible switchable) parts like a door or window that is a vertical surface

Example 6
$\text{balloon}(+3D(+\text{sphere}, +\text{containable}(+\text{vapor}), +\text{elastic}))$
an elastic sphere with space inside, easily transformed elastic 3-dimensional shape

*explanation about the categories: "+emotion, +intention, +information"

Although we have used existing thesauri in order to describe various phenomena, the categorization is generally so broad. Therefore, we decided to make use of the new concept of Recognition Primitives that could be used to describe the world in more specific terms. So, +information means: "what information signifies", in other words, how we treat and grasp the concept of "information".

3.2 Recognition Primitives Regarding Functions/Usages

Functions/usages are the purpose for which the human uses objects. An artificial object made by humans has a specific function intended for specific uses. For example, vehicles like a "car" or "train" has a function: "$\text{move (land): moving on the land}$. An inartificial object, by its very nature, does not have a specific function but nevertheless its function depends on how humans utilize it. For example, a horse or camel has a usage as a land vehicle: "$\text{move}
(land)". The recognition primitives of function/usages involve all human activities, so they are much more variable than the recognition primitives of shapes.

4 Formal description of the core concepts for basic verbs

One polysemy has many sub-concepts and the sub-concepts are further divided into more precise basic meanings. In the examples below, we will try to describe the core concepts of basic polysemous verbs in Japanese and English with various recognition primitives that we have introduced in Chapter 3.

Examples of Japanese Verbs

Example 1

Verb “Overflow” (afureru)

$physical movement (afureru (overflow)) \{(N1 \ ga \ N4 \ kara \ (N5 \ ni) \ V) < (N4 \ ga \ V) \}:

V\{ \emptyset \}

N1\{ +3D(+\text{liquid}) < (+\text{powder}/+\text{viscose}/+\text{herd} (+\text{solid})) \},

N4\{ +3D(+\text{container}) < +\text{container} \},

N5\{ +\text{place} \};

$change of state (afureru (fill)) \{(N1 \ ga \ N8 \ ni \ V) < (N8 \ ga \ N1 \ de/ni \ V) \}

V\{ \emptyset \}

N1\{ +3D(+\text{liquid}) < (+\text{powder}/+\text{viscose}/+\text{herd} (+\text{solid})/+\text{emotion}/+\text{intention}/+\text{information}) \},

N8\{ +3D (+\text{container}) < (+\text{container}/+\text{domain}) \}.

(ga, kara, ni, de are particles/post-positions coming after a noun in Japanese)

The symbol V represents a verb, and when necessary, we insert an element which implies its attribute within the brackets \{\}. Examples would be \text{intentional} and \text{accidental}. When no element is necessary fixed, we still insert $\emptyset$ within the brackets \{\}. Here “N1, N4, N5, N8” are labels for unification values used in a semantic valency dictionary for Japanese to English machine translation, where N1 = agent, N4 = origin, N5 = target, and N8 = place. To overflow has two core concepts: 1 the liquid can no longer be contained in the container and is flowing out > physical movement, 2 The liquid is filling up the container > change of state. For the former, examples include “Water is overflowing from the tank” or “The tank is overflowing.” For the latter, examples include “Water is filling the tank” or “The tank is filled with water.”
"{(N1 ga N4 kara (N5 ni) V) < (N4 ga V) }" means that the left-side of "<" represents the basic sentence pattern, and the right-side "<" represents the derived sentence pattern. Here, "(N5 ni)" is an element that can be omitted. Also, "N4 ga" could be transformed into "(N1{+3D(+liquid)} ga, N4 kara." (ni, ga, kara, and de are case markers/postpositions in Japanese: ga=after the subject, kara=from, ni=to, de=by) By this token, "The tank is overflowing" is understood as "The liquid is overflowing from the tank." After the colon(:), the unification value of the label for the selectional restriction using the recognition primitives and semantic features such as "+place" is indicated. Also, according to the selectional restriction after the sign (<), the condition can be applied in cases where the specific selectional restriction of the left side of "<" are not satisfied. In example 1: $change of state (to overflow), "+powder, +viscose, +herd(+solid) +emotion, +intention, +information" is reconsidered as "+3D(+liquid)", "+container, +domain" is reconsidered as "+3D(+container)"; so, for each incidence, the test for selectional restriction is repeated.

In view of such considerations, for "afureru", here we will describe the metaphorical features that are associated with the verb’s primary primitives.

\$physical movement (overflow (afureru)) \{(N1 ga N4 kara V)\}: “The sand is overflowing from the container.” (suna ga iremono kara afureru)

(metaphoric element: sand; its primitive: powder)

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Metaphoric element</th>
<th>its primitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>“The sand is overflowing from the container.”</td>
<td>sand</td>
<td>powder</td>
</tr>
</tbody>
</table>

\$change of state (overflow (afureru)) \{(N1 ga N8 ni V)\}

Some of the following examples are literal translations that are idiomatic in Japanese but may sound awkward in English.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Metaphoric element</th>
<th>its primitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>“The luggage is overflowing the sidewalk.”</td>
<td>luggage</td>
<td>herd</td>
</tr>
<tr>
<td>“The hall is being overflowed by the crowd.”</td>
<td>crowd</td>
<td>herd</td>
</tr>
<tr>
<td>“The tourists are overflowing the town.”</td>
<td>tourists</td>
<td>herd</td>
</tr>
<tr>
<td>“The face is overflowing with joy.”</td>
<td>joy</td>
<td>emotion</td>
</tr>
<tr>
<td>“The head is overflowing with ideas.”</td>
<td>ideas</td>
<td>information</td>
</tr>
<tr>
<td>“The market is overflowing with goods.”</td>
<td>goods</td>
<td>herd</td>
</tr>
<tr>
<td>“The surroundings are overflowing with the scent of flowers.”</td>
<td>scent</td>
<td>information</td>
</tr>
</tbody>
</table>

\$change of state (fill (afureru)) \{(N8 ga N1 de/ni V) is transformed to (N1 ga N8 ni V)\):
Example 2

Verb "rise" (agaru)

$physical movement (agaru (rise)) \{ (N1 ga (N4 kara) (N5 ni) V) < (N4 ga V) \}

V{ \emptyset }
N1{ (+animate, +concrete ) < (-animate, +self-movement, )}
N4{ +place }
N5{ +place }

$appearing into view (agaru (move))

V{ \emptyset }
N1{ (+animate, +concrete ) < (-animate, +self-movement, )}
N4{ +place }
N5{ +place }

$completion (agaru (goes out of view))

V{ \emptyset }
N1{ (+animate, +concrete ) < (-animate, +self-movement, )}
N4{ +place }
N5{ +place }

Example 3

Verb "climb" (noboru)

$physical movement (noboru (climb)) \{ (N1 ga N4 kara (N5 ni) V) < (N4 ga V) \}

V{ \emptyset }
N1{ (+animate, +concrete ) < (-animate, +self-movement, )}
N4{ +place }
N5{ +place }
$appearing into view (noboru (move))

\[
\begin{align*}
V &\{ \emptyset \} \\
N1 &\{ (+animate, +concrete) < (-animate, self-movement), \} \\
N4 &\{ +place \} \\
N5 &\{ +place \}
\end{align*}
\]

Example 4

Verb “be” (aru, iru)

$existence (aru (be)) \{(N8 ni) N1 ga V\}:

\[
\begin{align*}
V &\{ -accidental \} \\
N1 &\{ (-animate, +concrete) < (+human/+abstract/+attribute/+event) \} \\
N8 &\{ +place < -agent \}.
\end{align*}
\]

$possession (aru (be)) \{ N3 ni N1 ga V\}:

\[
\begin{align*}
V &\{ \emptyset \} \\
N3 &\{ +agent \} \\
N1 &\{ (-animate, +concrete) < (+human/+abstract/+attribute/+event) \}.
\end{align*}
\]

$generate (aru (be)) \{ N8 de N1 ga V\}:

\[
\begin{align*}
V &\{ \emptyset \} \\
N1 &\{ +event \} \\
N8 &\{ +place \}.
\end{align*}
\]

$existence (iru (be)) \{(N8 ni) N1 ga V\}:

\[
\begin{align*}
V &\{ +accidental \} \\
N1 &\{ (+animate, +concrete) < (-animate, self-movement) \} \\
N8 &\{ +place < +agent \}.
\end{align*}
\]

\( (ga, ni, de \) are particles/post-positions coming after a noun in Japanese) 

Generally speaking, the verb “iru” is used together with a noun that has an animate semantic feature with the case: “ga”, and the verb “aru” is used with a noun that has an inanimate semantic feature (-animate) with the case: “ga”. Inanimate nouns like “vehicle” and “typhoon” are seen as self-moving, that are translated as: “In front of the house, there is (aru/iru) a car.” “Off the shore of Boso Peninsula, there is (aru/iru) a typhoon.” So, instead of the usual/default “aru”, we can also use “iru”. In the examples, both indicate existence, when using “iru” instead of “aru”, and the car and typhoon carry the feeling of a moving animate thing although it is in fact not animate. The examples, illuminating this, are “A long time ago, there was (imashita/arimashita) an old man and woman.” “Is (imasenka/arimasenka) anybody around?” “There are (iru/aru) some people opposing the construction of a nuclear
power plant.” “He is (iru/aru) in the most powerful post.” So, instead of usual/default “iru”, we could use “aru” for animate subjects.

In these cases, both verbs indicate existence. When using “iru”, meaning that coincidentally/ temporarily/ supposedly it exists, it implies self-movement. When using “aru”, instead, it means that inevitably or universally it exists. The implication is that there is “no self-movement”. By -accidental or +accidental, we ascribe the differences in the nuances that the respective attribute possesses. Also, as in the expression “There are (iru/aru) two of his children playing over there” when using “iru”, it may indicate existence. And when using “aru” it may be reconsidered with a rationale: “The domain of he is animate with a will, and children exist within his consciousness.” When using “aru”, like in the sentence: “There is (aru) his experience.” It may indicate possession, so “He has children with whom he will never be able to sever genetic ties.” Moreover, the expression, “There was an earthquake in (ni/de) Turkey” can indicate one of two situations. When using “ni,” it means recognizing the earthquake as a state >> situation and when using “de,” it means recognizing the earthquake as a phenomenon >> occurrence.

Examples of English Verbs

Example 1

Verb “Go”

$departure (go) \{ (N1 V (to N8)) \}$

$V\{ (+intentional, -accidental) \}$

$N1\{ (+animate/+concrete) < +organizational \}$

$N8\{ +place \}$

$progression (go) \{ (N1 V (to N8)) \}$

$V\{ (+intentional, -accidental) \}$

$N1\{ (+animate/+concrete) < +organizational \}$

$N8\{ +place \}$

$arrival (go) \{ (N1 V (to N8)) \}$

$V\{ (+intentional, -accidental) \}$

$N1\{ (+animate/+concrete) < +organizational \}$

$N8\{ +place \}$

Example 2

Verb “Come”
In examples 1 and 2, we have discussed core concepts of "go" and "come" but theoretically they are not the exact opposites. In Roget's thesaurus, the first notion of "go" is "to depart" and its associated meanings are "to quit, withdraw, run away," and especially "to leave". To go implies a feeling of abandonment. On the other hand, in Roget's, the first notion of "come" is "to move toward" and its associated meanings are "to close in, to advance, to draw near," and especially "to approach". To come has a feeling of being close by. So, in analyzing the meanings of "go" and "come" and in comparing them, the verb "go" has a close association with "to leave", and "to start", while the verb "come" has a close association with "be near to". "Go" is "to leave", while "come" is not quite "to arrive" but is more like "to be approaching", being situated nearby, but not having arrived yet.

**Example 3**

**Verb "Get"

$transfer of possession (get) \{ (N1 V N2 (from N8)) \}

V{ +accidental }

N1{ (+animate/+concrete) < +organizational }

N2{ (+animate/+concrete) < (+abstract/+event) }

N8{ +place }

$change of condition (get) \{ (N1 V N2) \}

V{ +accidental }

N1{ (+animate/+concrete) < +organizational }

N2{ (+animate/+concrete) < (+condition/+abstract/+event) }

N8{ +place }
Example 4
Verb “Take”
$\text{transfer of possession (take) } \{ (N1 \ V \ N2 \ (\text{from N4})) \}$
\[V \{ (+\text{intentional}, -\text{accidental}) \}
N1\{ (+\text{animate}/+\text{concrete}) \text{<} +\text{organizational} \}
N2\{ (+\text{animate}/+\text{concrete}) \text{<} +\text{abstract}/+\text{event} \}
N4\{ +\text{human} \}
$\text{elimination (take) } \{ (N1 \ V \ N2 \ (\text{from N8})) \}$
\[V \{ (+\text{intentional}, -\text{accidental}) \}
N1\{ (+\text{animate}/+\text{concrete}) \text{<} +\text{organizational} \}
N2\{ (+\text{animate}/+\text{concrete}) \text{<} +\text{abstract}/+\text{event} \}
N8\{ +\text{place} \}

“Get” is more neutral than “take” although they both mean “transference of possession.” “Take” has a stronger sense of intention than “get.” While “get” implies movement of a possession without any subjective feelings involved, “take” has a more emotional facet implying to use force to obtain an object. There are contrasting sentences such as: “I took the money” implying: (I stole the money. (out of his pocket or from his wallet)); “I got the money.” implying: (I got a salary, as a valid payment for work that has been rendered to my employer.) Also, “get” exerts an influence on the condition of an object or animate being. “Take” has another nuance implying that it alters the place of an object away from where it was originally located.

Example 5
Verb “Give”
$\text{transfer of possession (give) } \{ (N1 \ V \ N2 \ (\text{to N4})) \}$
\[V \{ (+\text{intentional}, -\text{accidental}) \}
N1\{ (+\text{animate}/+\text{concrete}) \text{<} +\text{organizational} \}
N2\{ (+\text{animate}/+\text{concrete}) \text{<} (+\text{abstract}/+\text{event}) \}
N4\{ +\text{human} \}
$\text{production (give) } \{ (N1 \ V \ N2) \}$
\[V \{ +\text{accidental} \}
N1\{ (+\text{animate}/+\text{concrete}) \text{<} +\text{organizational} \}
N2\{ (+\text{animate}/+\text{concrete}) \text{<} (+\text{condition}/+\text{abstract}/+\text{event}) \}

Just as “Go” and “Come” are not exact opposites, there is a subtle difference about the
oppositional relationship between “Give” and “Take”. “Give” has a primary meaning, “to transfer”, according to Roget’s. “Take” has a primary meaning of “to seize”, so “Give” is “to grant”, while “Take” is “to capture”. “Give” has a feeling of “rendering one’s possession”, while “Take” has a feeling “to steal”. “Give” has a gentler connotation in its transference of possession; “Take” is not the exact opposite of “Give”.

In this way, the antonyms that are thought to be exact opposites have slight differences about their oppositeness. The same thing can be said about synonyms. Synonymous words exist necessarily because there are subtle distinctions among them. In this respect, “Take” and “Get” are synonyms but still there is a certain distinction. “Take” has a more aggressive overtone than “Get”. The verb “Take” has a connotation of “to seize”, but the verb “Get” has a milder connotation of “to acquire”.

*concerning the “/” and “,” dividing the primitives

In Chapter 4, there are “/” (slashes) and “,” (comma) signs, dividing the respective primitives. For example, there is an equation: (-animate/+concrete) < (+human/+abstract/+attribute/+event). It means: “not animate” or “concrete” primitives are recognized from “human” or “abstract” or “attribute” or “event” primitives. For example, in comparison to the above, there is an equation: (-animate, +concrete) < (+human, +abstract, +attribute, +event). It means: “not animate” and “concrete” primitives are recognized from “human” and “abstract” and “attribute” and “event” primitives. So, slashes (/) signify the meaning of “or”; commas (,) signify the meaning of “and”.

*application to other English verbs

Other English verbs that we could use in this research are: “to keep”, “to put”, “to set”, “to make”, and “to see”. These verbs have a fairly broad semantic field, and thus they could be divided into enough number of sub-cores within the broader core. In English, unlike the Japanese “aru” and “iru”, general auxiliaries “to have” and “to be” have too big semantic fields in their cores that it is recalcitrant to sort them into a manageable number of sub-cores.

5 Experiment

5.1 1st Experiment: Methods and Results

We have conducted two experiments with the 10 verbs that we discussed in Chapter 2 and Chapter 4. As for the first experiment, we have chosen a random set of 100 sample sentences for each verb, and we used, out of those 100, from 59 to 100 sentences for the actual imple-
mentation of the experiment. We checked if our usages in Chapters 2 and 4 could match each incidence in those 59 to 100 sentences. We obtained the following results.

The verb “afureru” was analyzed from the Point of Observation that was forwarded in the theory in Chapter 2. 35% of the sentence patterns were interpreted as having the usage of the “Out-side” point of observation and 65% of the sentence patterns were interpreted as using the “Inside” point of observation. “afureru” was also analyzed using the selectional restriction criteria that were forwarded in theory in Chapter 4. The results showed that 35% were interpreted as using the selectional restrictions of “physical movement.” 65% of the sentence patterns were interpreted as using the selectional restrictions of “change of state.”

We carried out this analysis with the rest of all the 10 verbs. Please note that some sentences are under the category of NA or “not applicable to any within our analyzing system”. NA in this context means that when checked with either criterion of “Point of Observation” (in Chapter 2) or “Selectional Restriction” (in Chapter 4), the usages of those sentences come under none of the highlighted criteria. For instance, among 100 sentences using “agaru”, 7 sentences were interpreted as usages that would come under neither “A good view” nor “To destination” nor “Starting point” for the Point of Observation criteria.

Also, some verbs have the same percentages for “Point of Observation” and “Selectional Restriction”. For instance, for “afureru”, the “Out-side” Point of Observation uses the same judgment criterion as the Selectional Restriction of “Physical Movement.” In other words, for “afureru”, the same judgment criterion was used when talking about the “Point of Observation” and “Selectional Restriction”. However, for the “Point of Observation” in Chapter 2, we used Out-side and Inside labels; and for the “Selectional Restriction” in Chapter 4, we used Physical Movement and Change of State labels. Still, they are theoretically the same thing when evaluating the 59-100 sentences that we have adopted for the samples of our experimentation.

*The number of sentences

The reason why the number of sentences like 59, below 100, came out in this experiment is because there are cases where some sentences are not suitable for the experimentation, even not coming under the NA (not applicable) classification. Sentences of NA are not applicable to selectional restriction of stipulated primitives but their part(s) of speech and use are still within the acceptable range, enough to become a part of the data which is still experimentable.
<table>
<thead>
<tr>
<th>Verb</th>
<th>NA = not applicable to any of them</th>
<th>Selectional Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>afureru</strong></td>
<td></td>
<td>Point of Observation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Out-side</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inside</td>
</tr>
<tr>
<td></td>
<td>35%</td>
<td>Physical Movement</td>
</tr>
<tr>
<td></td>
<td>65%</td>
<td>Change of State</td>
</tr>
<tr>
<td><strong>agaru</strong></td>
<td></td>
<td>Point of Observation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A good view</td>
</tr>
<tr>
<td></td>
<td>62%</td>
<td>Physical Movement</td>
</tr>
<tr>
<td></td>
<td>To destination</td>
<td>Appearing</td>
</tr>
<tr>
<td></td>
<td>17%</td>
<td>Completion</td>
</tr>
<tr>
<td></td>
<td>Starting point</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>14%</td>
<td>7%</td>
</tr>
<tr>
<td><strong>noboru</strong></td>
<td></td>
<td>Route of movement</td>
</tr>
<tr>
<td></td>
<td>71%</td>
<td>Physical Movement</td>
</tr>
<tr>
<td></td>
<td>To destination</td>
<td>Appearing</td>
</tr>
<tr>
<td></td>
<td>16%</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>13%</td>
</tr>
<tr>
<td><strong>aru</strong></td>
<td></td>
<td>Existence</td>
</tr>
<tr>
<td></td>
<td>97%</td>
<td>Possession</td>
</tr>
<tr>
<td></td>
<td>3%</td>
<td>Generation</td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>NA</td>
</tr>
<tr>
<td><strong>iru</strong></td>
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<td>Existence</td>
</tr>
<tr>
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<td>NA</td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>go</strong></td>
<td></td>
<td>Starting Point</td>
</tr>
<tr>
<td></td>
<td>16%</td>
<td>Departure</td>
</tr>
<tr>
<td></td>
<td>Mid-way</td>
<td>Progression</td>
</tr>
<tr>
<td></td>
<td>14%</td>
<td>Arrival</td>
</tr>
<tr>
<td></td>
<td>Destination</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>22%</td>
<td>48%</td>
</tr>
</tbody>
</table>
come  NA = not applicable to any of them

<table>
<thead>
<tr>
<th>Point of Observation</th>
<th>Selectional Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Destination</td>
<td>Arrival</td>
</tr>
<tr>
<td>Mid-way</td>
<td>Progression</td>
</tr>
<tr>
<td>Starting Point</td>
<td>Departure</td>
</tr>
<tr>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

get  NA = not applicable to any of them

<table>
<thead>
<tr>
<th>Point of Observation</th>
<th>Selectional Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>Transfer of possession</td>
</tr>
<tr>
<td>Distance</td>
<td></td>
</tr>
<tr>
<td>Generation</td>
<td></td>
</tr>
<tr>
<td>%Change</td>
<td>Change in condition</td>
</tr>
<tr>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

take  NA = not applicable to any of them

<table>
<thead>
<tr>
<th>Point of Observation</th>
<th>Selectional Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>Transfer of possession</td>
</tr>
<tr>
<td>Deprive</td>
<td>Elimination</td>
</tr>
<tr>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

give  NA = not applicable to any of them

<table>
<thead>
<tr>
<th>Point of Observation</th>
<th>Selectional Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision</td>
<td>Transfer of possession</td>
</tr>
<tr>
<td>Generation</td>
<td>Production</td>
</tr>
<tr>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

5.2 2nd Experiment: Methods and Results

We did the second experiment. The second experiment was to examine to what extent the stipulated primitives in Chapter 4 worked in more detail than they have been checked in the first experiment. We made analyses about each verb; for the selectional restriction for the 10 verb entries in Chapter 4, there were some stipulated primitives. Those primitives are expressed as, for example: \( N1 +3D (+\text{liquid}) < (+\text{powder}/ +\text{viscose}/ +\text{herd (+solid)}) \). We have, thus, experimented to what extent the primitives like this example can fulfill the restrictions for the incidence of stipulated recognition primitive, for this example, verb afureru’s instance usage of $\text{physical movement}$. Accordingly, we conducted the experiment with the
restrictions as how far the “left side” primitives (left side of “<” sign) are actually covering the particular instance of recognition primitive: $physical movement. Along the same rationale, we did the experiment with the restrictions as how far the “right side” primitives (right side of “<” sign) are actually covering the particular instance of recognition primitive: $physical movement.

Along the line of above reasoning, we have thoroughly conducted experiments with the rest of all the 10 verbs’ incidences. Below charts are the detailed results.

**Example 1**

Verb “Overflow” (afureru)

$physical movement (afureru (overflow)) \{ (N1 ga N4 kara (N5 ni) V) < (N4 ga V) \} [1]

\[
\begin{align*}
V & \{ \emptyset \} \\
N1 & \{ +3D(+liquid) < (+powder/+viscose/+herd(+solid)) \}, \\
N4 & \{ +3D(+container) < +container \}, \\
N5 & \{ +place \}; \\
\end{align*}
\]

$change of state (afureru (fill)) \{ (N1 ga N8 ni V) < (N8 ga N1 de/ni V) \} [2]

\[
\begin{align*}
V & \{ \emptyset \} \\
N1 & \{ +3D (+liquid) < (+powder/+viscose/+herd(+solid)/+emotion/+intention/+information) \}, \\
N8 & \{ +3D (+container) < (+container/+domain) \}.
\end{align*}
\]

<table>
<thead>
<tr>
<th>num</th>
<th>Left side of “&lt;”</th>
<th>Right side of “&lt;”</th>
<th>Total Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]</td>
<td>27</td>
<td>7</td>
<td>35%</td>
</tr>
<tr>
<td>[2]</td>
<td>2</td>
<td>62</td>
<td>65%</td>
</tr>
</tbody>
</table>

**Example 2**

Verb “rise” (agaru)

$physical movement (agaru (rise)) \{ (N1 ga (N4 kara) (N5 ni) V) < (N4 ga V) \} [1]

\[
\begin{align*}
V & \{ \emptyset \} \\
N1 & \{ (+animate, +concrete) < (-animate, +self-movement), \} \\
N4 & \{ +place \} \\
N5 & \{ +place \}; \\
\end{align*}
\]

$appearing into view \{ (agaru (move)) \} [2]

\[
\begin{align*}
V & \{ \emptyset \} \\
N1 & \{ (+animate, +concrete) < (-animate, +self-movement), \} \\
\end{align*}
\]
Example 3
Verb "climb" (noboru)
$physical movement (noboru (climb)) { (N1 ga N4 kara (N5 ni) V) < (N4 ga V) } [1]

V{0}
N1{ (+animate, +concrete) < (-animate, +self-movement, )}
N4{ +place }
N5{ +place }

$appearing into view (noboru (move)) [2]
V{0}
N1{ (+animate, +concrete) < (-animate, +self-movement, )}
N4{ +place }
N5{ +place }

<table>
<thead>
<tr>
<th>num</th>
<th>Left side of “&lt;”</th>
<th>Right side of “&lt;”</th>
<th>Total Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]</td>
<td>5</td>
<td>57</td>
<td>62%</td>
</tr>
<tr>
<td>[2]</td>
<td>2</td>
<td>15</td>
<td>17%</td>
</tr>
<tr>
<td>[3]</td>
<td>1</td>
<td>13</td>
<td>14%</td>
</tr>
<tr>
<td>NA</td>
<td></td>
<td>7</td>
<td>7%</td>
</tr>
</tbody>
</table>
Example 4

Verb “be” (aru, iru)

$existence (aru (be)) \{ (N8 ni) N1 ga V \}:
  V\{ -\text{accidental} \}
  N1\{ (-\text{animate}, +\text{concrete}) < (+\text{human}/+\text{abstract}/+\text{attribute}/+\text{event}) \}
  N8\{ +\text{place} < -\text{agent} \}.

$possession (aru (be)) \{ N3 ni N1 ga V \}:
  V\{ 0 \}
  N3\{ +\text{agent} \}
  N1\{ (-\text{animate}, +\text{concrete}) < (+\text{human}/+\text{abstract}/+\text{attribute}/+\text{event}) \}.

$generate (aru (be)) \{ N8 de N1 ga V \}:
  V\{ 0 \}
  N1\{ +\text{event} \}
  N8\{ +\text{place} \}.

$existence (iru (be)) \{ (N8 ni) N1 ga V \}:
  V\{ +\text{accidental} \}
  N1\{ (+\text{animate}, +\text{concrete}) < (-\text{animate}, +\text{self-movement}) \}
  N8\{ +\text{place} < +\text{agent} \}.

<table>
<thead>
<tr>
<th>num</th>
<th>Left side of “&lt;”</th>
<th>Right side of “&lt;”</th>
<th>Total Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existence</td>
<td>74</td>
<td>2</td>
<td>97%</td>
</tr>
<tr>
<td>NA</td>
<td>2</td>
<td></td>
<td>3%</td>
</tr>
<tr>
<td>*</td>
<td>22</td>
<td></td>
<td>−(*)%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Left side of “&lt;”</th>
<th>Right side of “&lt;”</th>
<th>Total Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existence</td>
<td>14</td>
<td>45</td>
<td>94%</td>
</tr>
<tr>
<td>Possession</td>
<td>0</td>
<td>2</td>
<td>3%</td>
</tr>
<tr>
<td>Generation</td>
<td>0</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>NA</td>
<td>2</td>
<td></td>
<td>3%</td>
</tr>
<tr>
<td>*</td>
<td>37</td>
<td></td>
<td>−(*)%</td>
</tr>
</tbody>
</table>
Example 1
Verb “Go”
$departure (go) \{ (N1 \ V \ (to \ N8)) \} \ [1]$
V\{ (+intentional, \ -accidental) \}
N1\{ (+animate/+concrete) < +organizational \}
N8\{ +place \}
$progression (go) \{ (N1 \ V \ (to \ N8)) \} \ [2]$
V\{ (+intentional, \ -accidental) \}
N1\{ (+animate/+concrete) < +organizational \}
N8\{ +place \}
$arrival (go) \{ (N1 \ V \ (to \ N8)) \} \ [3]$
V\{ (+intentional, \ -accidental) \}
N1\{ (+animate/+concrete) < +organizational \}
N8\{ +place \}

<table>
<thead>
<tr>
<th>num</th>
<th>Left side of “&lt;”</th>
<th>Right side of “&lt;”</th>
<th>Total Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]</td>
<td>16</td>
<td>0</td>
<td>16%</td>
</tr>
<tr>
<td>[2]</td>
<td>14</td>
<td>0</td>
<td>14%</td>
</tr>
<tr>
<td>[3]</td>
<td>21</td>
<td>1</td>
<td>22%</td>
</tr>
<tr>
<td>NA</td>
<td>48</td>
<td></td>
<td>48%</td>
</tr>
</tbody>
</table>

Example 2
Verb “Come”
$arrival (come) \{ (N1 \ V \ (to \ N8)) \} \ [1]$
V\{ (+intentional, \ -accidental) \}
N1\{ (+animate/+concrete) < +organizational \}
N8\{ +place \}
$progression (come) \{ (N1 \ V \ (to \ N8)) \} \ [2]$
V\{ (+intentional, \ -accidental) \}
N1\{ (+animate/+concrete) < +organizational \}
N8\{ +place \}
$departure (come) \{ (N1 \ V \ (to \ N8)) \} \ [3]$
V\{ (+intentional, \ -accidental) \}
N1\{ (+animate/+concrete) < +organizational \}
N8\{ +place \}
Example 3

Verb “Get”

$transfer of possession (get) \{ (N1 V N2 (from N8)) \}$ [1]

$change of condition (get) \{ (N1 V N2) \}$ [2]

Example 4

Verb “Take”

$transfer of possession (take) \{ (N1 V N2 (from N4)) \}$ [1]

$elimination (take) \{ (N1 V N2 (from N8)) \}$ [2]
Example 5

Verb “Give”

$\text{transfer of possession (give)} \{ (N1 \ V \ N2 \ (to \ N4)) \} \ [1]$

\begin{align*}
V\{ (+\text{intentional}, -\text{accidental}) \\
N1\{ (+\text{animate/+concrete}) < +\text{organizational} \\
N2\{ (+\text{animate/+concrete}) < (+\text{abstract/+event}) \\
N4\{ +\text{human} \\
\end{align*}

$\text{production (give)} \{ (N1 \ V \ N2) \} \ [2]$

\begin{align*}
V\{ (+\text{accidental}) \\
N1\{ (+\text{animate/+concrete}) < +\text{organizational} \\
N2\{ (+\text{animate/+concrete}) < (+\text{condition/+abstract/+event}) \\
\end{align*}

<table>
<thead>
<tr>
<th>num</th>
<th>Left side of “&lt;”</th>
<th>Right side of “&lt;”</th>
<th>Total Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]</td>
<td>13</td>
<td>36</td>
<td>49 %</td>
</tr>
<tr>
<td>[2]</td>
<td>1</td>
<td>15</td>
<td>16 %</td>
</tr>
<tr>
<td>NA</td>
<td>35</td>
<td></td>
<td>35 %</td>
</tr>
</tbody>
</table>

5.3 Discussion

afureru: The sample sentences are all in Japanese. In these sentences, the Japanese expressions mean “filling up”, and not “flowing out”.

agaru: The sample sentences are all in Japanese. Physical movement of ascending is the typical meaning in this sample set.

noboru: The sample sentences are all in Japanese. Like “agaru”, physical movement of ascention is the typical meaning in this sample set.

aru: The sample sentences are all in Japanese. For the Point of Observation, the “possession”
is translated from Japanese into English, meaning “to have”. For the Selectional Restriction, “existence” means “location”. In the data, the number applied to “existence” in the point of observation criterion is slightly higher than the number applied to “existence” in the selectional restriction criterion. This is because the application of point of observation to “existence” means “general being” while the application of selectional restriction to “existence” requires yet further discrimination as in “location”. The sample sentences meet the criteria slightly more often in the Point of Observation than in the Selectional Restriction. As you can see the criteria, the choosing standard for the Point of Observation in Chapter 2 is less strict than that of Selectional Restriction in Chapter 4. There are more criterion-primitives for the latter to discriminate sample sentences than the Point of Observation. This is because of the nature of the judgment between the Point of Observation and the Selectional Restriction. The former criteria can possibly use our intuitions in the brains, while for the latter we are constrained by more inflexible notions of primitives, having been rigidly stipulated.

iru: The sample sentences are all in Japanese. For the Point of Observation, “existence” is 100%, because of the translational interpretation of “there is (be).” For the selectional restriction, “existence” is comparatively lower in percentage, because of the translational interpretation of “~is situated (somewhere)”. As in “aru”, more strict criteria for the Selectional Restriction are required for existence than the criteria for the Point of Observation because of the same reason of intuitive judgment verses more rigid primitives. An example sentence as to be applicable only to the point of observation criteria is “masu ha tsuurei tansui ni iru” (The usual location in which the trout lives is fresh water. (not seawater or saltwater)) This “trout sentence” meets only the point of observation criteria, but not the criteria by the selectional restrictions because in the brains we can manipulate the complex syntactic structures in the case of point of observation, but the judgment criterion for the selectional restrictions cannot do this type of intuitive analyses because the checking must be done without the help of conceptual manipulations in the brains.

go, come: For “go” and “come”, the number of “not applicable” was relatively high compared to the first three entries for each verb: departure, progression, arrival, and arrival, progression, departure, respectively. This is because the figurative, metaphorical and auxiliary usages are relatively high in percentage for both verbs.

get: For the sample set, “Change” primitive was highest in percentage. (e.g.: get angry) The percentage of verb primitive in the category of “Acquisition” was relatively high concerning their “obtaining” aspect (e.g.: get a pen). Different cognitive outlooks are applied
considering distance (e.g.: get there), judged here as not applicable.

take: For this sample set, for both point of Observation and Selectional Restriction, the percentage of NA was high because this sample set had a relatively low inclusion of interpretation of “to seize”; instead, the sample set had a relatively high inclusion of interpretation of “to require” (takes time), “to transport” (take him there), “to undergo” (takes a hardship), “to comprehend” (takes an understanding), “to travel” (take a walk) and other usages that are hard to be included as applicable.

give: For this verb, the same data set is used for both the Point of Observation and the Selectional Restriction.

6 Conclusion

Aiming at a breakthrough to overcome the limitations of semantic processing based on the case patterns of the existing thesauri, and aiming at realizing more advanced system of semantic processing, we have theorized various meanings and usages of verbs that are indicated as the recognition primitives in their core concepts, and that are derived as basic terms that corresponded to various ways of recognizing the world phenomena. Targeting several linguistically “default” verbs with their fundamental notions, we have attempted to schematically describe their core concepts. We now have a reasonable insight into the possibility of discriminating the differences in meanings and usages between synonymous verbs that could not have been possible in previously existing analyzing patterns. Also, we have assigned attributes of basic terms and core concepts to concrete objects for abstract entities so that they can be understood by humans who perceive them with five senses.

Here, in an incidence where these selectional restrictions are not satisfied, the condition is a metaphor. Having done this, it was possible to create a general framework for assigning categorically metaphorical uses to the basic notions and core concepts. However, in certain categories of metaphorical uses, the rules of existing case patterns could not be applied. Then, we can classify the instances that can or cannot be applied to our sorting systems. Thus, by collecting and “abstractifying” various notions and usages for basic verbs, we could drastically reduce the number of meanings compared with existing case pattern dictionaries. So it can be hoped that, when doing semantic processing, we can reduce the exponentially large number of meanings in computing, and we would be able to limit the meanings during the semantic processing stage in the machine translation operations.

From now on, through the uses of various recognition primitives, we can actualize formal descriptions of core concepts for many basic or “default” verbs. Through verifying the applica-
bility of formal descriptions and through checking the comprehensibility of these descriptions, we can generate recognition primitives, and refine the formal descriptions of these primitives.

In order to realize a more advanced system of semantic processing, we need to unify and systematize the language in a multi-dimensional thesaurus. Moreover, we need to delineate the relationships among the concepts in that thesaurus from various viewpoints, such as in the core-concept-description data of basic verbs by the recognition primitives.

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Reference


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