

# Analogies and Metaphors in D. E. Rumelhart's Schema Theory

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## Introduction

The schema theory has been developed in the literature of cognitive theory to account for how one understands input perception. This theory is applied to the reading comprehension process, which criticizes the traditional view that one understands a text by extracting content from it. It is D. E. Rumelhart who initiated this concept of building a reading process based on the schema theory. In accounting for how the schema theory works in the reading process, Rumelhart employs the analogy of the script of a play and that of theory construction. In this paper, we will attempt to study his analogies to clarify how they give concrete images to his description of the schema theory. We will also show that these analogies depend on more fundamental metaphors.

## I

The notion of schema has been developed since the publication of Kant. While Rumelhart acknowledges that different ideas on schema have been presented by different theorists, he claims that all the ideas share the view that "schemata truly are the building *blocks* of cognition" (33) <sup>1</sup> and that "they are the fundamental *elements* upon which all information processing depends" (33). Schemata, which man uses to deal with information, is thought of

as being composed of its parts as metaphorically shown with the expressions "blocks" and "elements."

The point is that this idea comes from the view that cognition represented as schema is a substantial object which is composed of elements. The metaphor, "An abstract concept is a concrete thing," is used here, enabling us to see that an abstract cognition can be divided into elements just as a concrete object can be divided into its parts.

Moreover, these elements are not disorganized or fragmented, but rather related to one another:

A schema contains, as part of its specification, the network of interrelations that is believed to normally hold among the constituents of the concept in question. (34)

Rumelhart employs FACE to illustrate the structural nature of schema in a more concrete way. FACE is composed of MOUTH, NOSE, EAR and EYE, and the EYE is further composed of IRIS, EYELID and EYEBROW. If element B is contained in element A, and element C is contained in element B, it results in element C being contained in element A. The notion of FACE, therefore, shows this structural relationship since EYELID, for example, is contained in EYE, which is itself, contained in FACE. EYELID is therefore also contained in FACE. These relationships among the elements concerned with FACE appear in Figure 1.

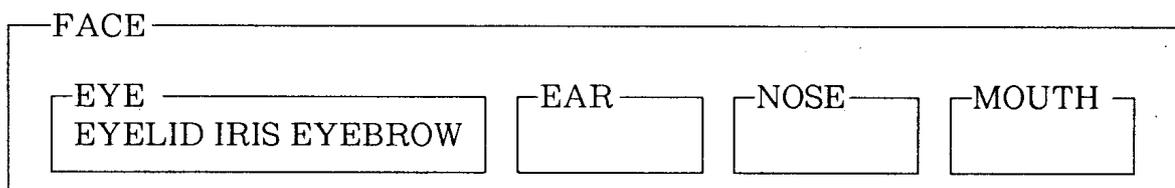


Figure 1

The whole-part relationship in FACE can be represented vertically in Figure 2, in which the whole-part relation is converted into a top-down figure. The metaphor, "The whole is up and the parts are down," is represented by Figure 2:

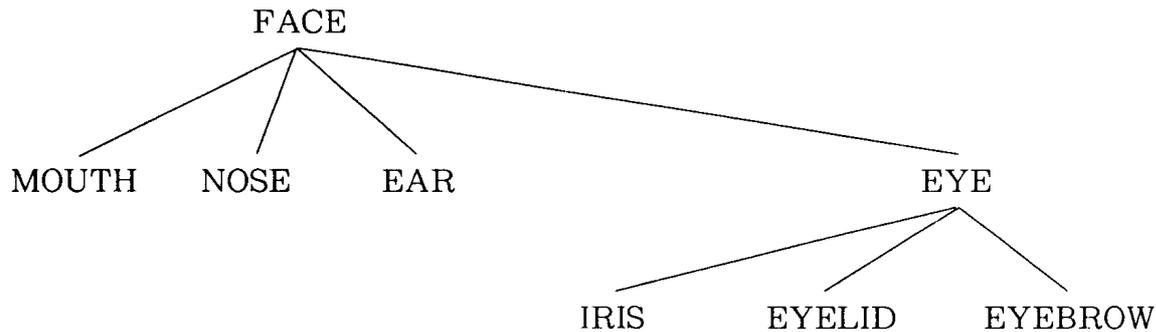


Figure 2

The structural nature existing in schema implies that each subschema is placed somewhere in the network of the whole schema. When all the subschemata are placed in their appropriate positions, it is possible to move from one subschema to another. Rumelhart indicates that there are two directions in the process of understanding, i.e., top-down and bottom-up. The former understanding proceeds from the whole to its parts, while the latter moves from its parts to their whole. The "whole" represents a comprehensive concept and the parts represent subconcepts.<sup>2</sup> Rumelhart explains these two processes as follows: "Thus, while conceptually driven activation *goes from whole to part*, data driven activation *goes from part to whole*." (48)

His explanation is based on the process of a moving image for understanding printed material. "Go from A to B" suggests the metaphor "Understanding process as movement." The word "move" suggests the processing of written material from beginning to end. "Move" also suggests that the reader should have "directions" and a "path" in understanding the components and structures in the comprehension process.

This process of reading takes the form of an “up and down” approach and follows a route which connects subschemata with schema or, in other words, submeanings and supporting data to full meanings and main ideas .

Rumelhart uses the FACE schema to illustrate these two comprehension processes. When a reader recognizes the FACE schema that corresponds to his/her input perception, the FACE schema will invoke the NOSE, EYE and MOUTH schemata, performing the top-down process of reading. However, when the reader, who has activated the FACE schemata, invokes the PERSON schema, he/she will use the “bottom-up mode” in reading. Rumelhart claims that, in fact, a reader tends to use both modes in the actual processes of reading comprehension. When the MOUTH schema is invoked, for instance, the reader goes up to the FACE schema which then activates the lower-level subschemata such as the EYE, MOUTH and EAR.

Rumelhart describes how schema works using the script of a play as an analogy. The script of a play is composed of characters, actions and events, and one associates concrete persons, other subactions, and supporting elements of events to these first three play components. This is also the case with how human beings interpret circumstances. Rumelhart notes:

Just as a play has characters that can be played by different actors at different times without changing the essential nature of the play, so a schema has variables that can be *associated with (bound to)* different aspects of instantiations of the schema. (35)

The image of connecting two objects together with some kind of connector appearing in Figure 3 is also used in Rumelhart's illustration of

schema. He uses the expression "bind to" to give a more concrete description to "associate with." The metaphor, "Understanding is binding our knowledge to new information," is used here.

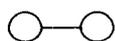


Figure 3

Rumelhart demonstrates how we utilize the BUY schema as an example. The BUY schema is composed of its subschemata such as SELLER, PURCHASER, MONEY, BARGAINING and other related transactional elements. It is useful to notice that the cognition of BUY is abstract in the sense that it can not be perceived as a physical object. The substantialization of BUY enables us to perceive BUY to have various subelements.

One does not associate a person with MONEY or MERCHANDISE. The reader knows that, while SELLER and BUYER are persons, modern MONEY normally refers to itself rather than to shells. These characteristics about subschemata, called "variable constraints," tell a reader what can be bound to which subschema. Moreover, the idea that variables have their counterparts in the text is based on the assumption that text is also composed of its parts, which, in turn, assumes that a text can be regarded as a concrete object divisible into elements.

Schema theory claims that reading comprehension is achieved not instantly but gradually in a series of processes. This is illustrated by the process of connecting variables of a schemata with new data:

There is also the notion of an instantiation of a schema that corresponds to an enactment of a play. A play is enacted whenever

particular actors, speaking particular lines, perform at a particular time and place. Similarly, a schema is instantiated whenever a particular configuration of values *is bound to* a particular configuration of variables at a particular moment in time. (36)

Just as a play has a beginning, middle and ending, text interpretation starts with binding data first encountered to an appropriate subschema. Interpretation ends with connecting the last data to a corresponding subschema.

## II

Rumelhart introduces the "Theory building" analogy to describe how our comprehension proceeds with the help of schema:

... it is useful to think of a schema as a kind of informal, private, unarticulated theory about the nature of the events, objects, or situations that we face. The total set of schemata we have available for interpreting our world in a sense constitutes our private theory of the nature of reality. (37)

A scientific researcher collects data, constructs a hypothesis on the basis of the collected data, and tests his hypothesis against further data. Rumelhart points out that schema works in the same way as hypothesis testing does:

... the fundamental processes of comprehension are taken to be analogous to hypothesis testing, evaluation of goodness to fit, and parameter estimation. Thus a reader of a text is presumably constantly evaluating hypothesis about the most plausible interpretation of the

text. (38)

It is worth noting that the process of theory building is analogous to the process of top-down and bottom-up comprehension. Whereas a researcher starts with data collection and goes on to make a hypothesis which produces estimations, lower schemata invoke higher schema, which activates lower subsidiary schemata as indicated in Section I with reference to the FACE schema. The data corresponds to lower schemata, hypothesis to higher schema, and estimations which a hypothesis brings about, to lower subsidiary schemata respectively.

Both the play and theory analogies share whole-part characteristics. While a play has roles and a theory has parameters, the play analogy can not involve changing a schema as Rumelhart puts it, "a play ... can be played ... without changing the essential nature of the play." (35)

Another affinity which theory building shares with schema is that just as a theory predicts an expected result,<sup>3</sup> a schema makes inferences as to how a story will proceed. A reader goes on reading with some expectation as to how the discourse will develop:

Not all possible observations are made. Instead, we use our theories to make inferences with some confidence about these unobserved events. So it is with schemata. We need not observe all aspects of a situation before we are willing to assume that some particular configuration of schemata offers a satisfactory account for that situation. (38)

One can make inferences about theories since theories are composed of their parameters. Rumelhart utilizes a more concrete analogy to account for how one anticipates future parameters. He uses knowledge about an

“automobile,” which is composed of an engine, headlights and other parts. The reader who has a basic knowledge about a car can predict it has these parts even if they do not appear in the automobile-related text being read.

Based on the analogy of theory, Rumelhart gives an example to show how schema works in text interpretation:

Business had been slow since the oil crisis. Nobody seemed to want anything really elegant anymore. Suddenly the door opened and a well-dressed man entered the showroom floor. John put on his friendliest and most sincere expression and walked toward the man. (43)

Readers will invoke the BUSINESS schema from the first sentence, and some readers may further go on to expect a gasoline-related business such as a gas station whose slump was caused by the oil crisis. But, when encountering the second sentence, they give up their hypothesis since “buying gasoline” is not something “really elegant.” This process indicates that text reading is like a theory building which has “the process of constructing a theory, testing it against the data currently available, and as more data become available, specifying the theory further.” (44)

When the BUSINESS schema is invoked in the first sentence, the BUY and SELL schemata comes to be activated as parts of the BUSINESS schema. The BUY and SELL schemata require appropriate counterparts in the passage:

The BUSINESS schema presumably has, as part of its specification, a reference to the BUY or SELL schema ... . Once activated, these schemata *search for potential variable bindings*. (45)

Notice that "search for" and "binding" are used here. As we have seen in Section I, understanding is perceived as two things getting bound by some connector, and each subschema is expected to be connected with a particular piece of subdata or supportive information in the text.

The notion "search for" presumes a certain object to be looked for and the place to discover it. As Rumelhart remarks, "Not only do schemata tell us what to see, but they also tell where to see it." (51) He employs the following example to give a more concrete description. When we have to find someone's phone number, we try to locate a telephone book. This requires us to remember where in the room we placed it. The whole-part image appears in this case, which reminds us that a schema contains its subschemata just as an object has its own component parts. The BUSINESS schema contains the BUY, SELL, BARGAIN and MONEY schemata, and once a reader recognizes the text as concerned with BUSINESS, he looks for the BUY, SELL, BARGAIN and "MONEY" subschema in the text. Just as a theory leads us to seek the data relevant to it, schema requires us to find its corresponding information in the text. The BUSINESS schema urges the reader to seek a piece of merchandise, a buyer, a seller and the money to pay for the merchandise. In this text, while the MERCHANDISE is "bound to" an automobile, the BUYER is bound to "a well-dressed man," and the SELLER to "John." The MONEY, however, has no referent in the text. Rumelhart only says that "... being well-dressed suggests MONEY" (44) without identifying any specific money in the text. This results from the expectation that each schema should be bound to some other element in the text, even if the text in question might not contain a relevant sub-reference. Since a schema is conceived as being an object, it is thought of as existing somewhere in the text.

Rumelhart maintains that "A schema, then, is a data structure for representing the generic concepts *stored in memory*." (34) Memory is seen as a container for schemata. The important point for understanding a text is whether the reader can extract an appropriate schema from memory which works as a helpful personal theory. This point develops into accounting for why and when a reader fails to interpret a passage correctly. Rumelhart shows the three reasons for failing to achieve correct interpretation of a text:<sup>4</sup>

1. The reader may not have the appropriate schemata. In this case he or she simply cannot understand the concept being communicated.
2. The reader may have the appropriate schemata, but the clues provided by the author may be insufficient to suggest them. Here again the reader will not understand the text but, with appropriate additional clues, may come to understand it.
3. The reader may find a consistent interpretation of the text but may not find the one intended by the author. In this case, the reader will "understand" the text but will misunderstand the author. (48)

The first failing derives from the reader not storing the necessary schema in his mind. The second failing results from the fact that the reader is unable to extract the correct schema from his mind. The third failing stems from the fact that the reader has extracted a wrong schema from his mind.

### Conclusion

In this paper, we have studied how Rumelhart describes schema and have tried to illustrate how his explanation implicitly utilizes the metaphor "An abstract concept is a concrete thing composed of parts." We

have also attempted to explain how Rumelhart shows that an understanding of this metaphor makes it possible for a reader to assume where each subschema is placed in terms of the high-low networks among the schemata in any reading material.

In this paper, the play and theory analogies proposed by Rumelhart have also been discussed. While these two analogies are based on the whole-part metaphor, it has also been shown that the play analogy emphasizes the image of connection and that the analogy of theory stresses the organized building image. The contrast of the play analogy with the theory analogy shows that different analogies shed light upon different aspects of schema, and that these analogies are largely dependent on more basic images like whole-part, connection and high-low patterns of discourse. It is suggested that an abstract theory is described through analogies, which are themselves dependent upon related metaphors. It should also be emphasized that some order always exists among metaphors. The metaphor, "An abstract concept is a concrete object," produces "an abstract concept which is divisible and connectable."

Although I concentrated this study on the schema theory presented by Rumelhart, I anticipate other schema theories proposed by different theorists, who have succeeded Rumelhart's basic idea, might employ models and metaphors similar to Rumelhart. My next article will be to investigate how schema theory has developed and changed from Rumelhart's ideas in the light of other interpretations and applications of his schema theory to the process of reading comprehension.

#### Notes

- 1 All the quotations are from D. E. Rumelhart, "Schemata: The Building Blocks of Cognition," *Theoretical Issues in Reading*

*Comprehension*, ed. R. J. Spiro, B. C. Bruce, and W. F. Brewer (Hillsdale., N.J. : Erlbaum, 1980) and every italicization is made by the author.

- 2 Rumelhart seems to use the term "whole" and "abstract" in the same meaning when referring to "top" as he remarks that "This higher, more abstract schema would then activate, from the top down, still other of its constituent schemata, ...." (42) His remark is not adequate, however, considering the fact that FACE is not more abstract than MOUSE, NOSE or EYE which are constituents of FACE.
- 3 Max Black points out that scientific models are productive by the remark that "A promising model is one with implications rich enough to suggest novel hypotheses and speculations in the primary field of investigation." (From Max Black, "Models and Archetypes" *Models and Metaphors*, Ithaca: Cornell UP, 1962, 233.)
- 4 While Rumelhart acknowledges the possibility that knowledge about the world affects and sometimes distorts text interpretation, Wilga M. Rivers holds the traditional view that "Reading is extracting meaning from text," while stressing the significant role played by the knowledge of the world in reading. For a detailed discussion, see Wilga M. Rivers, *Teaching Foreign-Language Skills* (Tokyo: Kinseido, 1968) 213-26.