WHAT MAKES A SYSTEM LESS GRAPHICAL?

Atsushi Shimojima
Japan Advanced Institute of Science and Technology/ATR Media Information Science Labs

Abstract.
Certain representation systems, loosely called “linguistic” ones, seem to lack the inferential efficiency, the expressive inflexibility, and the expressive richness possessed by certain other systems, loosely called “graphical” ones. This paper investigates the semantic mechanism underlying this intuitive phenomenon, and attributes the reason to the fact that semantic interpretation in “linguistic” systems is applied to only fairly specific properties of representations.

Key words: Graphical representation, linguistic representation, diagrammatic reasoning, non-verbal communication, semantics of graphics

1. Introduction

Intuitions tell us that graphics have opposing functional traits: they are rich in content; they facilitate our inferences on the depicted objects; but they often have severe limitations in what can be expressed. For example, a typical road map expresses a great amount of information that would be quite tedious to spell out in English sentences; tracing such a map often helps our thinking of a suitable itinerary in the depicted region; yet it is hard to express non-specific information in such a map: it cannot tell that a bank is at the corner of Pine street and Oak avenue without also telling which side of the corner it is located. In short, (a) inferential efficiency, (b) expressive richness, and (c) expressive inflexibility are often co-present in a graphical system.

This intuitive phenomenon has an interesting flip side. Certain representations, typically those called “linguistic” or “sentential,” have an exactly opposite combination of functional traits: sentences are not rich in content (they express information “piece by piece”); inferences done only with sentential representations (e.g., formal proofs in a first-order deductive system) are often quite tedious; but they have little limitation in expressing non-specific information (English can simply tell that “a bank is at the corner of Pine street and Oak avenue”). In short, the functional traits (a)–(c) are often co-absent from a certain type of representation systems.

These intuitions raise two natural questions. Why do the opposing traits (a)-(c) tend to be co-present in a certain type of representations systems, and why do they tend to be co-absent in a certain other. Let us call the first question the positive trade-off problem and the second the negative trade-off problem. A number of authors (e.g., Sloman 1971) have been interested in the positive problem, and some (e.g., Stenning and Oberlander...
What Makes a System Less Graphical?


The main target of this paper is the negative problem. Why, for example, is it
that certain systems could not have expressive flexibility without sacrificing expressive
richness and inferential efficiency? Why do the traits (a) and (b) have to go away when
(c) is gone?

In the next section, we will illustrate this issue by comparing three particular rep-
resentation systems. One of them is a simple position diagram system featuring the
traits (a)–(c) altogether, while the others are typical “linguistic” systems mostly lacking
(a)–(c). Section 3 then analyzes the similarity and difference of these systems. We will
show that the main difference consists in the specificity of structural properties of repre-
sentations that are required for semantical interpretation. Specifically, we will propose
the hypothesis that systems that require more specific structural properties for interpre-
tation tend to lack (a)–(c) altogether, while systems that require less specific properties
do not. Section 4 refines this proposal by showing that there are (at least) three different
types of “linguistic” systems, which are significantly different in the specificity and kind
of properties they require for interpretation.

Throughout this paper, our method is rather philosophical: it emphasizes the devel-
opment of a key concept plus initial arguments on how it helps solving a problem, rather
than a development of the theory with a full range of data or technical details.

2. Examples

Compare three different representations in Fig. 1, each of which expresses, in its own
way, the same information (1).1

(1) Jon is to the left of Bob.

These three representations belong to different representation systems, as they ex-
press information in different ways. The top representation is an atomic sentence of a
particular first-order language. The sentence consists of a two-place predicate Left_Of
and its arguments Jon and Bob. The bottom representation is a sentence of English,
with the subject phrase Jon and the predicate phrase is to the left of Bob. The
middle representation belongs to a system of “position diagrams”, where the way names
are horizontally arranged express the ways the corresponding people or objects are hori-
zontally arranged. The name Jon is placed to the left of the name Bob in this particular
position diagram, and hence the diagram expresses the information that Jon is to the
left of Bob.

1Throughout this paper, we conveniently use an English sentence (e.g., “Jon is to the left of Bob.”) to
describe a particular information item, and the corresponding number (e.g., (1)) to denote that
information item. Thus, numbers do not denote the corresponding sentences (as typically in linguistics
papers), but the information items described by those sentences.

Fig. 1. A first-order sentence (top), a position diagram (middle), and an English sentence (bottom) that express the information (1).

More detailed discussions on how these representations express information will follow immediately. For now, we just assume that there are a fixed system of syntactic and semantic rules underlying each of these representations. We call the system underlying the top sentence “FOL”, that underlying the middle diagram “PD”, and that underlying the bottom sentence “ENG”.

On the surface, these representations look similar. All of them look linear in basic structure, and the ways they express information seem to be similar, different only in small details. In reality, however, there is a significant difference, a difference in kind, in the ways they express information.

2.1. Difference 1

Suppose we modify the representations in Fig. 1 so that each may express the information (2), in addition to the information (1).

(2) Ken is to the right of Bob.

Fig. 2 shows one possible result of such modification. Here the modified position diagram, shown in the middle, expresses the additional information (2) as the name Ken is now placed to the right of the name Bob. It keeps expressing the information (1) as the name Jon stays to the left of Bob.  

Interestingly, there holds another significant fact in this diagram: the name Ken is to the right also of the name Jon. Thus, the diagram also expresses the following information:

(3) Ken is to the right of Jon.

We are assuming that PD has no special grammatical method for conjunction, disjunction, or negation. Allowing such constructions would make PD much closer to ENG and FOL (for the reason discussed later) and would not serve for an illustrative purpose.

Thus, another piece of information (3) is automatically expressed, as the result of
the operation of expressing (1) and (2) in a PD diagram. Note that (3) is in fact a
consequence of (1) and (2), something that is necessarily true if (1) and (2) are true.

Now consider the FOL sentence, shown in the top, and the ENG sentence, shown in the
bottom. As conjunctive sentences, both express both information (1) and (2). However,
neither expresses the information (3), unlike the PD diagram. Certainly, it is easy to
infer (3) from (1) and (2). Given either the first-order sentence or the English sentence
in Fig. 2, it is only a short step to reach the information (3). Yet this is not the same as
saying that these sentences express (3). They only express certain premises from which
(3) can be easily inferred.

Generally, expressing certain sets of information in PD can result in the expression
of additional, consequential information, while expressing information in FOL and ENG
has seldom such results. Note that a system’s potential for such automatic expression of
consequences can makes a substantial difference when one uses representations of that
system as an aid to one’s inference. With such a system, one can just express certain
premises and read off some of their consequences from the resulting representation, rather
than figuring out those consequences oneself.

Various researchers have noted on this general phenomenon (Sloman 1971, Lindsay
1988, Barwise and Etchemendy 1990). Shimojima (1995) called it “free ride” and inves-
tigated its semantic mechanism. Various representation systems, such as various map
systems, Venn-Euler systems, and pictorial drawing systems, are known to have the
potential for free rides, often with much more dramatic effects than illustrated above.

2.2. Difference 2

There is another important difference between PD on the one hand and FOL and ENG on
the other. Let us suppose that we try to express the following information along with
the information (1):

Fig. 2. A first-order sentence (top), a position diagram (middle), and an English sentence (bottom) that
express the information (1) and (2).
(4) Ken is to the left of Bob.

It is simple to express this pair of information in FOL and ENG. We can just write conjunctive sentences, such as those in Fig. 3.

In contrast, we cannot simply express this pair of information in PD. In order to do so, we need place the name “Ken” to the left of “Bob”, while also placing “Jon” to the left of “Bob”. But there are at least two alternative ways to do so: (i) placing “Ken” between “Jon” and “Bob” (as in Jon Ken Bob) and (ii) placing “Ken” to the left of “Jon” (as in Ken Jon Bob). Unfortunately, whichever choice we may make, the operation results in the expression of certain unwarranted information: the expression of (5) with the choice of (i) and the expression of (6) with the choice of (ii):

(5) Jon is to the left of Ken.

(6) Ken is to the left of Jon.

Neither of these information items follow from the original pair of information, (4) and (1). Without any ground for making either choice, we have to give up the expression of (4) and (1).

Thus, one cannot express certain sets of information in PD without expressing additional, unwarranted information. FOL and ENG seldom suffer from the same type of expressive inflexibility. As with free rides, the phenomenon is common in many so-called "graphical" systems, including various map systems and geometry diagram systems. Let us call this restricting property of a system its "over-specificity".

Philosophers have long been aware of the general phenomenon, at least since Berkeley (1710) discussed it in connection with geometry diagrams. Stenning & Oberlander (1995) first discussed its impacts on the overall inferential or expressive potentials of representation systems. Shimojima (1995) characterized the semantic mechanism underlying a system’s over-specificity.
What Makes a System Less Graphical?

2.3. Difference 3

Fig. 4 shows one possible result of expressing the information (7) and (8) along with the previously introduced information (1) and (2).

(7) Gil is to the left Jon.
(8) Ron is to the right of Ken.

Look at the pd diagram, shown in the middle. Here, we see that there are three names to the left of the name “Ken”. From this, we can see that there are (at least) three people to the left of Ken. Generally, we can count the number of names satisfying a certain condition in a pd diagram to see the count of people satisfying the corresponding condition. Thus, we can count the number of names to the right of “Ken” and see that there is at least one person to the right of Ken, or we can count the number of names between “Gil” and “Ken” and see that there are at least two people between Gil and Ken. In short, the count of names means the count of people in pd.

In contrast, the count of names in the fol sentence or the eng sentence in Fig. 4 does not mean the count of people. Most likely, the number of names means nothing in these systems—it does not make sense to count the number of names in these representations in extracting information from them.

Returning to the pd diagram, note that the basic semantic rules for this system are defined from horizontal relations between names to horizontal relations between people. The following is one of the simplest ways to state them:

(9) For arbitrary names x and y, if x is to the left of y, it means the bearer of x is to the left of the bearer of y.

This rule specifies what the left-of relation between two individual names means. It is not concerned with the meaning of the counts of names (satisfying a certain condition). For example, it does not directly say that there’s being three names to the left of “Ken” means there’s being (at least) three people to the left of Ken. Yet it is clear that this
meaning relation is somehow based on the rule (9). It is an additional meaning relation that automatically holds given the basic rule (9). It is an derivative meaning relation.

Kosslyn (1994) pointed out that the possibility of meaning derivation of this kind marks the characteristics of certain systems of statistical graphs and charts. Shimojima (1999) analyzed the general mechanism of meaning derivation, clarifying that a significantly wider class of representation systems supports it.

With such derived meaning relations, representations can have quite rich semantic contents. The short pd diagram in Fig. 4, for example, expresses a surprisingly many pieces of information, including the ones listed above. In contrast, the fairly long eng sentence or fol sentence in Fig. 4 expresses none of these pieces of information. The four pieces of information (1), (2), (7) and (8) are most likely all that they express.

2.4. Question Reformulated

Using pd as an example, we have illustrated how a system’s inferential efficiency, expressive inflexibility, and expressive richness respectively derive from the system’s potentials for free rides, over-specificity, and meaning derivation. Also, we have seen specific examples of how systems like fol and eng tend to lack these potentials altogether. On the basis of this illustration, we now propose the following reformulation of the negative trade-off problem, the main question in this paper:

Negative Trade-Off Problem Why is it that potentials for free ride, the property of specificity, and potentials for meaning derivation tend to be co-absent from certain representation systems?

Originally, the negative trade-off problem was formulated in more intuitive terms: why it is that inferential efficiency, expressive inflexibility, and expressive richness tend to be co-absent from certain representation systems. The above reformulation therefore has already incorporated substantial analyses on the nature of these functional traits, namely, the analyses that identify the potentials for free rides, specificity, and meaning derivation as the main sources of the inferential efficacy, expressive inflexibility, and expressive richness at issue.

Thus, the appropriateness of any proposal on the basis on the above reformulation of the problem heavily depends on whether those initial analyses are on the right track. However, it is not the purpose of this paper to give a full justification of these analyses beyond what is given by the previous illustrations. We will concentrate on the presentation of a solution of this reformulated question, assuming the underlying analyses are true.
3. Analysis

So, why do those potentials tend to be co-absent from certain representation systems, such as FOL and ENG? In a nutshell, our answer attributes the reason to the kind of properties of representations that are interpreted in those systems.

By a property of a representation, we mean any quality, feature, or structure that the representation has itself. It is a type that the representation has as a token. For example, the on/off indicator on my radio is yellow now, and being yellow is its color property at this moment. It was dark last night and being dark was its color property at that time. The name plate at my office door has a character sequence “Shimojima”, and having that character sequence is one of its properties. The English sentence in Fig. 1 has a certain arrangement of words, and that arrangement is one of its structural properties. If an Euler diagram has over-lapping circles in it, that over-lapping pattern of the closed curves is one of its structural properties.

Only selected properties are interpreted in a given system. For example, the color quality of the on/off indicator on my radio is interpreted to express the on/off condition of my radio, but the shape of the indicator is not subject to interpretation in this use of the indicator. The name plate at my office is made of plastic, but this property is not interpreted in the standard uses of name plates. The English sentence in Fig. 1 has the property of being written in the font Courier, but this property itself is not interpreted to express information in the average reading of the sentence. What properties of a representation are interpreted depends on what particular use the representation is being put in—what particular representation system it belongs to.

Let us return to our examples of FOL, ENG, and PD, and see what properties of representations are subject to interpretation in these systems. Consider the PD diagram in Fig. 1, which expresses the following information:

(10) Jon is to the left of Bob.

Clearly, this diagram expresses the information (10) because it has the name “Jon” to the left of the name “Bob”. That is, the following structural property of the diagram is responsible for the expression of (10):

(11) Having the name “Jon” to the left of the name “Bob”

As long as a PD diagram has this property, we can interpret it as expressing the information (10). Likewise, as long as a PD diagram has the properties (12) or (13), it can be interpreted to express the information (14) or (15):

(12) Having the name “Bob” to the left of the name “Ken”
(13) Having the name “Ken” to the left of the name “Ron”
(14) Bob is to the left of Ken.
(15) Ken is to the left of Ron.
To wit, the PD diagram in Fig. 2 and that in Fig. 4 both have the structural property (12) and hence expresses the information (14). The latter also has (13) and hence expresses (15) too. Generally, if a single PD diagram has multiple structural properties of this kind, it expresses the multiple pieces of information corresponding to them.

The story is not so simple for FOL and ENG. Consider the FOL representation in Fig. 1, which expresses (10). What structural property of this sentence is responsible for the expression of this information? If one simply extends the way of analysis applied to PD, the answer would be: the sentence expresses (10) because it has the following structural property:

(16) Having the names “Jon” and “Bob” in this order inside the parenthesis to the right of the predicate “LeftOf”.

This type of answers, however, cannot be right. There are numerous, in fact infinitely many, possibilities for FOL sentences to have this structural property without expressing the information (10). Consider a negative construction “¬LeftOf(Jon, Bob)” or consider “LeftOf(Jon, Bob) ∨ LeftOf(Bob, Jon)”. Both these sentences have the structural property (16). Yet neither expresses (10). Neither expresses even information from which (10) is deducible. True, each sentence has a clearly distinguishable component that expresses the information. But this is not the same as saying that either sentence expresses (10) as a whole.

Thus, structural properties such as (16) does not seem to be the right kind of properties interpreted in the system FOL. What kind of structural properties are subject to interpretation in FOL then?

One obvious problem with the structural property (16) is that it is not specific enough to exclude the possibilities of negative or disjunctive constructions. That is, even when (16) holds in a FOL sentence, the sentence may well have a negative or disjunctive construction scoping over the component in which (16) holds, and then the sentence as a whole does not express the information (10). The appropriate structural property should be at least specific enough to exclude these possibilities. An example of such stronger properties is:

(17) Having the names “Jon” and “Bob” in this order inside the parenthesis to the right of the predicate “LeftOf” in a component that no negation or disjunction scopes over.

We are not claiming that there is any actual use of first-order sentences that employs this exact way of specifying structural properties for interpretation. Our point is that generally, interpretation in FOL requires a significantly specific structural property of a representation. In particular, the structural property corresponding to the information (10) must be at least as specific as (17).\(^3\)

\(^3\)Just what makes a property specific or strong? For the purpose of the present paper, it can be defined roughly as follows. Let \(\Gamma\) be the set of interpretable properties in a particular representation system \(R\),
An analogous consideration obviously applies to ENG. For example, it would be wrong to say that the ENG sentence in Fig. 1 expresses (10) because it has the following structural property:

(18) Having the phrase “is to the left of” between the words “Jon” and “Bob”.

Such an analysis ignores the possibilities of negative and disjunctive constructions in English, such as (19) and (20). It also ignores “intensional” constructions such as (21).

(19) It is not the case that Jon is to the left of Bob.

(20) Jon is to the left of Bob or Ken.

(21) Ken believes that Jon is to the left of Bob.

Thus, a more appropriate specification of the structural property corresponding to (10) would be a significantly stronger one, such as the following, that excludes these possibilities:

(22) Having the letter-sequence “is to the left of” between the letter sequence “Jon” and “Bob” in a component that no negative, disjunctive, or intensional constructions scope over.

Thus, essentially, interpretable structural properties in systems like FOL and ENG are significantly strong, or specific. In our view, this fact is the key. That is, the following is our proposed solution to the negative trade-off problem:

Main Proposal Representation systems requiring stronger structural properties for interpretation tend to lack the potentials for free ride, over-specificity, and meaning derivation altogether.

It is not difficult to see how this is so. Consider the case of free ride. In the example discussed in section 2, the free ride occurs because the operation of expressing the information (1) and (2) in the PD diagram automatically results in the expression of information (3). Thus, this operation realizes at least three different interpretable properties in the PD diagram, namely, those properties corresponding to (1), (2), and (3). The resulting PD diagram therefore end up with three interpretable structural properties. Generally, this co-presence of multiple interpretable properties is a necessary result of any free ride process. So, in order for a system to support free rides, interpretable properties in that system must be of the kind that allows such co-presence.

Note, however, that stronger structural properties are less likely to coexist in a single representation. The greater strength of a structural property means a smaller class of objects satisfying it, and hence the intersection of several of such classes must be even...
smaller. Thus, a system’s requirement for stronger properties for interpretation and the system’s capacities for free rides are two conflicting demands.

Similarly, a system’s requirement for stronger properties for interpretation runs counter to its potentials for over-specificity and meaning derivation. For, again, the possibility of co-presence of multiple interpretable structural properties in a single representation is a necessary condition for the over-specificity property and meaning derivation in the system. We omit detailed discussions here, trusting that examples in section 2 should make the point clear.

4. Refining the Analysis

This much is the initial motivation for our proposal on the negative trade-off problem. It claims that systems such as FOL and ENG lack the potentials for free rides, over-specificity, and meaning derivation altogether because they require stronger structural properties for interpretation.

There is, however, an important question remaining to be addressed. Underlying this proposal is the assumption that there are in fact systems that “require stronger structural properties for interpretation.” In particular, it assumes that this description does fit systems like FOL and ENG. Although we have seen some cases where FOL and ENG require stronger properties than PD does, we have not seen that for the general case. Do systems like FOL and ENG always require stronger properties in extracting any information?

We have seen in the previous section that if a system always requires stronger properties for interpretation, it has lower potentials for free rides, over-specificity, and meaning derivation. But we have not clearly seen whether the antecedent really holds of our “target”, namely, those systems whose low potentials for free ride, over-specificity, and meaning derivation we are trying to explain.

Actually, this question cannot have a straight-forward answer. For there is no single system that may be called “the” English representation system, and for any first-order language $L$, there is no single system that may be called “the” $L$ representation system. As we will see in the moment, there are more than one uses of English with slightly different interpretative practices, and the same applies to first-order languages too.

In the following, therefore, we will classify different uses of English or first-order languages into three categories, and address the question separately with respect to individual categories of uses. Systems of the first category are called “full Fregean systems”, and we will find these systems do require quite strong properties for interpretation. Interestingly, systems of the other two categories have different behaviors.
What Makes a System Less Graphical?

4.1. Full Fregean Systems

In our terminology, a system is full Fregean if every structural property for interpretation in that system is specified in the form of a total function assigning lexical items or phrases to the set of argument places in some syntactic structure.

Fig. 5 shows a particular example of such specification. It is a typical phrase-structural analysis of the “LF” of an English sentence employed in generative grammar, where an LF is the structural property of a sentence that is subject to interpretation. Here, the relevant syntactic structure of the sentence is specified in the form of a tree, and all open nodes of the tree are assigned certain lexical items or phrases. It is generally assumed that an analysis of this type is adequate to extract the interpretable properties of every English sentence. Thus, if one uses English in this way, if one employs this way of specifying the structural property of English sentences for interpretation, then that particular use of English is a full Fregean system. Let us call this system “eng-ff”.

Now eng-ff is a canonical example of what we called “systems requiring stronger structural properties for interpretation”. As is clear from Fig. 5, LFs are a quite strong kind of structural properties of sentences. In fact, LFs are so strong properties that it is generally assumed that every sentence must have a unique LF, or equivalently, that no single sentence can have more than one LFs. Thus, eng-ff can be considered a system that requires extremely strong properties for interpretation.

In particular, such a system allows no free ride, no over-specificity, and no meaning derivation. As we have seen, the possibility of co-presence of multiple interpretable properties in a single representation is a common necessary condition for these phenomena, yet in the current system, no two interpretable structural properties (LFs) can be co-present in a single sentence. It follows that such a system prohibits all these phenomena.

Beside eng-ff, there are also full Fregan systems of first-order languages. It is rare,
in the case of a first-order language, to specify the interpretable structural property of a sentence in the explicit form of a tree plus an assignment for its open node. The standard way of specifying the semantic contents of first-order sentences is a recursive definition of their truth-conditions, where the truth-condition of a sentence is composed bottom-up from the semantic contents of its most basic constituents, according to the ways those constituents are syntactically structured. The definition of the semantic content of a sentence, therefore, presupposes that the relevant syntactic structure of the sentence is specified along with an assignment of lexical items to the most basic constituents in the structure.

So, the situation is basically the same as the phrase-structural specification of the LFs of English sentences. The interpretable structural property again takes the form of a total function assigning lexical items or phrases to the set of argument places in a particular syntactic structure. Thus, the use of an first-order language that actually employs this way of specifying interpretable properties, the use that embodies the standard recursive definition of the semantic contents of sentences, is a full Fregean system. Again, the structural properties thus specified are generally quite strong—so strong that it is generally assumed that every first-order sentence has a unique analysis of that kind, prohibiting the coexistence of more than one of such properties. Accordingly, such a system prohibits free ride, over-specificity, and meaning derivation, as was the case for ENG-FF.

In his early attempt to identify the semantic characteristics of systems such as English and first-order language, Sloman (1971) introduced the notion of “Fregean systems”. According to him, interpretable structural properties in those systems should be understood as successive applications of functions to constituents of various levels (pp. 216–217). In this connection, our account on full Fregean systems can be viewed as a development of his general idea, with the addition of an explanation why such systems lack the functional traits of free rides, over-specificity, and meaning derivation shared by certain other systems such as PD (“analogical systems” in his terms).

4.2. Partial Fregean Systems

There certainly are cases where one distinguishes, in a single English sentence, more than one interpretable structural properties for distinct pieces of information. Consider, for example, the following conjunctive sentence:

(23) Jon is to the left of Bob and Ken is to the right of Bob.

This sentence could be taken to express two different pieces of information, namely:

(24) Jon is to the left of Bob.

(25) Ken is to the right of Bob.

It would be then natural to suppose that (22) has two different structural properties corresponding to these pieces of information. They would be:
(26) Being a conjunctive sentence with a conjunct consisting of the subject phrase “Jon” and the predicate phrase “is to the left of Bob”.

(27) Being a conjunctive sentence with a conjunct consisting of the subject phrase “Ken” and the predicate phrase “is to the right of Bob”.

Thus, under certain circumstances, even English seems to allow a sentence to have more than one interpretable properties. A similar case can be made about first-order languages, citing conjunctive first-order sentences for example.

This use of English is certainly not full Fregean. The structural properties (26) and (27) are not full assignments of lexical items or phrases to the argument places in the specified syntactic structures. They are partial assignments, and as such they are compatible with each other—they can reside together in a single sentence. There is nothing wrong with an interpretative practice that employs partial assignments rather than total assignments. It is just a different practice than a full Fregean interpretative practice, and it has its own merits and demerits over the other. We call it a partial Fregean system.

Although structural properties such as (26) and (27) are not as strong as their full assignment counter-parts, they are still pretty strong properties, mentioning the global syntactic structures of sentences. In fact, it is not easy to find non-trivial cases of free rides, over-specificity, and meaning derivation, in a system that employs this sort of structural properties for interpretation. And of course, this is exactly what our proposed theory predicts. Partial Fregean uses of English and first-order languages are actual examples of systems that “require stronger structural properties for interpretation”, and their potentials for free rides, over-specificity, and meaning derivation are accordingly low.

4.3. Textual Fregean Systems

Another interesting example is the following. Consider the left-hand text in English in Fig. 6. Here, the sentence “Jon crossed the street.” spatially precedes the sentence “Jon kicked the door of the barber.”. In certain contexts, this means that the event reported in the first sentence temporally precedes the event reported in the second sentence. Thus, the entire text expresses not just (28) and (29), but also (30):
(28) Jon crossed the street.
(29) Jon kicked the door of the barber.
(30) Event (29) occurred before event (30).

Under this type of reading, free rides, over-specificity, and meaning derivation do occur. For an example of free ride, suppose that one adds the following information to the left-hand text in Fig. 6:

(31) Mary punched the signboard.
(32) Event (29) occurred before event (31).

One easy way of adding this pair of information is to place the sentence “Mary punched the signboard.” after the second sentence (see the right-hand text in Fig. 6). But this operation automatically places this sentence after the first sentence too. Thus, one ends up expressing the following consequential information too:

(33) Event (28) occurred before event (31).

For an example of over-specificity, just observe that this simple addition of the sentence would not work if one had to add the pair of information (31) and (33), instead of (31) and (32). It would require one to make an arbitrary choice as to which of the events (29) and (31) preceded which.

For an example of meaning derivation, observe that in the right text in Fig. 6, the count of sentences preceding the sentence “Mary punched the signboard” mean the (minimal) count of the events that happened before the event reported by this sentence, just as the count of names to the left of the name “Ken” in the PD diagram in Fig. 4 meant the (minimal) count of people to the left of Ken.

It should be clear that the use of English illustrated above is fairly distant from full or partial Fregean systems. Some of the structural properties it employs for interpretation are not properties of individual sentences, but properties of objects consisting of multiple sentences or, in short, texts. For example, the structural property responsible for the information (30) is the following:

(34) The sentence “Jon crossed the street.” spatially precedes the sentence “Jon kicked the door of the barber.”.

This property is concerned with the spatial relation between two sentences, and as such, it is a property of the entire left text in Fig. 6, rather than any individual sentences in that text. Thus, this interpretational practice takes entire texts as a representational unit, as well as individual sentences. So, even if it employs full Fregean strategies at the level of individual sentences, it cannot be a full Fregean system. In fact, in interpreting texts, it employs a fairly weak kind of structural properties: properties such as (34) only specifies configurations of local constituents (i.e., sentences) of texts, without dictating the overall structures of texts. As such they are comparable with structural properties (such as (11)–(13)) that PD employs for interpretation. Thus, it is natural that this
system allows free rides, over-specificity, and meaning derivation in its interpretative practice for texts. We might call this type of systems textual Fregean systems, as they combine full or partial Fregean interpretative practices on individual sentences with an interpretative practice on texts.

5. Conclusion

We have argued that as a representation system requires stronger structural properties for interpretation, the system has a lower potential for free rides, over-specificity, and derivative meaning. These phenomena commonly require coexistence of multiple interpretable properties in single representations, and the demand for strong properties in certain first-order or English representation systems intervene with this very possibility. This explains why such systems prohibit these phenomena altogether, and accordingly, lack certain types of inferential efficiency, expressive inflexibility, and expressive richness altogether. A system’s rejection of interpreting weak structural properties of representations—its restriction of interpretation into fairly specific structural properties of representations—makes the system less graphical in this sense. This, we propose, amounts to a solution of the negative trade-off problem.

Full Fregean uses of English or FOLs are canonical example of systems with such restrictive interpretative practices. Partial Fregean uses largely fit this description, although interpretation is less restrictive. When it comes to textual Fregean uses, however, non-restrictive interpretative elements can enter in, at the level of textual interpretations. They are graphical uses of spatial configurations formed by sentences, so to speak. Thus, our theory implies that seemingly subtle differences of language uses can make substantial differences in their functional traits. The theory demands significant sensitivity to differences in restrictiveness of interpretative practices under analysis, even when they are applied to apparently the same syntactic structures.

There are still room for additional support to this theory. Ideally, this theory should be combined with mathematical characterizations of the phenomena of free rides, over-specificity, and meaning derivation (e.g., Shimojima 1995, 1999) in order to show, more exactly, how interpretative demands for stronger structural properties intervene with these phenomena. Also wanting is more precise characterizations of partial Fregean systems and textual Fregean systems, or more generally, more detailed classifications of language uses with the focus on the types and strength of structural properties that they demand for interpretation. This would open a way to more systematic evaluations of the inferential efficiency, expressive flexibility, and expressive richness of the large class of language uses whose differences have been either ignored or under-appreciated.

A final note. The theory developed in this paper is designed as a solution to the negative trade-off problem only. It is supposed to explain why certain systems lack certain functional traits altogether, not how some systems gain them. So, just because...
we propose a demand on stronger properties for interpretation as an explanation for the common absence of these traits, it does not follow that a non-demand on stronger properties for interpretation explains their presence. The explanation for their presence requires separate treatments. In particular, our theory does not imply that those functional traits always come together or go together, excluding the possibility of systems with only some of those traits. In fact, combined with the treatment of the positive trade-off problem in Shimojima (2002), our theory predicts a large playroom for such “intermediate” systems. In this view, systems combining maximal inferential efficiency with expressive richness and flexibility are a genuine possibility (as well as systems lacking all of these).

References

1710

1971

1988

1990

1994

1995


1999

2002