Tough Adjectives, Intensional Contexts and Speakers' View

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1. INTRODUCTION

In this paper we present an analysis of the *tough adjective* from the view point of possible world semantics. As will be discussed later, this topic has a deep connection with the problem of *intensional contexts*, which has traditionally been a benchmark topic of linguistic semantics. The main difficulty lies in the fact that both unavoidably include in the center of their meaning the mental states of the people involved. The theoretical device we offer to analyze these phenomena is a mental-state-introducing procedure or, as we call them, *indexing procedure*, where indices represent in whose mental state each expressions are to be interpreted. This simple procedure, as we will explicate, goes quite a long way to solve not only recalcitrant aspects of tough adjectives but some of the well-known problems such as *Kripke Paradox* and *Hob-Nob problem* to cite a few.

The rest of the paper is structured as follows. In Section 2, based on Jacobson (1992) we provide a brief sketch on how a semantic description of tough adjectives is related to a full-scale analysis of tough constructions. The potential problem of Jacobson's account will also be pointed out. Section 3 presents a detailed analysis of intensional contexts, and the indexing procedure developed through the discussion will be applied to the analysis of the tough adjective at the end of this section. Section 4 concludes this paper.

2. BACKGROUND

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Tough constructions, such as in (1), have attracted much attention because of their baffling array of properties. One of the recalcitrant facts is the "link" between the subject NP *the rock* and "the gap" in the embedded constituent to *move*.

(1) The rock is hard for me to move.

In 2.1, we provide a rather sketchy introduction to the analysis in Jacobson (1992), where no syntactic relationship is assumed between them, and the explanatory burden is shifted to the lexical meaning of tough adjectives. But, as will be seen in 2.2, the very semantic apparatus is so sketchy that it cannot be regarded as a serious proposal. we discuss the essential part of the meaning of tough adjectives and its deep connection to intensional problems.

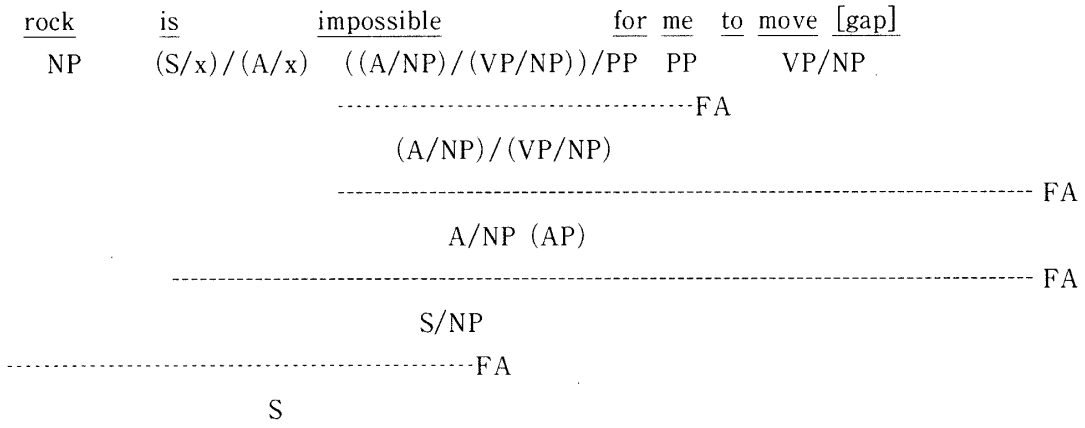
2. 1. Lexicalists' Hypothesis on Tough Constructions

As for the aforementioned "link" between the subject NP and the gap in tough constructions, Jacobson (1992) provides an analysis in a fashion parallel to *lexical entailment theory of control*, as discussed in e.g., Chierchia (1984), Dowty (1985) and others, where traditional "control" relations are recaptured merely as one of entailments associated with lexical items.

Based on the premises of Categorial Grammar, Jacobson (1992) assumes the following derivation:

(2) The rock is impossible for me to move.

(3)



FA: Functional Application

As foreshadowed in the categorial definition of *impossible*, the tough adjective is simply assumed to subcategorize for a VP that contains a gap of the same sort found in wh-constructions. For in this definition there is no syntactic apparatus that guarantees the syntactic relationship between the subject NP and the gap: *impossible* simply combines first with PP and then with VP in want of NP (VP/NP).[1]

If the above (or similar) analysis is on the right track, then the explanatory burden must be shifted to semantics, since some explanation must be given as to the understood object relation. In the present analysis, the lexical meaning of the tough adjective is assumed to bear the burden: the fact that the subject NP is understood as filling the gap position is explained purely by the lexical meaning of tough adjectives. For example, *impossible* receives the semantic description and meaning postulate roughly as follows:[2]

(4) a. *impossible*:

a three place relation holding among an individual x (semantic entity corresponding to subject NP), a two place relation R (embedded VP) and an individual y (PP)

b. Meaning Postulate (MP) for *impossible*:
if x, y and R stand in the impossible'-relation, then there is no possible world out of some suitably defined set in which y stands in the R relation to x.

Notice that without a semantic framework rigid enough to describe semantic properties of lexical items, such an analysis could not be maintained. Categorial Grammar, on which Jacobson bases the analysis, fulfills this requirement, since it presupposes finetuned model theoretic semantics that precisely goes it tandem with the syntax. In Categorial Grammar, the following relationship generally holds:

(5) $h(f_1(a_1 \ldots\ldots a_n)) = g_1(h(a_1) \ldots\ldots h(a_n))$,

where h is a meaning assignment function, f_1 is a syntactic operation, and g_1 is a semantic operation corresponding to f_1. This close relationship between syntax and semantics makes it possible to state precise semantic properties of a lexical item.
In (4b), the understood object relation that we intend to explain is guaranteed by the MP. Other tough adjectives such as *easy* and *hard* are also assumed to receive similar MP's.

But unfortunately this meaning postulate does not work as it is. Though this much attains the present purpose of interpreting the subject NP in the object position, still the vagueness found in the definition of the MP, as Jacobson admits, suggests the need for serious investigations into the semantic properties of the tough adjective, which is the main topic here.

2. 2. *Semantic Property of Tough Adjectives*

Tough adjectives such as *hard, easy* and *impossible* involve the speaker's view in the center of their meaning. For example, *impossible* is not a word for *strict* impossibility: what seems impossible for one person can be fairly easy for another. If it were a word for strict impossibility as in the above MP, the following sentence would always be a simple absurdity:

(6) John is a reliable man. He always makes the impossible possible.

What makes this sentence meaningful is the speaker's view point about the world. That is, the precise meaning of (6) is: John always makes possible what seems *impossible for the speaker* (possibly for the vast majority of people including the speaker).

(7) John: The rock is impossible for me to move.
Mary: No! It's possible!

Again, what is impossible *for John* seems possible *for Mary*. From these examples, it must be enormously clear that impossibility expressed by *impossible* is far from strict impossibility such as logical contradiction, rather it totally depends on the speaker's mental state. This

holds also for other tough adjectives such as *hard* and *easy*. This aspect of meaning is so essential for tough adjectives that any formalization without such considerations, like Jacobson's MP, must receive serious modifications.

The major difficulty in formalizing tough adjectives lies in the fact that it forces us to step into the realm of human minds. Surprisingly, this is not limited to tough adjectives, rather it is what any serious semantic theory must take into consideration.

For example, Donnellan (1966), in the discussion on the two uses of definite descriptions, points out that under certain circumstances they fail to refer. Suppose John is at the party and, pointing to a man, he says, "The man in a red jacket is a friend of mine". But unfortunately John is colorblind and the man is, in fact, in a green jacket. In this situation, the definite description *the man in a red jacket* fails to single out the intended person, simply because there is no such person. But in John's mind at least (more technically in John's belief world) such a man exists and he is a friend of John's. To provide a precise semantic description of this situation will require us to build into our semantic theory a place for mental states.

The importance of this will perhaps best be brought out by considering what has been called intensional contexts. In what follows, through examining problems of intensional contexts we develop a tool to build mental states into our semantics.

3. Intensional Contexts

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Intensional contexts, typical examples of which are complements of attitude report verbs such as *believe* and *know*, have long received a special attention and almost been benchmark phenomena for natural language semantic theories since their peculiarities pose problems for any existing semantic theory (especially serious problems for those based upon logical systems such as *Montague Semantics*). This is solely because, as in the case of the tough adjective, these phenomena force us to take human minds into consideration, which refuse any simple application of logical systems *per se*. The problems that have received serious attentions and many linguists and philosophers have been struggling for, are basically of the following kinds:

Failure of Substitutivity of Extensional Equivalents

(8) John believes that the Morning Star is the Morning Star.
The Morning Star is the Evening Star.
(Hence,) ----------
John believes that the Morning Star is the Evening Star.

Failure of Substitutivity of Intensional Equivalents

(9) a. John believes that Kupe landed in New Zealand.
b. John believes that Kupe landed in Aoteraora.

(10) a. John believes that 2 + 2 = 4.
b. John believes that square-root(144) = 12.

(11) a. John believes that p.
b. John believes that p & (q or -q).

These examples show that intensional contexts refuse not only extensional analyses of meaning, where the interpretation of terms are determined only with respect to the real world, but also intensional analyses such as *Montague Semantics*: the complement sentences in (9-11) are intensionally the same but still show sharp differences of meaning. Many attempts have been made to solve this problem, which apparently shows inapplicability of logical analyses to semantics. For example, Lewis-Cresswell analysis called *structured meaning*, which counts as meaning of an expression not only intensions but its syntactic structure, avoided such illegal substitutions as (11) but left (9) unsolved (see Bauerle and Cresswell (1987) and Lewis (1970)). But if a logical yystem flexible enough to incorporate human minds is devised, these problems on intensional matters solves quite naturally. This section provides such a system based on a first order modal system.[3]

The key feature of the analysis in 3.1 is to inject mental states of the people involved (henceforth, *agents' views*) into a logical system. For example, in (8-11) once we succeed in incorporating John's view into our semantics, it naturally follows that *New Zealand* and *Aotearoa* can refer to quite different objects, that *p* and *p* & (*q or -q*) are different propositions, and so on. Theoretically this *view* is captured by possible worlds: in each possible world compatible with one's beliefs and knowledge, the same propositions or terms receive quite different interpretations.

But such a solipsistic analysis, as even a short reflection reveals, runs into trouble when analyzing knowledge rr belief that many people have in common: states where more than one persons share information, which constitutes the other main topic to be discussed in 3.2.

Finally in 3.3, we sketch how our technique developed through the discussion in 3.1 and 3.2 is applied to the meaning of tough adjectives.

3. 1. *Indexing Procedure and Its Applications*

We introduce the reader to a mental-state-making procedure, the *indexing procedure*, which has been developed in the field of Epistemic Logic Programming of computer science (e.g., Jiang (1990), Akama & Ohnishi (1990)).

Before getting into the details of the indexing procedure, consider:

(12) John believes that *Susie* is a spy.

From what has traditionally been claimed, the italicized part *Susie* receives two different interpretations. One is what has been called *de re* reading and the other *de dicto*. On the former reading the reference of *Susie* is determined by the speaker and John does not necessarily know the name of the person in question. In John's mind, the name *Susie* might receive different interpretation or no interpretation (i.e., have no denotation) at all. John simply believes that someone he knows is a spy. and the speaker is describing it as *Susie*. On the latter, on

the other hand, *Susie* is John's description of the person in question. This example suggests that one and the same term can be interpreted differently depending on who is responsible for the description. For Londoners the term *London* denotes a big city in an island north to Europe, but for some people this term might be meaningless with no proper semantic value assigned. Such indeterminacy of the interpretation is not confined to terms. Predicates also receive quite different interpretations. The ordered pair ⟨me, Izumi⟩, for me, is in the denotation of *love*, but for others it is not, and so on. Each people has his own interpretation of terms and predicates. This is what the indexing procedure clarifies. The ooverall strategy of Jiang's (1990) indexing procedure can be summarized as follows:

(13) *Indexing Procedure*
  a. the varying domain across possible worlds accessible for an agent
  b. no assumption of rigid designators (two same terms need not have the same denotation across possible worlds.)
  c. multi-leveled intensionality
  d. predicates/ function terms are flexible depending on the agent involved

The above principles of his proposal make interpretations of terms and predicates totally dependent on *each* possible world, which is, intuitively, *agent's belief or knowledge world (i.e., his/her mental states.)*. By combining interpretations with worlds, his proposal enables us to incorporate an agent's view into the system of modal logic. In his system expressions in the scope of attitude report verbs (i.e., *beleave, know* and so on) are optionally assigned indices that determine which possible world they should be interpreted (i.e., who is responsible for the given expressions). Expressions with no indices are interpreted in the real world.[4]

Now we apply the indexing procedure to treat aforementioned problem of the failure of substitutivity of intensional equivalents. Consider the sentence (10) reproduced as (14) below:

(14) a. John believes that 2 + 2 = 4.
  b. John believes that square-root(144) = 12

Obviously John has different beliefs in (14a-b). But they have been formally indistinguishable: they share the same intension. Bauerle and Cresswell (1987) argues that meaning is not equal to intension but rather to intension and a syntactical make up (this is called *structured meaning*) following Lewis (1970). But still their analysis, as they admit, left unsolved such sentences as below, where two sentences differ only in their co-referring terms.

(15) a. John believes that Kupe landed in New Zealand.
  b. John believes that Kupe landed in Aoteraora.

New Zealand and *Aoteraora* are not distinguishable for they have the same intension "if we

consider an essential function of a name is denoting". Furthermore, in this case the two sentences share the syntactic structure. We can use here the indexing procedure quite effectively; the following is the indexed representation of (15a-b):

(16) a. **B**(John, landed-in(Kupe, New Zealand^j)
b. **B**(John, landed-in(Kupe, Aoteraora^j)

Note that here *New Zealand*^{j} and *Aoteraora*^{j} are clearly distinguished (they may be different in John's mind), hence generally they are not interchangeable.

As for (11) consider:

(17) a. John believes that Susie is a spy.
b. John believes that Susie is a spy and Tom is 7 years old or Tom is not.

Since (17a-b) are logically equivalent, previous approaches can not distinguish these two sentences. Quite contrary to our intuition, if *John believes Susie is a spy*, these approaches inevitably conclude *John also believes Susie is a spy and Tom is 7 rears old or Tom is not*, even if John actually does not know who Tom is. With our indexing procedure we can avoid such undesirable consequence: if John does not know Tom, any suitable individual is not assigned to *Tom*, hence the second sentence receives the truth value undefined.[5]

Precisely in the same way, several puzzles called *Kripke's Puzzle* in Kripke (1979) falls within this analysis. First of these is a story of Pierre; a Parisian Pierre had a belief that *Londres is not pretty*. Afterwards he moved to London and came to have another belief that *London is pretty*, not knowing what *Londres* denotes the same city as *London*. How can we describe this situation? The two beliefs about the same city is completely coherent in Pierre's mind (since in his mind, *Londres* and *London* refer to two distinct cities, his two beliefs do not contradict each other), and at the same time they are, of course, externally incoherent. If names are assumed to be *rigid designators*, this problem is insurmountable: since *London* and *Londres* denote the same entity, if Pierre has two externally incoherent beliefs, his beliefs should be incoherent also internally (in his mind). But once we give up the assumption, the paradox naturally resolves. The following set of sentences *a* represents external incoherence of Pierre's beliefs, and *b* internal coherence:[6]

(18) a. **B**(Pierre,¬Pretty(Londres))
B(Pierre, Pretty(London)
b. **B**(Pierre, ¬Pretty(Londres_p))
B(Pierre, Pretty(London_p))

His second puzzle, though a little more complicated, is similar to the first in essence; Peter, not knowing that a famous pianist *Paderewski* and Polish statesman *Paderewski* are one and the same person, came to have the following two beliefs:

(19) a. Peter believes that Paderewski had musical talent.
b. Peter believes that Paderewski had no musical talent.

This situation seems to arise when: on one occasion Peter, who is skeptical of the musical talent of politicians, learned the name *Paderewski* as a name of a famous pianist, and later on another occasion got to know Polish politician *Paderewski*. In such cases, he will naturally be led to have the above externally contradictory beliefs (though, of course, internally these two beliefs are coherent as above). The point that differs from the first puzzle and hence makes it more difficult, is only that two homonyms are receiving different interpretations. Hence if we distinguish two Paderewskis (e.g., *Paderewski** and *Paderewski***), this puzzle collapses into the first: in Peter's beliefs these two names have each own reference, *Paderewski*$^{*}_{p}$ and *Paderewski*$^{**}_{p}$', and in reality *Paderewski** and *Paderewski*** refer to the same person.

As above, examples beyond the reach of Montague semantics can be resolved by using the indexing procedure. There is a further advantage in this method: we can formalize intensional concepts in first-order logic without relying in first-order mechanism such as *intensional logic*.

3. 3. Hob-Nob Problem

As discussed in the previous section, the indexing procedure provides a powerful tool for analyzing intensional contexts. The striking point of this procedure is that we can bring people's specific view of the world into a logical system. But still there are a set of data that can not be treated so easily. We here deal with a well-known example of Geach (1962) that Jiang's indexing procedure can not cover, and extend it for wider applications.

Consider the following sentence:

(20) Hob believes that a witch has killed Cob's cow and Nob believes that she has blighted Bob's mare.

Now the situation is that we have to guarantee that the speaker does not believe that there exists a witch, and, at the same time, Hob and Nob have beliefs about the very same witch. As is clear from this, if we are to give this sentence a logical representation, we have to fulfill two contradictory requirements: one is that the existential quantifier has to take a wide scope so that it may bind both *a witch* and *she*, since both words refer to the same instance of witch. The other is that we have to keep the scope of the quantifier narrow, since the speaker does not believe in its existence in the actual world. Clearly Jiang's indexing procedure, as it is, does not provide a suitable basis for the analysis of this example.

(21) $\exists x_1$ [Hob believes that witch (x_1) has killed Cob's cow and Nob believes that x_1 has blighted Bob's mare.]

The would-be representation in (21) does not guarantee that Hob and Nob has their beliefs about the same individual since the first x_1 is in Hob's mind, and the second in Nob's (i.e., they may be quite different).

The next simple sentence reveals that the inability to treat this sentence stems from general problem of representing the shared view of agents.

(22) John and Mary know that Nancy is kind.

In the reading where John and Mary both have the same object in their minds Jiang's analysis simply fails, since if we decompose the sentence into two sentences as below, we have no way to guarantee that they share the same knowledge about the same person.

(23) John knows that Nancy_1 is kind.
and
Mary knows that Nancy_1 is kind.

The difficulty lies in the fact that while the indexing procedure provides solipsistic view of the world (i.e., interpretations of terms and predicates differ depending on agents involved), that is necessary to solve the problem here is to provide a common view (or shared view) of the world.

For this reason, we provide a special type of index ⟨*concatenated agents*⟩ to represent the shared view of the agents.[7] The representation for the above sentence will be, roughly, as follows:

(24) John and Mary know that $\text{Nancy}_{\langle j,m\rangle}$ is kind.

where the series of letters *j,m* within the angled bracket depicts the concatenated agents. Intuitively, *Nancy* with concatenated agents ⟨j,m⟩ denotes Nancy from the shared viewpoint of John and Mary: John and Mary share the knowledge about the same object denoted by *Nancy*.

Now it should be clear how we can treat the above Hob-Nob problem. Since the only remaining problem is how we can guarantee that Hob and Nob have beliefs about the same entity (i.e. the denotation of *witch*), the following representation satisfies our requirements:

(25) $\exists\, x_{\langle h,n\rangle}$ [Hob believes that witch ($x_{\langle h,n\rangle}$) has killed Cob's cow and Nob believes that $x_{\langle h,n\rangle}$ has blighted Bob's mare]

where the variable $x_{\langle h,n\rangle}$ ranges over objects in the shared view of Hob and Nob. We omit indices on the other expressions irrelevant to this topic. As is clear, this representation guarantees, as required, (1) Hob and Nob has the same witch in their beliefs since the variable $x_{\langle h,n\rangle}$ ranges only over the shared view of Hob and Nob (2) the speaker does not have to be responsible for the existence of the witch since the variable $x_{\langle h,n\rangle}$ is assigned its value not

in the real but in the shared belief world.

3. 4. *Tough Adjectives Revisited*

Now the application of the indexing procedure so far developed to the central aspect of the tough adjective is straightforward. Recall the MP for *impossible* in (5) (reproduced here as (26)):

(26) Meaning Postulate (MP) for *impossible*: if x, y and R stand in the impossible'-relation, then there is no possible world out of some suitably defined set in which y stands in the R relation to x.

The main difficulty in the definition was that though tough adjectives include the mental state of speakers, what is in the definition is strict impossibility that allows no intervention of the mental state between the expression and its denotation.

Our indexing procedure provides a breakthrough to this situation. The application is just as we saw in the cases of intensional contexts. The only difference is that indices are assigned not by the subject of attitude report verbs but, in default cases, by the speaker.[8] This is because the impossibility expressed by *impossible* is purely confined to the mental state of the speaker. Then the MP in (27) will be roughly as follows:

(27) if x, y and R stand in the impossible'-relation, then there is no possible world *accessible for the speaker* in which y stands in the R relation to x,

where *a possible world accessible for the speaker* corresponds, as in the cases of intensional contexts, to the speaker's mental state.

The meaning of other tough adjectives such as *hard* and *easy* seem to require much more complex treatment, but the essential point remains the same: since they, in the core of meaning, include speakers' judgments, semantic descriptions for them must be made in the mental states of the speakers.

4. CONCLUSION

In this paper we presented an analysis of tough adjectives and intensional contexts, both of which require us to treat human mental states.

As far as I know, there exists two main streams of natural language semantics. One is psychologically oriented and generically called *cognitive semantics*, and the other is logical and its tradition dates back to Montague (1974). The main advantage of the former is that it can easily incorporate personal grasp (view) of the world and that of the latter is formal preciseness. Then it must be reasonable to search for the third approach: the one which can express mental states and, at the same time, entertains logical preciseness. Our analysis was designed to proceed on this approach. While entertaining formal preciseness through modal logic, it also reflected personal grasp of the world through the indexing procedure. Though the

account we presented was so speculative and sketchy, we believe this is the first step in the right direction.

Notes

1. For arguments against raising and feature matching analyses, see Jacobson (1992) and the references cited there.
2. For the formal properties of meaning postulates, see Dowty (1979).
3. For expository purposes, in the following we keep the discussion as intuitive as possible. For the fully formal explication of our system based on the modal system K45 and "detuned" S5, see Akama and Ohnishi (1990) and Ohnishi and Akama (1992, 1993).
4. Technically, this indexing procedure is realized in the following Kripke-like model:

   $M = \langle W, D, p, F \rangle$

   where W is a non-empty set of possible worlds, D_i is a domain for each possible world, p_j the accessibility of an agent J, F the interpretation function. The mental state of J is formally captured as a possible world accessible from the real world with J's accessibility. For further details, see Jiang (1990).
5. Technically the truth value that such a sentence is assigned depend on the logic one adopts (i.e., false or undefined), but the essential point remains the same here.
6. For the solution in the framework, see Barwise and Perry (1983).
7. For the formal definition of concatenated agents, and semantic model for the indexing procedure including this special type of agent, see Ohnishi and Akama (1992, 1993).
8. In the case of interrogative sentences, an index should be assigned by the hearer, and when embedded in an attitude report verb, by the subject of the verb.

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