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The Representation of Word Meaning

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Abstract: This article shows that a substantial portion of the empirical evidence regarding the representation of word meaning can be explained by the definitional semantic theory of Jerrold J. Katz (henceforth ST). First, we look at the relative complexities of four types of negatives which, according to Fodor, Fodor, and Garrett (1975; henceforth FFG), show that definitions are not psychologically real. The ST definitional structures explain the FFG results in terms of the number of disjuncts generated by the negative elements in their ST representations. Next we look at the arguments of Gentner for componential structure from evidence from a recall experiment that considers connectedness relationships between the noun phrases of sentences with three types of verbs. Gentner's results can be explained in terms of the number of argument places in the ST representations, and the same explanation can be used with respect to evidence from studies by Fodor, Garrett, Walker, and Parkes (1980; henceforth FGWP) and Gergely and Bever (1986).

John Locke devotes a great deal of <u>An Essay Concerning Human Understanding</u> (1689) to his account of the mental representation of word meaning, and this account is essentially definitional or decompositional in character:

> The Mind being, as I have declared, furnished with a great number of simple *Ideas*, conveyed by the *Senses*, as they are found in exterior things, or by *Reflection* on its own Operations, takes notice also, that a certain number of these simple *Ideas* go constantly together; which being-presumed to belong to one thing, and Words being suited to common apprehensions, and made by use for quick dispatch, are called so united by one subject, by one name; . . . (II, xxiii, 1)
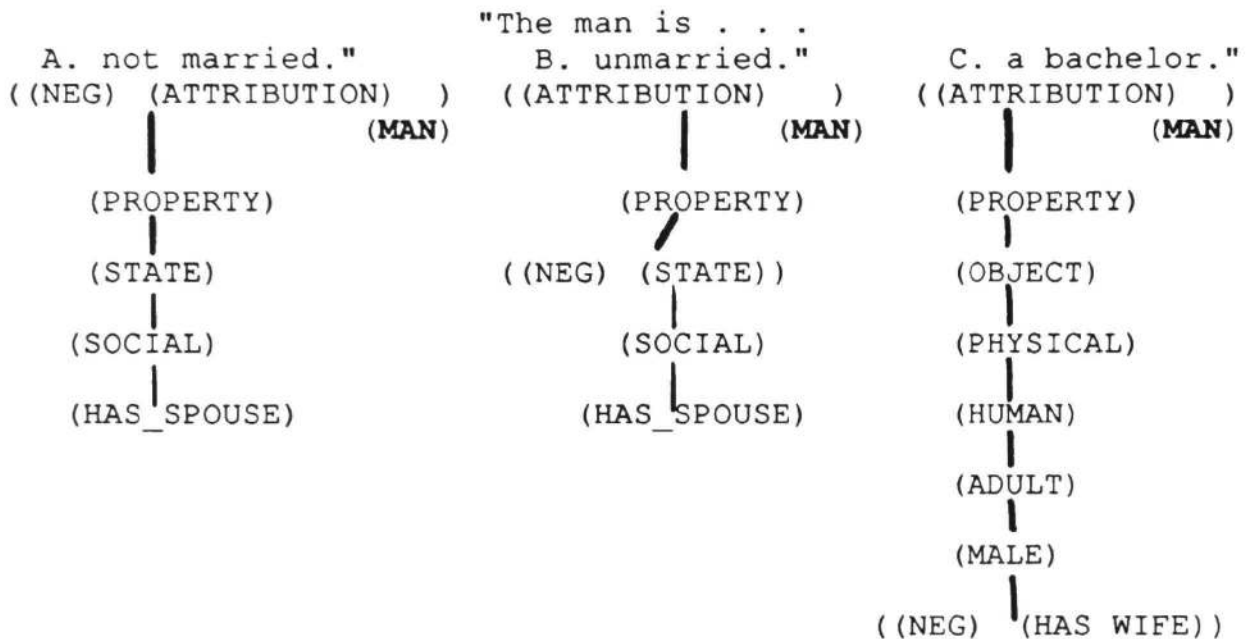
Contemporary versions of this definitional approach came into such substantial criticism (Fodor et al, 1975 and 1980) that for most of the 1980s many investigators in this area worked under the erroneous assumption that it had been completely discredited. However, three hundred years after the first publication of Locke's <u>Essay</u>, in a thorough critical review of all of the evidence and arguments, McNamara and Miller (1989) came to a pro-decompositional view, concluding that "there's little evidence against conceptual structure and there's some evidence for it." In this paper I will show that a substantial portion of the empirical evidence can be perspicuously explained by the definitional semantic theory of Katz (1972, 1976, 1989; henceforth ST).

Part 1: Fodor, Fodor, and Garrett and the Complexity of Negatives

One of the major components of the FFG argument against the psychological reality of definitional structures was the results of a psycholinguistic study involving four types of negatives: explicit negatives, e.g. "not married"; implicit negatives, e.g. "doubt," deny," fail"; morphological negatives, e.g. "unmarried"; and pure definitional negatives (PDNs) e.g. "bachelor." Subjects
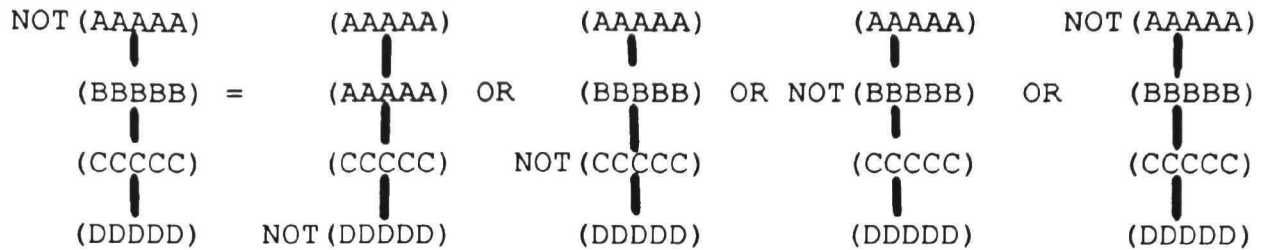
were presented with the sentence "If practically all of the men in the room are _____, then few of the men in the room have wives," with either "not married," "unmarried," or "bachelor" in the blank. The subjects were then asked to judge the correctness of the inference and response times were measured. FFG found that explicit negatives were the most difficult; morphological and implicit negatives were both less difficult; and PDNs were the least difficult. Based on this evidence FFG argued that "PDNs do not act as though they contain a negative element," and that "PDNs are not semantically analyzed," contrary to the definitional view.

However, in ST we might have the following representations:

"The man is . . .

A. not married."	B. unmarried."	C. a bachelor."
((NEG) (ATTRIBUTION))	((ATTRIBUTION))	((ATTRIBUTION))
(MAN)	**(MAN)**	**(MAN)**
(PROPERTY)	(PROPERTY)	(PROPERTY)
(STATE)	((NEG) (STATE))	(OBJECT)
(SOCIAL)	(SOCIAL)	(PHYSICAL)
(HAS_SPOUSE)	(HAS_SPOUSE)	(HUMAN)
		(ADULT)
		(MALE)
		((NEG) (HAS_WIFE))

Our reading for sentence A says that the attribution to the man of the property of being in a social state of having a spouse is negated, while our reading for B says that there is an attribution to the man of the property of not being in the social state of having a spouse, and finally our reading for C says that there is an attribution to the man of the property of being a physical, object, that is human, adult, male, and that does not have a wife.

The scopes of the negative elements in these structures explain the FFG results. In a hierarchical structure as in a semantic reading, a negation of a node in the structure results in a disjunction made by attaching the negative element to alternate nodes below the initial negative element. The following schema illustrates this format:

```
NOT(AAAAA)        (AAAAA)          (AAAAA)            (AAAAA)       NOT(AAAAA)
    |                |                |                  |              |
 (BBBBB)   =      (AAAAA)  OR      (BBBBB)  OR  NOT(BBBBB)   OR     (BBBBB)
    |                |                |                  |              |
 (CCCCC)          (CCCCC)        NOT(CCCCC)            (CCCCC)        (CCCCC)
    |                |                |                  |              |
 (DDDDD)       NOT(DDDDD)          (DDDDD)            (DDDDD)         (DDDDD)
```

The taller the structure and the higher up in it the negative element occurs, the more disjuncts or the more ORs you get. By simple calculation we see that the complexity relationships between explicit, morphological and definitional negatives that FFG found are exactly mirrored by considering the ST representations for sentences A, B, and C, taking into account the number of disjuncts generated by the negative elements in these structures. So a sentence like C, with the PDN "bachelor" gets no disjunction since the negative element is at the bottom of the semantic reading. Sentence B, with the morphological negative "unmarried" gets three disjuncts; and sentence A, with the explicit negative "not married" gets five disjuncts. Sentences with an explicit negative plus a morphological negative get fifteen disjuncts, and an explicit and a PDN get eight.

The following markers show that the relative complexities of the explicit, morphological, and implicit negatives also correspond to the FFG results.

```
     D. Not believe                      E. Doubt/Disbelieve

  ((NEG) (STATE)        )              ((STATE)          )
          |    [NP,S]                     |    [NP,S]
          |      X                        |      X
          |   <HUMAN>                     |   <HUMAN>
          |                               |
  (PSYCHOLOGICAL)                  (PSYCHOLOGICAL)
          |                               |
  ((ACCEPT AS TRUE)      )    ((NEG) (ACCEPT AS TRUE)      )
               [NP,VP,S]                        [NP,VP,S]
                  X                                 X
            <PROPOSITION>                     <PROPOSITION>
```
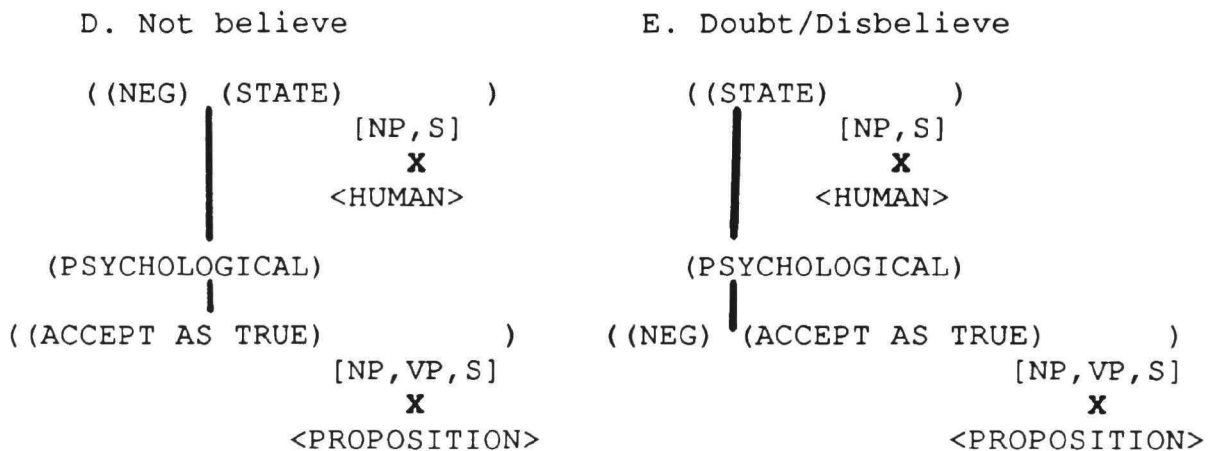
Part 2: Three Connectedness/Relatedness Studies

Unlike the FFG experiment on negatives which dealt with the relative semantic complexity of sentence meanings, Gentner's recall experiments dealt with the relative connectedness of noun phrases in SVO sentences. Specifically, Gentner's experiment compared connectedness relations in such sentences for three different types of verbs: general verbs like "gave," connecting-specific verbs like "sold," and non-connecting specific verbs
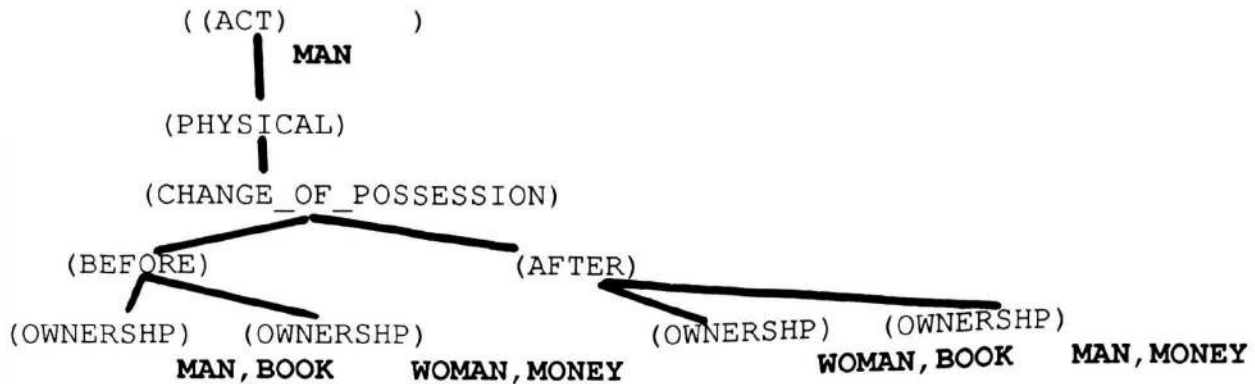
like "sent." When we compare the meanings of such verbs we see that a connecting specific verb like "sold," because it involves an exchange of merchandize and money between buyer and seller, provides for a greater degree of connectedness between noun phrases in its simple sentences than either the general or non-connecting specific verbs. While both "gave" and "sent" suggest a one-way transaction, "sent" is more specific or complex since it suggests a causative relation in the transaction, perhaps something like "cause to be given." One of Gentner's experiments involved reading simple sentences with these verbs to subjects and then asking them to recall the direct object, "woman" in the examples below, given the subject as a cue.

Basically, Gentner's approach was to distinguish between two hypotheses, both intended to test the definitional view. The first, the complexity hypothesis, is the one on which FFG had based their rejection of the psychological reality of definitions. The second Gentner called the connectivity hypothesis. Now, with respect to sentences like F, G, and H below the connectivity and complexity hypotheses make different predictions. The complexity hypothesis would predict that recall would be best for sentences with verbs like "gave" since the meanings of these verbs are the least complex and so leave more memory space available for recall. On the other hand, the connectivity hypothesis would predict that sentences with verbs like "sold" would bring about better recall since there is stronger connectedness between the referents of the noun phrases in such sentences.
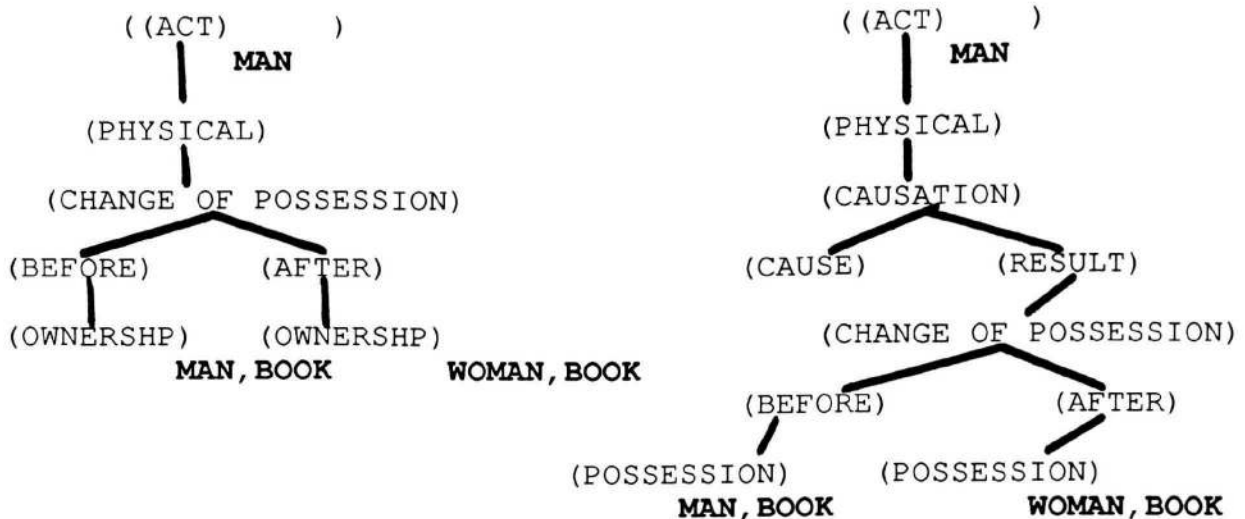
In fact, it is the connectivity hypothesis that wins out in the Gentner results, with sentences with verbs like "sold" providing for much better recall of the object noun phrases than either sentences with verbs like "gave" or sentences with verbs like "sent." The definitional structures of ST do in fact provide a fairly straightforward explanation of these results in terms of the number of argument places in the ST representation of the verbs' meanings. Very simply, the more argument places there are in a structure the more connected the referents of the noun phrases that fill these argument places. As the following structures for sentences with the three verbs show, with arguments appearing in boldface, the sentence for "sold" has more work for the projection routine than either the sentence with "sent" or the one with "gave," which are equal in this respect. If we consider just the number of insertions of the subject noun phrase into its argument places we see that "sold" requires three, while "gave" and "sent" each require just two. If we consider the total number of argument insertions required for the subject, used as the cue in the Gentner experiment, and the direct object, which had to be recalled, then we see that while there are five argument insertions for "sold," there are three each for "gave" and "sent." This corresponds to the Gentner

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results.

F. The man sold the woman a book.

```
            ((ACT)        )
                    MAN
                |
            (PHYSICAL)
                |
            (CHANGE_OF_POSSESSION)
          /                        \
    (BEFORE)                      (AFTER)
     /      \                    /        \
(OWNERSHP) (OWNERSHP)     (OWNERSHP)   (OWNERSHP)
   MAN,BOOK  WOMAN,MONEY    WOMAN,BOOK   MAN,MONEY
```

(G & H). The man _____ the woman a book.
G. gave   H. sent

```
        ((ACT)     )                      ((ACT)        )
              MAN                                MAN
           |                                  |
        (PHYSICAL)                         (PHYSICAL)
           |                                  |
        (CHANGE OF POSSESSION)             (CAUSATION)
        /            \                     /           \
   (BEFORE)        (AFTER)           (CAUSE)         (RESULT)
      |               |                                |
  (OWNERSHP)      (OWNERSHP)                    (CHANGE OF POSSESSION)
    MAN,BOOK        WOMAN,BOOK                   /                  \
                                          (BEFORE)               (AFTER)
                                             |                      |
                                        (POSSESSION)           (POSSESSION)
                                          MAN,BOOK              WOMAN,BOOK
```

Turning now to the FGWP evidence, we find that it concerns the relative degree of relatedness between noun phrases in simple sentences. Basically, FGWP claim that while on the basis of a supposedly definitional representation of causative verbs we would expect their subject and object NPs to be less related than the subject and object NPs of non-causative transitive verbs, in fact the experimental evidence shows that this is not the case. Now while FGWP choose to use the term "related" and Gentner, perhaps leaning towards the connectionist or parallel distributed processing approach, chooses to use the term "connected," and while FGWP employ a different methodology, direcly asking subjects to make relatedness ratings, the conclusions about greater or lesser relatedness or greater or lesser connectedness seem to be about the same thing. Very briefly, then, I would like
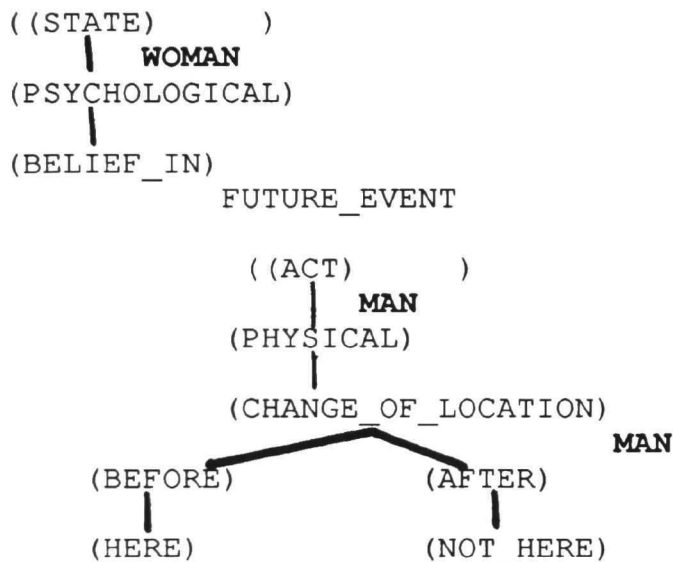
to show how the previous explanation of the Gentner evidence can also be applied to some of the FGWP results. Consider the following two sentences:
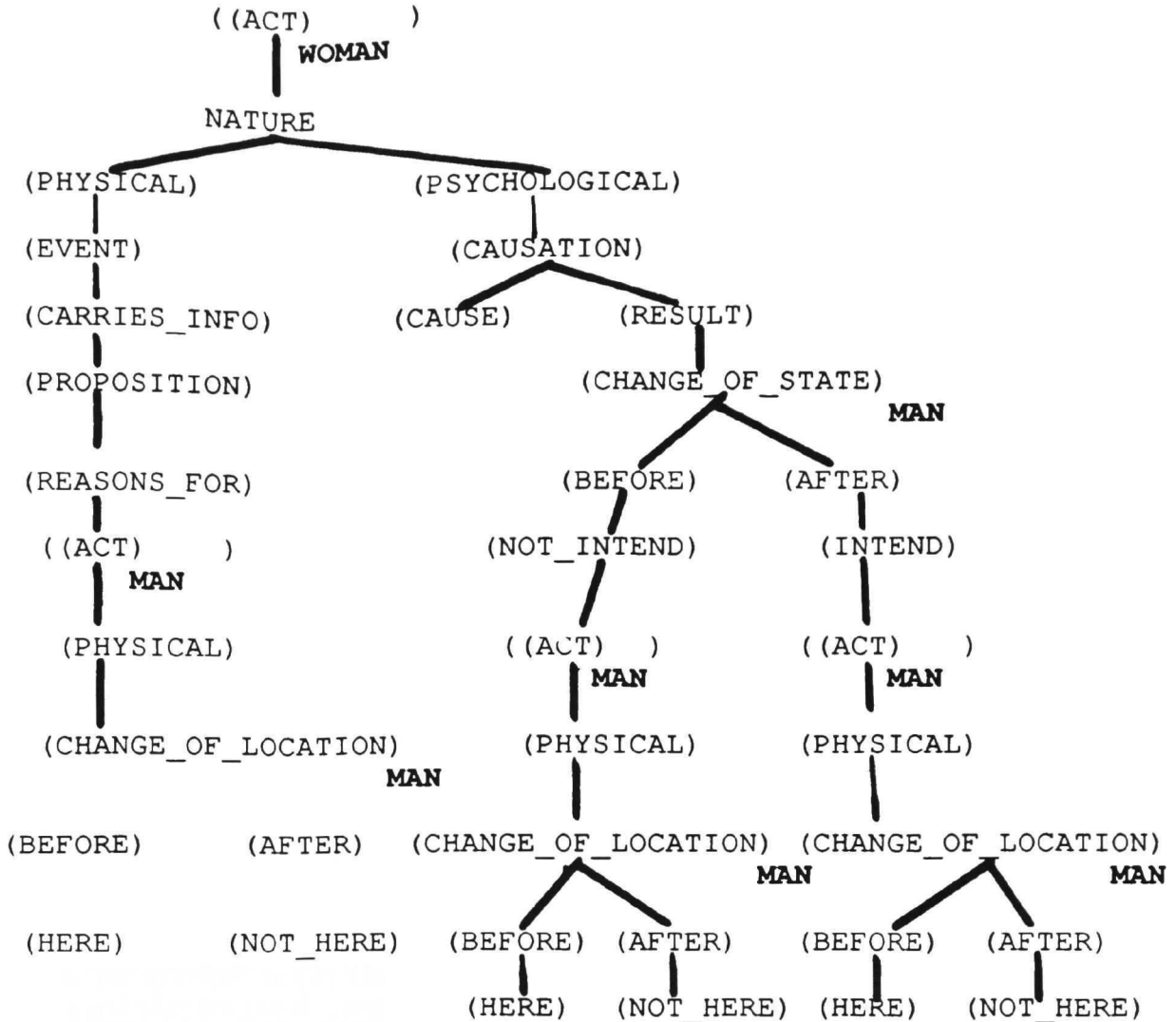
    I. The woman expected the man to leave.

    J. The woman persuaded the man to leave.

Gergely and Bever (1987) and FGWP both found that "the woman" and "the man" in (J) are judged to be more closely related than the same NPs in (I). FGWP offer a syntactic explanation for this which Gergely and Bever have shown not to work for other cases. In fact, Gergely and Bever suggest a semantic explanation: namely, that verbs like "persuade" whose meanings include a change in intention by the referent of the object NP brought about by the referent of the subject NP cause stronger relatedness judgements for these NPs than do other verbs which do not have this semantic structure. The Gergely and Bever study is very persuasive on this score. Nevertheless, consider the following representations of the meanings of these two sentences:

    I. The woman expected the man to leave.

```
((STATE)        )
      |    WOMAN
(PSYCHOLOGICAL)
      |
(BELIEF_IN)
           FUTURE_EVENT

             ((ACT)       )
                  |    MAN
             (PHYSICAL)
                  |
             (CHANGE_OF_LOCATION)
                  /        \        MAN
        (BEFORE)          (AFTER)
           |                 |
        (HERE)          (NOT_HERE)
```

J. The woman persuaded the man to leave.

```
                    ((ACT)        )
                    |  WOMAN
                 NATURE
        (PHYSICAL)              (PSYCHOLOGICAL)
         (EVENT)                  (CAUSATION)
     (CARRIES_INFO)        (CAUSE)        (RESULT)
    (PROPOSITION)                    (CHANGE_OF_STATE)
                                                    MAN
   (REASONS_FOR)              (BEFORE)        (AFTER)
     ((ACT)    )            (NOT_INTEND)      (INTEND)
        MAN
    (PHYSICAL)              ((ACT)    )      ((ACT)    )
                                MAN              MAN
  (CHANGE_OF_LOCATION)      (PHYSICAL)       (PHYSICAL)
              MAN
                        (CHANGE_OF_LOCATION) (CHANGE_OF_LOCATION)
                                       MAN                    MAN
 (BEFORE)   (AFTER)   (BEFORE) (AFTER)  (BEFORE)  (AFTER)

 (HERE)   (NOT_HERE)  (HERE) (NOT_HERE) (HERE)  (NOT_HERE)
```

It is clear that the structure for "persuade" involves many more argument insertions than does the structure for "expect": eight for the former and only three for the latter. This, in my view, is what accounts for the difference in relatedness in the NPs in these sentences.

Moreover, this explanation would work for all verbs that involved a change of intention on the part of the referent of the object NP since all such verbs must have a branch in their semantic representations similar to the CHANGE-OF-STATE branch in the above reading for the "persuade" sentence, and this is the branch that has in it the proliferation of argument insertions below the highest BEFORE and AFTER nodes.

Conclusion: The explanations presented here for both the negative

sentences and the NP relatedness experiments are quite natural. But what seems compelling to me is that both of these explanations depend crucially on the definitional character of the representations. Moreover, the psychological data that these explanations handle so well arise both from opponents and exponents of the definitional approach. For all these reasons psycholinguists and specialists in cognitive science interested in the mental representation of word meaning should give more credence to the definitional view.

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