Against definitions*

J. A. FODOR
M. F. GARRETT
E. C. T. WALKER
C. H. PARKES

Psychology Department
Massachusetts Institute of Technology

Epigraph

There existed an adult male person who had lived a relatively short time, belonging or pertaining to St. Johns (a college of Cambridge University), who desired to commit sodomy with the large web-footed swimming birds of the genus Cygnus or subfamily Cygninae of the family Anatidae, characterized by a long and gracefully curved neck and a majestic motion when swimming.

So he moved into the presence of the person employed to carry burdens, who declared. "Hold or possess as something at your disposal my female child! The large web-footed swimming birds of the genus Cygnus or subfamily Cygninae of the family Anatidae, characterized by a long and gracefully curved neck and a majestic motion when swimming, are set apart, specially retained for the Head, Fellows and Tutors of the College."

from 'Two Semantic Limericks'
by Gavin Ewart

Abstract

Definitional accounts of language structure are explored in this paper. Several classes of arguments for definitions are reviewed; those which connect to: classical theories of reference, theories of informal validity, theories of sentence comprehension, and theories of concept learning. We suggest that, for each of these areas, accounts which rely upon definition are, in fact, not to be preferred on evidential grounds to plausible non-definitional alternatives. We also present a series of experimental observations bearing on one of these areas — that of sentence comprehension. We show that one widely cited class of examples of definitional structures — that of "causative verbs" —

*Reprint requests should be sent to Dr. Merrill Garrett, Psychology Department, M.I.T., Cambridge, Mass. 02139, U.S.A.
fails to affect subject judgments of those relations among the words of causative sentences which depend upon the putative definitional structures. Such subject judgments are independently demonstrated to be sensitive to structural relations of comparable type for other linguistically non-problematic types.

The idea that there are definitions — that the morphemes of a natural language typically have internal structure at the 'semantic level' — has fascinated philosophers and psychologists at least since Plato. Epistemologists, to be sure, have recently shown signs of disaffection (see footnote 1, page 265). But in the 'cognitive sciences' the notion of definition remains one of those ideas that hardly anybody ever considers giving up. Perhaps for that very reason, there have been relatively few attempts to provide direct empirical evidence for the psychological reality of definitions. Still rarer are discussions of theoretical alternatives to definitional treatments of language and mind.

We think that a general reconsideration is long overdue; not only because the empirical basis of the definition construct is exiguous, but also because the whole theoretical superstructure in which it plays a central role has commenced to wobble. This paper has three parts and an Appendix. In Part I, we discuss, in some detail, the way that the notion of definition has served to connect several aspects of classical theories of language with one another and with widely credited accounts of concept acquisition. We will call this complex of views 'The Standard Picture (TSP)'. We are particularly interested in two issues: to what extent is TSP plausible independent of questions about the empirical status of the definition construct; and in what ways would TSP have to be revised if the definition construct were to be abandoned. Part II presents informally an experimental investigation directed toward determining whether claims for the psychological reality of definitions can be sustained. This is not, of course, a 'crucial experiment'; probably nothing could be. But we believe we can make a case that some important predictions which flow naturally from the view that definition is a basic notion in the theory of language are strikingly disconfirmed. The methods, materials, and statistical treatment of the results of the experiments are reserved for the Appendix, q.v. Finally, Part III returns briefly to The Standard Picture. We try to suggest in outline what cognitive psychology might look like in the post-definitional era.

Part I: The Standard Picture

Why do so many people think that there are definitions? Not, according to us, because there's much direct evidence that there are. Still less because
there are many persuasive examples of the kind. Rather, there are several other theories that people hold about language and mind, and these other doctrines either rest upon, or anyhow closely comport with, the definitional account. There are, in fact, five such theories in which the notion of definition plays a significant — if not ineliminable — role. We will consider four of them.¹

I.a. Language and the world: the definition of a word determines its extension

According to TSP, the definition of a word makes explicit what is true of a thing if and only if the word applies to it. Consider the word “bachelor”. It’s often said that the definition of “bachelor” is “unmarried man”. Suppose that this is true. Then the intended consequence is that:

1. Every bachelor is a man.
2. Every bachelor is unmarried.
3. Whatever is both unmarried and a man is a bachelor.

Or, to put the same point slightly differently, the idea is that the set of bachelors and the set of unmarried men are coextensive in virtue of the definition of “bachelor”. In some sense or other, the fact that the definition of “bachelor” is “unmarried man” is supposed to explain the coextensivity of these sets.

It’s important to see just how the explanation is supposed to go. Assume that the extension of the phrase “unmarried man” is determined somehow. Then, it’s a consequence of the intended interpretation of the notion definition that if “unmarried man” is the definition of “bachelor”, then “bachelor” has the same extension as “unmarried man”, whatever that extension may be. That is: the definition of “bachelor” as “unmarried man” fixes the extension of “bachelor” relative to the extension of “unmarried man”.²

¹The fifth is the epistemological doctrine according to which definitions guarantee the necessity (or unrevisability, etc.) of certain general truths, e.g., that bachelors are unmarried or that F = MA. We put this view aside because (a) it leads further into the philosophy of science than we propose to go, and (b) it is pretty thoroughly discredited as the result of work by such philosophers as Duhem, Putnam, and especially, Quine. For an airing of these issues, see Katz (1975) and Putnam (1975).

²This situation is not materially altered if, for example, we think of definitions in the way that many linguists do: viz., as couched in a universal metalanguage. On such a view, a definition fixes the extension of an object language expression relative to an interpretation of the metalanguage. This is a nicety which we will henceforth ignore (but see J. A. Fodor (1975) and J. D. Fodor (1977) for extensive discussion).
If the definition of “bachelor” fixes its extension relative to the extension of “unmarried man”, what fixes the extension of “unmarried man”? Patently, there are two possibilities: (a) the extension of “unmarried man” is determined by the definition of its constituents, or (b) it is determined in some other way. It is also patent that we’ll have to get to option (b) eventually, since exploiting option (a) raises the question: what fixes the extensions of the expressions in terms of which “unmarried” and “man” are defined? Definitions have to stop somewhere.

These considerations suggest the following view (which is itself part and parcel of TSP). The lexicon3 of a natural language can be partitioned into (1) definable terms, and (2) a primitive basis. Definitions relate the definable terms to expressions in the vocabulary of the primitive basis.4 They thereby fix the extensions of definable expressions relative to an interpretation of the primitive basis. Definition is thus viewed as an asymmetric relation in that there is a preferred direction of analysis for expressions in a language: analysis runs from definable expressions into the primitive vocabulary. Definitions typically apply in chains, and the further along a chain we go, the closer we get to expressions couched in the vocabulary of the primitive basis. The primitive basis is where definitions stop.

It should be emphasized that this view would be vacuously satisfied if all (or practically all) of the morphemically simple expressions in a natural language belonged to the primitive basis of that language. This is, of course, not what TSP intends. For TSP, the primitive basis of a natural language is notably smaller than the lexicon. Moreover, TSP has it in mind that definitions should exhibit the systematic articulation of the lexicon into semantic subsystems. In virtue of shared features of their definitions, morphemes should fall together into such families as action words, person words, color words, causatives, etc. (See, for example, Clark and Clark (1977)).

Definitions fix the extensions of definable expressions relative to an interpretation of the primitive basis. What fixes the interpretation of the primitive basis? TSP provides no unequivocal answer to this question, but one version of the doctrine deserves special notice as historically venerable and currently influential. According to this (Empiricist) reading of TSP, items in the primitive vocabulary express sensory/motor properties. The

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3 Strictly, the morphemic inventory. We won’t distinguish between morphemes and lexical items; the former are always intended.

4 Another pedantic footnote: Definitions relate definable terms to expressions in a vocabulary consisting of items in the primitive basis together with logico-syntactic vocabulary. So, for example, “bachelor” means “man and not married”, where “and” and “not” belong to the logico-syntactic apparatus. We’ll distinguish between primitive terms and logico-syntactic terms only where the distinction makes a difference.
extensions of these items are thus fixed by a causal account of the sensory/motor transducers. So, for example, the extension of "red" is that set of objects which do (or, more plausibly, would) appropriately activate the red-transducers; the extension of "angular" is that set of objects which do or would trigger appropriate motor-tracking responses; and so forth. According to this view, then, all non-primitive expressions are definable in a sensory/motor vocabulary whose items are, in turn, related to their extensions by a specifiable causal hook-up. Taken together, the definitions and the causal account of the transducers fix the interpretation of the entire lexicon. We believe that, insofar as the problem of interpreting the primitive basis has been faced at all by contemporary adherents of TSP (especially in AI and psychology) it has usually been something like the Empiricist version of the doctrine that they have had in mind. (Showing this would require more textual exegesis than we have space for here, but see J. A. Fodor, op. cit.).

Suffice it for present purposes that any theory which appeals to definitions to answer the question 'what relates words to the world?' must cope with the problem of interpreting the primitive basis somehow. One hasn't got a theory of language and the world unless that problem has been adequately addressed: all one has is a theory of a relation between uninterpreted linguistic forms. (Note that such formulae as "the definition of 'bachelor' is 'unmarried man'" assert relations between forms of words, not between forms of words and their extensions.) We stress this point in aid of dispelling an illusion. It's easy to suppose that, if one gives up the notion of definition — if, for example, one assumes that the entire lexicon is primitive — one thereby loses an account of the relation between language and the world; an account which exploitation of the definition relation would otherwise secure. On the contrary: for purposes of specifying the relation between a word and its extension, there is no principled difference between a theory which says that "unmarried" and "man" are primitive while "bachelor" is defined, and a theory which says that they're all primitive. It's just that the former sort of theory delays the question of interpretation till it gets to the primitive basis, while the latter sort faces the question straight off.

One further point under this general head. If the Empiricist version of TSP were plausible, that would be a strong argument for the strategy of using definitions to delay the question of interpretation. For, as we've seen, the Empiricist does have a (schematic) account of how a sensory/motor basis is to be interpreted; viz., by reference to the causal structure of the sensory/motor transducers. So, if he can use definitions to provide sensory/motor equivalents for each of the non-primitive items in a language, he really will have a theory of how the expressions in the lexicon of that language are related to their extensions.
It's thus important to emphasize that the Empiricist version of TSP is not plausible. If there are few convincing examples of definitions, there are literally no convincing examples of definitions which take prima facie non-sensory/motor terms into a sensory/motor vocabulary. There is, indeed, no reason to believe even that the definitions we have examples of generally exhibit an epistemically interesting direction of analysis. On the contrary, the 'right hand' (definiens) side of standard examples of definitions does not tend, by and large, to be more sensory/motor than the 'left hand' (definendum) side. So, for example, the conventional wisdom has it that "grandmother" means "mother of father or mother"; "ketch" means "two masted sailing vessel such that the aft (or 'mizzen') mast is stepped forward of the helm"; "bachelor" means "unmarried man", "kill" means "cause to die", etc. It's hard to discern a tendency toward the sensory/motor in these examples, and these examples are quite typical. Surely, no one could seriously argue that words like "mother, father, mast, vessel, cause, die, married and man", all of which occur in the definiens, are somehow closer to transducer language, than say, "grandmother", "ketch", "kill" or "bachelor" are.\(^5\)

To summarize: definitions provide a useful part of a theory of language and the world only if they empty into a primitive basis which is independently interpreted. That is, definitions figure seriously in theories of language and the world only if: (a) all the expressions of a language are equivalent to expressions in the vocabulary of its primitive basis; (b) the primitive basis is notably smaller than the lexicon; and (c) the extensions of expressions in the primitive basis can be fixed without further appeal to the notion of definition. The only primitive basis which has so far been seriously alleged to satisfy (a)–(c) is sensory/motor, and it is morally certain that that allegation cannot be sustained. It may well be that definition plays no serious role in theories of language and the world, TSP to the contrary notwithstanding.

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\(^5\)We are not denying that natural languages like English contain a vocabulary of sensory/motor terms, where sensory/motor terms are those whose extensions can be specified solely by reference to the causal structure of transducer mechanisms. Perhaps, for example, "red" is in this sense a sensory/motor term (though recent work on color perception makes this seem unlikely). Our claim, in any event, is that even if there are sensory motor terms, the lexicon is not reducible to expressions containing only such terms and logico-syntactic vocabulary.
I.b. Intersentential relations: definitions underwrite the validity of informally valid arguments

There are lots of ways of thinking about logic; here's one. People have pre-theoretic intuitions about the validity of arguments. These are intuitions to the effect that the conclusion of an argument does (or doesn’t) 'follow from' its premises; that the truth of the premises does (or doesn’t) guarantee the truth of the conclusions, etc. Logic provides a 'rational reconstruction' of these intuitions by systematizing, correcting, extrapolating and extending them.

Or, at least, it does so insofar as validity intuitions turn upon the logical form of the sentences which constitute the premises and conclusions of an argument. Logical form is that representation of a sentence which remains invariant under substitution for items in its non-logical vocabulary; and the non-logical vocabulary is specified by enumeration. Roughly, it's anything except such expressions as "all, some, not, or, equals, if then", and "and". In effect, according to this view, logic provides an account of the validity of an argument insofar as validity is mediated by the behavior of expressions in the logical vocabulary. One might go further and say something like this: logic provides an account of the validity of an argument insofar as its validity turns upon the meanings of items in its logical vocabulary. On this view, one has said what there is to say about the meaning of a word like "and" when one has said (for example) that (P is true and Q is true) = (P and Q is true) is valid.

If one does think about logic this way, one might well be led to ask: what's so special about the logical vocabulary? Suppose that argument 4 is valid in virtue of the meaning of "and" (and "therefore"). Isn't it equally plausible that argument 5 is valid in virtue of the meaning of "bachelor"? If the goal of logic is to reconstruct pre-theoretic intuitions of validity, isn't the second case as apt for treatment as the first?

4 John left and Mary wept, therefore Mary wept.

5 John is a bachelor, therefore John is unmarried.

In short, it's possible to view standard logic as providing a reconstruction of validity for only a rather arbitrary selection of the intuitively valid arguments. It then becomes natural to seek a more extended treatment; one which provides an account of the informally valid arguments. Informally valid arguments are those whose validity turns, at least in part, upon the meaning of items in the non-logical vocabulary.
The appeal to definitions comes in here. Suppose we assume that there is a 'semantic level' of linguistic representation and that at that level definable expressions are represented by their definitions. So, for example, the semantic-level representation of sentence 6 is something like formula 7.

6 John is a bachelor.
7 John is a man and John is unmarried.

Assume further that principles of valid inference (including, for example, simplification of conjunction, the rule which allows us to infer $P$ from $P \land Q$) apply to the semantic representations of sentences rather than to their surface forms. On these assumptions, we need postulate no principled difference between arguments 4 and 5; in the extended sense of 'formally valid' where validity is a relation over semantic-level representations, both these arguments instantiate the formally valid scheme $P \land Q \rightarrow P$. Or, to put the same point slightly differently, given the present assumptions about semantic representations, we need not alter the standard logical apparatus in order to exhibit the validity of arguments which turn on the meaning of "bachelor"; for, on these assumptions, the word "bachelor" doesn't even occur at the level of representation for which validity is formally defined. All that occurs there is the (conjunctive) definition of that word. Similarly, mutatis mutandis, for other definable expressions.

The idea that systematic exploitation of the notion of definition might provide for an account of intuitions of informal validity enters the modern linguistic literature with Katz and Fodor (1963) and has been widely influential in 'linguistic semantics' (for a review, see J. D. Fodor, op. cit.). It connects in obvious ways with the definitional theory of language and the world sketched in I.a. For example, if the argument from "bachelor" to "unmarried" is valid in virtue of the meaning of "bachelor", it's hardly surprising that the extension of the former is included in the extension of the latter.

There are, nevertheless, several reasons for viewing the definitional account of informal validity with considerable suspicion. We will consider three. First, it's by no means certain that all informally valid arguments will be revealed as formally valid (as subsumed by the inferential apparatus of standard logic) even if couched at the (putative) level of semantic representation. In this respect, the "bachelor $\rightarrow$ unmarried" case may be quite misleading. Consider, for example, a kind of case which we will presently

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6 There's every reason to believe that, if there are such things as semantic representations, they must be syntactically analyzed formulae; perhaps they are something like tree structures, as practically all linguists have assumed. For present purposes we can ignore this, but it will be important further on.
return to at length: the informal validity of arguments like 8. According
8 John killed Mary \(\rightarrow\) Mary died.

to the conventional wisdom, the definition of “kill” is “cause to die”, so that
“John killed Mary” comes out as “John caused Mary to die” at the level of
semantic representation. There is, however, no rule of standard logic which
underwrites the validity of arguments like 9; this latter inference appears

9 John caused Mary to die \(\rightarrow\) Mary died

to turn essentially on the meaning of “cause”,\(^7\) which is not itself a logical
word. Of course, it’s conceivable that we could make 9 formally valid by
replacing “cause” by its definition. But, as things now stand, nobody knows
whether “cause” has a definition;\(^8\) or, if it does, how it ought to be defined.
And there is certainly no reason at all to believe that such a definition, if
somebody could find it, would render arguments like 9 formally valid.

In short, the idea that informally valid arguments will prove to be for-
formally valid when couched at the semantic level is equivalent to the idea that
only their logical form is relevant to determining the validity of semantic-
level arguments; and, as things now stand, there is simply no reason to
believe that this is true. If it is not, then a reconstruction of informal validity
may require an enrichment of the inferential apparatus of standard logic
(e.g., the incorporation of rules which govern the behavior of formulae
containing words like “cause”) even if it also assumes the existence of
definitions.\(^9\)

The second consideration which militates against definitional accounts of
informal validity is that there appear to be at least some informally valid
arguments which cannot be reconstructed by appeal to the definition rela-
tion.\(^10\) The point turns upon the symmetry of the inferences which defini-
tions license. Suppose that “bachelor \(\rightarrow\) unmarried” is valid in virtue of the

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\(^7\)Compare the invalid argument “John wanted Mary to die \(\rightarrow\) Mary died”

\(^8\)If you just caught yourself thinking: ‘but, surely, every word has a definition’, that shows that you
are in the grip of TSP. Words in the primitive basis are not definable, by assumption. Perhaps “cause”
is one of these.

\(^9\)There is, of course, nothing incoherent about the proposal that a theory of informal validity
requires both the existence of a semantic level and the extension of the logic. It’s our impression, in
fact, that most linguists who opt for definitions opt for an extended logic as well (barring, perhaps,
Prof. Katz). We’ll see, however, that there’s a prima facie parsimony argument against such “mixed”
thories since it’s adequately clear that any argument whose validity can be expressed by an extended
logic plus definitions can equally be expressed by an appropriately extended logic without definitions.

\(^10\)For discussion, see J. D. Fodor (op. cit.) and also Geach (1957) where this point is made the basis
of an argument against ‘abstractionist’ accounts of concept acquisition.
definition of "bachelor". Then we can be sure that there will be some predicate \( P \) (in fact, the predicate "man") such that "unmarried \& P \rightarrow bachelor" is also valid.\(^{11}\) Quite generally, if an informally valid argument turns on a definition, then there will be some clause that we can conjoin to the consequent which will make the corresponding bi-conditional true. Any informally valid argument which does not meet this condition can't be a definitional argument.

The problem is that there appear to be informally valid arguments which don't meet this condition. The standard examples are formulae like "if \( x \) is red then \( x \) is colored". A moment's reflection should serve to make clear that there is no predicate \( P \) such that "\( x \) is \( P \) and colored \( \rightarrow \) \( x \) is red" is valid; hence that the validity of the first formula can't follow from the definition of 'red'.\(^{12}\)

The moral here parallels the one we drew from the validity of arguments like 9. Even given the apparatus of definitional analysis, it looks as though some informally valid arguments can't be captured within the inferential apparatus of standard logic. Rather, to get "red \rightarrow colored" we will need a special rule of inference that does for "red" what the standard logical rules do for the operators, connectives and quantifiers. "Red" shows what "cause" suggests: assuming a semantic level won't, all by itself, buy you a theory of informal validity.

This brings us to our third point, which is that there is a serious alternative to appealing to definitions as part of an account of informal validity. TSP proposes a theoretical apparatus that looks like Fig. 1: definitions apply to syntactically analyzed natural language formulae to provide domains for the inferential apparatus of standard logic. The alternative account looks like Fig. 2: syntactically analyzed representations provide domains for an enriched inferential apparatus; one which contains rules which govern the behavior (not just of the logical vocabulary but also) of such non-logical words as "bachelor", "cause", "red" and the rest. In point of terminology, such non-standard rules of inference are traditionally called "meaning

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\(^{11}\) If the definition of "bachelor" were just "unmarried", then the condition is satisfied vacuously; i.e. "bachelor \rightarrow unmarried" and "unmarried \rightarrow bachelor" would both be valid. It is not, by the way, required that \( P \) be an atomic predicate in "unmarried \& P \rightarrow bachelor".

\(^{12}\) Of course "\( x \) is red and colored \( \rightarrow \) \( x \) is red" is valid, but it's presumably not a candidate, since definable expressions (including, by assumption, "red") are not available at the semantic level. Alternatively, we could take "colored" to be the defined term, so that the semantic representation of "\( x \) is colored" is something like "\( x \) is red, or green, or purple, or brown...". This treatment would give "red \rightarrow colored" as valid, but it will not commend itself to anyone who wants a psychologically plausible semantics; e.g. who wants the semantic representation of a sentence to be what is internally displayed when tokens of the sentence are understood.

There's an inclination to argue as follows: if your theory is willing to acknowledge an inference rule (meaning postulate) of the form “x is a bachelor iff x is unmarried and a man”, isn't your theory really indistinguishable from one which acknowledges “bachelor” means “unmarried man” as a definition? The answer to this question is certainly “no”. Looked at from the linguist's point of view, the two theories disagree on what levels of representation there are (levels of linguistic representation are individuated, inter alia, by their vocabulary. According to the definitional view, there is a level of description at which “bachelor” is unavailable for the representation of “John is a bachelor”; whereas, the meaning postulate account denies that this is so.) Looked at from the psychologist's point of view, the theories disagree on what representation of tokens of “John is a bachelor” is recovered when they are understood. The definitional view holds that such representations have the form “... unmarried man...”; whereas the meaning postulate view holds that such representations have the form “...bachelor...”. In short, the two theories differ in just about every way that two theories
can, given that they both assume a datum that "bachelor ↔ unmarried man" is valid.

As things now stand, it's hard to see any very decisive reason for preferring the TSP account to the meaning postulate alternative. It's sufficiently obvious, for example, that if the validity of an argument can be captured by the former sort of theory, then it can also be captured by the latter. This is because, so far as questions of validity are concerned, definitions just are a special case of meaning postulates. Roughly, they're the symmetrical ones. On the other hand, we've seen reason to suppose that even if you have definitions, you will have to have meaning postulates as well: arguments like "cause die → die" and "red → colored" probably aren't formally valid even at the semantic level.

So, the best that can be said for TSP, in the present context, is that definitions may form part of the theory of informal validity. On the other hand, there are alternative structures for such a theory and these may be able to do the job without appeal to definitions; for that matter, without appeal to any 'semantic level' as that notion is popularly understood. Moreover, the whole discussion proceeds modulo the uncertain assumption that there is such a thing as informal validity; that there's some sense of "valid" such that both simplification of conjunction and "bachelor → unmarried" are usefully stigmatized. If, in short, the phenomenon of informal validity is our best reason for believing that there are definitions, then we have no very compelling reason for that belief and TSP is in trouble.

I.c. Sentence comprehension: to understand a word is to recover its definition

If a definition gives the meaning of a word, then it's natural to assume (a) that knowing what a word means is knowing its definition; and (b) that understanding a (token) utterance/inscription of a word is, or involves, having the definition 'in mind'. We reserve (a) for section I.d.

The natural way to understand (b) is to situate it in the context of a 'computational' account of higher mental processes. According to such accounts, perception (including language perception) involves the assignment of 'internal representations' to distal stimuli. These representations specify salient

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13 More precisely, they're the ones that are both symmetrical and eliminative.
14 This may well be a special case of the general principle that problems 'solved' by appeal to definitions tend to recur in the form of problems about the primitive basis. In the present case, it looks as though 'red' and 'cause' are good candidates for membership in the primitive basis of English. What, then, shall we do about the informal validity of arguments which turn on the meaning of "red" and "cause"?
and/or task relevant properties of the stimulus. A theory of perception for a given stimulus domain must say: what these properties are, what format is employed for their mental representation and what mental operations are involved in the assignment of the representations to the stimuli.

Viewed in this context, TSP claims that understanding a sentence involves the recovery of its representation at the semantic level\(^{15}\) where, as we have seen, a semantic level representation is one in which definable expressions are replaced by their definitions. So, according to TSP, to understand a token of "John is a bachelor" involves representing the token as something like "John is an unmarried man".\(^{16}\)

There are several preliminary points to make about this claim. To begin with, like any interesting theory, it operates only modulo suitable idealizations. Nobody has to maintain that every case of understanding a sentence token involves recovering definitions, even where the sentence contains definable terms; there might be any number of heuristic procedures for avoiding the recovery of definitions in special circumstances. All that has to be claimed is that understanding a sentence token involves recovering the definitions in, as it were, the systematic cases. It follows that – here as elsewhere – bringing about circumstances relevant to testing the theory (in particular, by eliminating the possibility of reliance upon heuristic short-cuts) might well require elaborate experimental manipulation. We will return to this point presently.

Second, there’s the by now familiar point that the theory can at best be vacuously satisfied for sentences which draw their vocabulary entirely from the primitive basis. Perhaps understanding a sentence of the form "...bachelor..." involves computing an internal representation of the form "...man...". But if "man" belongs to the primitive basis, then all that the definitional theory of understanding can say is that "man" is its own internal representation, that is, so far as the definitional theory is concerned, to

\(^{15}\) It also claims that the semantic level representation of a sentence is the one that the speaker has in mind and which primarily (causally) explains his producing the token. We’ll concentrate on the TSP model of the hearer for purposes of simplifying the exposition but cf. Fodor and Fodor (forthcoming).

\(^{16}\) TSP doesn’t, of course, claim that understanding tokens of "John is a bachelor" involves hearing them as tokens (of the sentence) "John is an unmarried man". TSP allows that sentence comprehension requires the recovery of morphological and syntactic as well as semantic representations, and the two sentences are morphologically and syntactically distinct, however much they may converge at the semantic level.

The reader may, by the way, be getting rather tired of bachelors and unmarried men, and we apologize for the paucity of our examples. Practically all the plausible examples of definitions come from jargon vocabularies ("ketch"), kinship vocabularies ("grandmother") and axiomatized systems ("triangle"). This rather limits one’s range of choices and is a fact which should cause adherents of TSP to ponder.
understand an utterance of a sentence of the form "...man...", is just to compute a token of a semantic representation of the form "...man..."

We stress this point because it's part of the intuitive appeal of the definitional theory that it avoids the necessity of saying things like "bachelor" is defined as "bachelor", or the internal representation of "bachelor" is "bachelor". Progress appears to be made when tokens of "bachelor" are internally represented by tokens of some other formula (like "unmarried man"). Once again, however, this is only progress towards the primitive basis, once one gets there, some notion of understanding a word other than recovering its definition will have to be invoked.

As usual, then, reflection leads to the moral that nothing principled changes if we consider the entire vocabulary to be primitive, so that each word functions as its own internal representation for purposes of sentence comprehension. In fact, the account of the lexical aspect of sentence comprehension that emerges from such treatment is actually quite attractive; it's a serious alternative to TSP.

Any theory of sentence comprehension must somehow license a distinction between processes involved in understanding a token and processes involved in exploiting the information which the token carries. According to TSP, this distinction is drawn at the semantic level. That is, the output of the sentence comprehension system is the semantic representation of the sentence. This output, in turn, provides a domain for such further transformations as logical and inductive inferences, comparison with information in memory, comparison with information simultaneously available from other perceptual channels, etc. Since these "extra-linguistic" transformations are defined over the semantic representations, they have access to the definitions of the lexical items that the sentence contains.

Whereas, on the alternative theory, extra-linguistic transformations are defined directly over the grammatical form of the sentence, roughly, over its syntactic structural description (which, of course, includes a specification of its lexical items.) To say that the output of the syntax provides the domain for extra-linguistic transformations is, to all intents and purposes, to suggest that understanding a sentence token is just assigning it to a sentence type. The specification of a sentence type requires an ambiguity-free notation, but

17We shan't consider the possibility that understanding a sentence involves recovering a representation which specifies its logical form in the traditional sense of that notion, roughly, a specification which formally determines such properties of the sentence as quantifier and operator scope, variable binding, etc. but which provides no access to internal structure in lexical items. This, in fact, seems to us quite a plausible view, but it's independent of the issues about definition which are our primary concern.
that is precisely what syntax (together with appropriate subscripting for ambiguous lexical items) ought to provide.

Notice that, on either account, the sentence comprehension system functions to provide domains for the extra-linguistic transformations. Both accounts thus postulate a sharp distinction between the mechanisms of sentence comprehension and those which determine the consequences (inductive, logical, plausible, etc.) of information that sentence tokens convey. The theories differ only in respect of the character of the representations that the sentence comprehension system provides; one alleges, and the other denies, that the system has access to (putatively) definable expressions like "bachelor".

There is, in fact, some rather tentative experimental evidence in favor of the non-definitional view. TSP entails that representations which specify definitions are internally displayed in the process of sentence comprehension; but experiments which have sought to test the psychological reality of such representations have not, thus far, met with notable success. In general, the tactics of such experiments involve (a) bringing about a situation in which it seems plausible to claim that S has understood a stimulus sentence; and then (b) attempting to show that some parameter of S's response is sensitive to properties of the definitions of items in the sentence. For example, Kintsch (op. cit.) used the phoneme monitor task (and other) experimental procedures in an attempt to show that RT to lexical items in a sentence is a function of the relative complexity of their definitions; and Fodor, Fodor and Garrett (op. cit.) used a speed-of-inference task to determine whether words which contain "negative" in their definitions (such as "bachelor", which means "not married man") show typical chronometric effects of the presence of negative morphemes.

Both experiments were unsuccessful as, indeed, untutored intuition might have predicted. There is, for example, no intuitive support for the following entailment of TSP: given two otherwise identical sentences which are respectively of the form "...L_i..." and "...L_j..." and such that the definition of L_i is a proper part of the definition of L_j, the second sentence should be more complex than the first. For example, TSP predicts that "John is a bachelor" should be more complex than "John is unmarried" since the definition of "unmarried" is a proper part of the definition of "bachelor". And it predicts that "John broke the glass" is more complex than "the glass broke" since, according to the conventional wisdom, "break\textsubscript{transitive}" is defined as "cause to break\textsubscript{intransitive}". Neither prediction appears to have much intuitive warrant, and, as we remarked in the preceding paragraph, attempts at experimental vindication have, in general, not proved successful.
Such experimental studies have, however, been roundly criticized for their reliance upon chronometric measures. For example, Katz (1977) has argued that they show at most that subjects employ heuristic shortcuts to avoid the recovery of semantic representations when they are placed under time pressure. Katz doesn't offer any direct evidence that this is true, nor does he offer any suggestions as to what sort of task might have construct validity for testing the psychological reality of definitions.

We'll return to this worry in section II where we consider evidence from some non-chronometric measures.

To summarize: In section I.b., we say that there is a trade-off between, on the one hand, theories which propose to save the inferential apparatus of standard logic by constructing a level of linguistic representation at which definitional structure is displayed; and, on the other, theories which dispense with a semantic level but propose to capture informal validity by a suitable enrichment of the inferential apparatus of standard logic. Not suprisingly, we now see that there is the possibility of the same sort of trade-off in theories of sentence comprehension. 'Deep' theories of comprehension (like TSP) require definitional analysis as part of the process of decoding tokens. In effect, they say that some inferences (like "bachelor → unmarried man") must be drawn on pain of failure to understand the sentence. Whereas, 'shallow' theories claim that the entire inferential apparatus is extra-linguistic (in the sense that there are no inferences which must be drawn in the course of understanding a sentence; including, NB, inferences which turn on definitions.) It's an open, and interesting, question how to choose between these views. But what should be clear from our discussion is that this is entirely an empirical question; there's no a priori reason why theories of sentence comprehension need to assume that definitions express important linguistic relations. Theories of sentence comprehension – at least in modern cognitive psychology – are functions from sentences onto internal representations. Internal representations are themselves expressions in a formal language. Nothing principled hinges on the size of the primitive vocabularies that this formalism exploits, a fortiori, nothing principled requires that it do without "bachelor".

I.d. Definitions and theories of concept learning: definitions express the decomposition of concepts into their elements

The discussion in the last three sections has tended to exhibit TSP as one approach among others to a variety of problems about language and mind. We haven't yet found any very persuasive reason for preferring the definitional account to its alternatives, and we've suggested some reasons for sup-
posing that TSP might be seriously flawed. If this is correct, it raises a question which has some interest from the point of view of intellectual history: Why has the definition story been taken so seriously by so many theorists? In this section, we seek to provide part of the answer.

It's natural — perhaps it's mandatory — to speak of words as expressing concepts. Two consequences are implied thereby. First, the child's task of mastering the lexicon of his language is bifurcated into learning the concepts that lexical items express and learning which morpho-phonological forms are used to express those concepts in his language community. Second, the distinction between defined and primitive lexical items generates a corresponding distinction between complex and basic concepts. 18

Given this presumptive parallelism between the lexical and conceptual systems, we can think of the definitions themselves as expressing not only the relations between definable expressions and the primitive vocabulary, but also the relations between complex and basic concepts. That is, we can say both: the meaning of "bachelor" is constructed from the meanings of "unmarried" and "man" and the concept BACHELOR is a construct out of the concepts UNMARRIED and MAN. The rule of definition supplies the principle of construction in both cases; definitions articulate both lexical decompositions and conceptual analyses.

This is a point of some significance since, so far as we can tell, practically all of the influential theories of concept learning in philosophy and psychology have relied heavily upon the possibility of constructing complex constructs from a primitive conceptual basis. 19 There is, in this respect, a direct line which runs from Locke and Hume, through Vygotsky and Bruner, to Winston and Miller and Johnson-Laird. We'll try to say, in outline, what it is that the views of such theorists have in common.

1. There is a presumed distinction between basic and complex concepts (paralleling, as we've seen, the presumed distinction between primitive and definable expressions.)

2. The potential conceptual repertoire of the organism is the closure of the primitive basis under some specified set of combinatorial operations. 20

In early versions of TSP, this combinatorial apparatus was implicit in the

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18 In fact, this puts the matter slightly backwards since TSP is wont to view the distinction between complex and basic concepts as fundamental (e.g., as epistemologically principled) and the distinction between definable and primitive terms as merely derived (primitive terms being the ones which express basic concepts... etc.).

19 The glaring exception is the work of the Cartesians and their followers, for whom concept acquisition is not assumed to be a learning process at all. We'll return to this presently.

20 Just as, mutatis mutandis, the potential lexicon is the closure of the primitive vocabulary under whatever logico-syntactic apparatus definitions are assumed to have access to.
formal properties of the presumed associative principles. Recent versions (of which Miller and Johnson-Laird (1976) provide an unusually instructive example) typically assume much richer formalisms taken from logic, set theory or computer mathematics. In either case, however, the form of the theory is quite straightforward: the concepts you can have are the ones that can be constructed out of an inventory of basic concepts by the application of an inventory of combinatorial principles.

3. Given this account of the space of potentially available concepts, the theory of concept learning consists of a set of inductive procedures — to all intents and purposes, an inductive logic — which determines the availability of a complex concept relative to (a) the availability of appropriate basic concepts (in particular, the ones from which the complex concept is constructed) and (b) the experience of the organism.

So, in its most familiar form, the theory has it that concept acquisition is a matter of framing and confirming hypotheses. In the Vygotsky/Bruner paradigm, for example, the concept BIK is said to have been learned when some such generalizations as "x is Bik iff x is round and red" controls the subject's sorting behavior. In such accounts, the inventory of basic concepts (together, as usual, with the logico-syntactic apparatus) provides the vocabulary in which the hypotheses are couched. And the presumed laws of learning (problem solving strategies, principles of association, or whatever) operate to determine the degree of subjective confirmation of each hypothesis (the extent to which S believes it) as a function of environmental inputs, possibly including error-signals.

We are, in fact, inclined to believe that all standard theories of concept learning are variations on this model; that they all consist, fundamentally of an inventory of basic concepts, a combinatorial apparatus and an inductive logic. We'd be pleased to hear if the reader can think of a counter-example; we cannot. (For further discussion, see J. A. Fodor (1975), especially Chapters 1 and 2).

The point of present concern is this: if our account of concept learning models is correct, then all such models are theories of the inductive acquisition of complex concepts relative to the presumed availability of a primitive basis. WHAT THEN OF THE ACQUISITION OF THE CONCEPTS IN THE PRIMITIVE BASIS? It seems to us that there is only one possible answer:

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21 Strictly speaking, the operation of the inductive procedures requires not only a source of hypotheses, but also a canonical format for the representation of the (dis)confirming data. The inventory of basic concepts serves both functions: RED and ROUND, for example, occur both in the subject's hypotheses ("x is Bik iff it's red and round") and also in his internal memory representation of the experimental trials and their outcomes ("on trial n, the distal object was red and round and the hypothesis that it was Bik was rewarded").
theories of concept learning presuppose the availability of the primitive conceptual basis; they don’t explain it. If, however, the primitive basis is presupposed in concept learning, then it cannot itself be learned. If it is not learned, then, presumably, it is innate.

The claim, then, is that all standard theories of concept learning require the innateness of the primitive basis and explain at most the acquisition of complex concepts relative to the availability of that basis. This claim may seem quite radical, but if it does that is only because the logical structure of theories of concept learning has not been widely appreciated in the modern literature. In fact, the idea that everyone has always been committed to the innateness of the basic concepts was common ground in many of the early discussions. William James, for example, who can hardly be viewed as a wild-eyed Nativist, comments as follows: “The first thing I have to say is that all schools (however they otherwise differ) must allow that the elementary qualities of cold, heat, pleasure, pain, red, blue, sound, silence, etc. are original, innate or a priori properties of our subjective nature, even though they should require the touch of experience to waken them into actual consciousness, and should slumber to all eternity without it.” (Principles of Psychology, Vol. 2, p. 618). In fact, James is here quite close to Descartes; they both realize that concept acquisition presupposes a primitive basis, hence that the basic concepts cannot themselves be learned. On the other hand, neither thinks that the availability of basic concepts is causally independent of experience (of, for example, the activation of the sensorium). From the contemporary point of view, one might say that James is a triggering theorist vis-à-vis the primitive basis and a constructivist (of the Associationist variety) about complex concepts. Whereas Descartes is a triggering theorist about practically everything: if the acquisition of concepts requires sensory stimulation, that is not because “...these extraneous things [distal stimuli] transmitted the ideas themselves to our minds through the organs of sense, but because they transmitted something which gave the mind occasion to form these ideas, by means of an innate faculty, at this time rather than at another.... Hence it follows that the ideas of ... movements and figures are themselves innate in us. So much the more must be the ideas of pain, colour, sound and the like be innate, that our mind may, on the occasion of certain corporeal movements envisage these ideas.” (Quoted by Adams, p. 770).22

22What, according to Descartes, shows that sensory stimulations are at best ‘occasions’ (viz. triggers) for the formation of concepts is the dissimilarity between our concepts and their distal causes. A modern way of making this (very perceptive) point is that our experience does not, in general, provide a good inductive sample for the concepts we acquire. (See Chomsky (1975) on the relation between the corpus which triggers language acquisition and the grammar thereby induced.)
These reflections put a rather significant twist on how one construes the traditional Rationalist-Empiricist debate. If all parties are committed to the innateness of the primitive basis, then the residual dispute must be over how much of the (potential or actual) conceptual repertoire is primitive. Here, surely, is one source of the widespread commitment to the existence of definitions. If there are no definitions then presumably the entire lexicon is primitive. If the entire lexicon is primitive, then presumably all the concepts that lexical items express are primitive. If all the concepts that lexical items express are primitive, then presumably all the concepts that lexical items express are innate. If that does not precisely amount to the innateness of all concepts, it is quite enough to give an Empiricist the willies.

The moral, then, is this: what is not definable must be innate. Most of us are inclined to assume that it just can't be the case that all concepts are innate; most of us have therefore thought that many — indeed, very many — concepts must be definable. This is a persuasive line of argument if Empiricism is true. But what if Empiricism isn't true?

In short, the argument cuts both ways; if there is evidence that there are no definitions, then that is evidence against the standard views of concept learning. Since the standard views are the only ones we've got and since the only alternative to concepts being learned is that concepts are innate, it appears that the substance of the Rationalist-Empiricist debate turns quite centrally on the empirical status of the definition construct. That makes the empirical status of the definition construct a matter of very considerable interest. We are about to turn to it.

I.e. Summary

We've sought to show, in the preceding discussion, how the assumption that there are definitions plays a variety of roles in the conglomerate of theories that we've called "The Standard Picture". We've seen, in particular, that theories of concept learning are more heavily invested in the psychological reality of definitions than might at first appear; indeed, that the dispute

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23There is, of course, an infinity of concepts if one uses "concept" to denote not just what is expressed by words but also what is expressed by phrases. So, in particular, even if one claims that all lexically encoded concepts are primitive — hence innate — there will be infinitely many phrasally encoded concepts that are not primitive, hence learnable; even if the concepts expressed by "tin" and "trumpet" are basic, the concept expressed by "tin trumpet" is complex. Much of what modern theories of language (since Frege) are about is exhibiting the mechanisms in virtue of which a finite, lexically encoded primitive basis is projected onto an infinity of phrasally encoded forms which express complex concepts.
between Empiricist and Rationalist accounts of the acquisition of concepts turns largely upon this issue.

If TSP were clearly true, that would in itself be a conclusive argument for endorsing the definition construct; if you accept a theory, you must accept its entailments. But, as we hope we've convinced the reader, there are plausible alternatives to TSP, and these alternatives are not committed to definitions. It would obviously be desirable if the question could be brought to empirical test.

Equally obviously, no single experiment could validate (or refute) the whole of TSP. The goal of Part II is to discuss experimental evidence relevant to assessing just one aspect of the standard picture: the doctrine (discussed in I.c.) that understanding a sentence token involves recovering (e.g., displaying in working memory) the definition of such lexical items as the sentence contains. This is part (though by no means all; see Part III) of what one might mean by saying that definitions are 'psychologically real'\(^\text{24}\) for purposes of sentence comprehension.

**Part II: The Psychological Reality of Causative Constructions: An Experimental Inquiry**

As we remarked above, a test of I.c. would require first bringing about an experimental situation in which subjects understand a sentence token, and then determining whether their behavior in that situation is sensitive to properties of the definitions of the words in the sentence. Constructing such a test involves solving three methodological problems: (a) we need stimulus materials that contain words which we can be reasonably certain have definitions if any words do; (b) we need to choose as the manipulated variable a property which we can be reasonably certain that the definitions have if they exist at all; and (c) we need to find an experimental measure which we can be reasonably certain is sensitive to the presence or absence of that property in S's internal representation of the stimulus sentences. We will discuss (a) and (b) under the head "materials" and (c) under the head "methods".

\(^{24}\)We assume throughout that "there are definitions" and "definitions are psychologically real" are just two ways of saying the same thing; more generally, that psychological states and processes provide the truth conditions on existential claims in linguistics. We realise that this view is sometimes denied, but we are quite unmoved thereby. For discussion, see the section entitled *Psychological Reality of Grammars* in Block (1980).
II.a. Materials

It's hard to find good examples of definitions, and this fact prejudices any negative results in a test of I.c. Such results might always be 'explained away' by claiming that the stimulus items aren't really among the definable expressions, or that, if they are, the definitions assumed by the experiment aren't the right ones. One can't test the entire lexicon, and random sampling would be meaningless without a criterion for distinguishing definable from primitive terms. The indicated strategy is therefore a 'best case' approach: test for definitions where the linguistic argument for definability is strongest. This is the strategy that we have followed.

It seems clear that, in the present state of the literature, the examples which provide the best arguments for definitions are the 'causative' verbs. English causative verbs include, for example, "break, tear, smash, bounce" etc. and also "kill, feed, remind, grow" etc. According to the proposed analysis, such verbs have two salient features: they're transitive (in particular, they satisfy surface syntactic structures like Fig. 3) and they're non-primitive (in particular, they satisfy semantic analyses like Fig. 4).

Figure 3. Surface structure for causatives; e.g., "John broke the glass".

This account of the causatives has several interesting features. First, as just mentioned, it makes causatives defined expressions; whereas their intransitive counterparts are primitive, at least so far as this analysis is con-

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25 Notice that the morphological identity between the transitive and intransitive form of a verb like "break" is accidental according to the present analysis. That is, we have examples like "John broke the glass/The glass broke" but we also have examples like "John killed Mary/Mary died". "Die" fed raised ate grew is thus taken to be the intransitive counterpart of "kill", just as "break" is taken to be the intransitive counterpart of "break".
Figure 4. Semantic analysis for causatives; e.g., "John broke the glass".

Concerned. Since causatives are defined, they do not appear in semantic-level representations, and this raises the question of how they manage to get into surface forms. Linguists who agree that causatives are defined tend to disagree on this latter issue; roughly, it divides the 'generative' from the 'interpretive' schools of linguistic semantics. According to the former, the mapping from semantic onto surface structures is transformational (raising and lexicalization are critically involved). According to the latter, it is non-transformational and accomplished by rules of a form that remain to be specified. This issue has been extensively reviewed elsewhere (see, in particular, J. D. Fodor (op. cit.)) and need not concern us here. It's sufficient, for our purposes, that there is wide agreement on the structures despite the disagreement about the derivations.²⁶

The second noteworthy point about the definitional account of causatives is that it makes sentences like "John broke the glass" both surface simplex and deep multiplex; that is, they're one clause sentences at the level of surface structure, but they contain (at least) two clauses at the level of semantic representation. The fact that causative constructions are assumed to be deep

²⁶It's a good rule of thumb that a theorist accepts the definitional account of causatives iff he holds TSP, You'll find versions of the analysis in sources as scattered as Katz (1972); Schank (1975) Lakoff (1970); McCawley (1971), Miller and Johnson-Laird (1976) etc. This rule must, however, be applied with caution; Katz, for example, accepts both a definitional view of the lexicon and a radically nativist view of the acquisition of concepts.
multiplex has a consequence which will be decisive for our experimental manipulation: there are critical pairs of items in causative constructions which are analyzed as grammatically related in the surface structure but NOT grammatically related at the level of definitional/semantic representation. Consider, for example, "John" and "the glass" in "John broke the glass". These items are related as subject and object of the verb "break" in the surface sentence (see Fig. 3); but they are not so related in the putative semantic representation (see Fig. 4). In fact, on the definitional analysis, there is no verb of which "John" and "the glass" are both arguments at the semantic level. Rather, "John" turns up as the subject of the underlying verb "cause", and "the glass" turns up as subject of the underlying verb "break_{intransitive}". Another way of putting this is as follows: given what is presumably the intended interpretation of the logical syntax, "John broke the glass" does not express a relation between John and a glass. On the contrary, it expresses a relation (of causing) between John and an event (viz., the glass breaking). Similarly, according to the definitional analysis, "John killed Mary" does not express a relation between John and Mary... etc.

We said that the definitional treatment of causatives represents a best-case example of definability. We are thus under some obligation to show that the analysis has face plausibility. There's the following to be said in its favor:

1. "John broke the glass" does imply "the glass broke", and this fact is predictable from the putative semantic representation of "break_{transitive}" given the appropriate meaning postulates for "cause".

2. There exist languages (including, apparently, Japanese) in which verbs of causative import have an explicit surface morphological marking. If this doesn't argue directly that surface verbs like "break_{transitive}" are represented by "...cause..." at the semantic level, at least it suggests that "causative" is a morpheme category which universal grammar will have to acknowledge.27

3. By far the most persuasive argument for the definitional treatment of causatives is that there exist types of sentential ambiguity for which it provides an elegant and appealing explanation. Consider sentence 10. It's argued

10 John almost killed Mary

27We are not, then, denying that the lexicon is cross-classified by features like "causative". On the contrary, the existence of such a cross-classification is suggested by a variety of linguistic and psychological phenomena. What we do deny is that the cross-classification of the lexicon implies that lexical items are semantically represented by their definitions. That the mechanism of cross-classification must be definitional has been widely but gratuitously assumed by theorists in linguistics, psychology, and AI. Yet, alternative mechanisms are easily imagined, and we know of no substantive reasons why definitions are so widely preferred. For further discussion, see Fodor, Fodor and Garrett, op. cit.
that 10 can mean either that John almost brought about Mary’s death (e.g., he brought the poison but then he changed his mind) or that John brought it about that Mary almost died (he brought the poison and he fed it to her, but they saved her with a stomach pump.) The difference between the readings is the difference between attempted homicide in the latter case and mere premeditation in the former.

The point of these observations is the following: if we accept the definitional analysis of “kill”, and if we accept that the scope of adverbs is defined over semantic-level representations, then we can predict the possible adverb scopes for sentences like 10 purely geometrically; viz. by the principle that an adverb can have scope over any clause in a semantic representation. The difference between the two readings of 10 is thus captured by the difference between Fig. 5 and Fig. 6.

Figure 5. Long scope analysis of adverb in “John almost killed Mary”.

Figure 6. Short scope analysis of adverb in “John almost killed Mary”.

The force of the argument, then, is that accepting the causative analysis of “kill” allows us to preserve the following generalization about the scope of adverbs: any form with the deep geometry of \((NP \text{ Verb } (S))\) will provide a source of scope ambiguities analogous to sentence 10. The generalization applies not only to 10 itself, but also to ambiguous sentences like “John cooked the meat slowly” (“\(\text{cook}_{\text{transitive}}\) = df “cause to cook\(\text{intransitive}\)” ) etc.

Lest this argument seem so good that it settles the case in favor of the definitional decomposition of causatives, a few caveats ought to be entered.

First, it’s not all that obvious that sentences like 10 are ambiguous. It’s not clear how to decide between structural ambiguity (\(\text{à la} \) definitional story) and mere disjointness of truth conditions. This is a general problem with the evaluation of ambiguity arguments that are proposed to motivate multiplicity of linguistic representations, and we don’t know how to solve it.

Second, there are alternative accounts of the (putative) ambiguity of 10. According to these accounts, such ambiguities are handled either by appeal to the interpretative apparatus (see Dowty, 1976) or to principles which define adverb scope over surface structure (see Chomsky, 1972).

Third, and most important, it appears that the generalization that adverb scope is definable over the geometry of semantic representations cannot, after all, be sustained. Notice that ‘try-verbs’ have the same (putative) definitional geometry as causatives. So, for example, “seek” = df “try to find” and “chase” = df “try to catch” precisely parallel to “kill” = df “cause to die” or “break” = df “cause to break”. That is, the underlying geometry of Fig. 7 is precisely congruent with the underlying geometry of Fig. 4; what distinguishes them is just that in 4 the embedding verb is “cause” whereas in 7 the embedding verb is “try”.

Nevertheless, the rule of adverb scope assignment that works for causatives doesn’t work for try-verbs. So, “Schliemann almost sought the site of Troy” means almost (Schliemann tried to find the site of Troy) but has no reading Schliemann tried (to almost find the site of Troy). Similarly, “John almost chased Mary” has no reading John try (to almost catch Mary); rather it means univocally almost (John try to catch Mary). In general, and despite the congruence of Figures 4 and 7, adverbs like “almost” yield only the long scope reading in sentences containing try-verbs.

These observations strongly suggest that adverb scope assignment rules are not geometrical; viz., that they will have to be sensitive to particular verb classes (causatives versus try-verbs) even if definitional analyses are allowed. This means that ambiguities like “almost kill” provide no argument for a two clause analysis of causatives. The most they show is that scope
rules apply (inter alia) in virtue of the causativity of verbs, and that \textit{that} requirement could be met even by scope rules defined over surface structure, assuming that the lexicon is cross-classified by some such feature as "\textpm causative". The argument that the causative analysis allows us to preserve a generalization about the geometrical character of adverb scope assignment is unsound because, as it turns out, there is no such generalization to preserve.

To summarize: the linguistic evidence for the causative analysis is at best inconclusive, but at least there \textit{is} some evidence. Causatives are very nearly the only case for which serious distributional grounds for the existence of definitions have thus far been alleged. In practically every other case, the argument has been quasi-methodological; e.g., that definitions must be posited in order to preserve some or other tenet of TSP. It’s therefore the causative analysis that we have chosen for experimental scrutiny.

The next question dictating the choice of experimental materials is: what property of the definitional representations ought we to test for? Here there are two main considerations: we want to choose a non-adventitious property of the definitions, and we want to choose a property which allows for the construction of appropriate controls. So, for example, it would be inadvisable to test the definitional account of causatives by appealing to the fact that “cause” is alleged to be the main verb in the deep representations. Nothing essential to the theory chooses between, say, “cause” and “bring about”, so if there were reason to believe that the definition of “break” contains a \textit{Verb + particle} construction, the
analysis could accommodate that fact without essential revision. On the other hand, the analysis does seem to be essentially committed to a claim that we remarked upon above: the pattern of grammatical relations among phrases shifts as between the surface form and the semantic representation of a causative construction. In particular, it's built into the geometry of the analysis that the surface subject and object of a causative verb are not in grammatical relation in the corresponding definition. This, then, is the strategy of the experiment: find a test which is sensitive to the distinction between constructions in which grammatically related surface phrases are not so related in underlying representations; then apply that test to the case of causatives.

This raises the question of controls, in particular, of determining the construct validity of the test procedure. This issue is especially pressing if, like us, you suspect that the definitional analysis of causal verbs is false. To see this, consider the view on which verbs like "break" are primitive and undefined. On this account, the semantic representation of "John broke the glass" is "John broke the glass"; hence a test which is sensitive to shifts of grammatical relations as between surface and semantic representations would be predicted to fail when applied to causative verbs in general and to "break" in particular. This threatens to leave the experimenter in the nasty position of making a prediction of no-difference and, hence, of being unable to distinguish the truth of his theory from the insensitivity of his test instrument.

There is, of course, a way of coping with this sort of problem. What one needs is independent validation of the test instrument. Fortunately, this is possible in the present case. As it turns out, there exist several kinds of sentences (we will call them "shift sentences") in which the pattern of grammatical relations among phrases changes as between surface and abstract representations, but where the existence of the shift does not depend upon the definitional decomposition of lexical items in the sentence. Moreover, in the case of each of these kinds of shift sentences, it is possible to provide close approximations to minimal pair controls; sentences which share the surface organization of the shift sentence, but where the key grammatical relations do not change as between surface and deep structures.

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28 Some psychologists appear to believe that the confirmation of predictions of no-difference is somehow inherently uninteresting. This view is, of course, absurd; if it were true, it would be practically impossible ever to provide empirical evidence that the ontological commitments of a theory are false. It is also, by the way, bad history of science. To take just one example: modern estimates of the size of the universe were initially confirmed by the demonstration that the two hundred inch reflector telescope could not resolve Cepheid variables in the Andromeda Nebula.
The general strategy of the experimental design may now be characterized:

Phase 1: Validate the test instrument by showing that it is sensitive to the difference between an arbitrary shift sentence and its non-shift control.

Phase 2: Apply the test procedure to determine whether causatives behave like shift sentences (a positive result tends to validate the definitional analysis of causatives; a negative result tends to disconfirm it.)

We are almost ready to consider the problem of validating the test instrument. Before doing so, however, we need to call attention to a crucial feature of the experimental strategy just described: it depends upon the assumption that any plausible account of the causatives in which they are lexically decomposed will be one in which the subject and object of the surface causative verb are NOT co-clausal in underlying representation. It is thus essential to consider the possibility of alternative decompositional analyses; ones which do not share this feature. (This possibility was first pointed out to us by Professor Zenon Pylyshyn, to whom we wish to express our gratitude. Some day we are going to do him a favor.)

Consider, then, a treatment of the causatives according to which the underlying structure of ‘John killed Mary’ is the one represented in Fig. 8.

Figure 8. *Semantic analysis schema for “John killed Mary”:*

Paraphrased into surface English, this structure says that ‘John killed Mary’ is synonymous with ‘There is something which John did to Mary which caused Mary to die.’ Notice that, according to this analysis, ‘John’ and ‘Mary’ are co-causal in semantic representation; they occur as subject and indirect object of the abstract verb ‘do’. (Or, to put it more semantically, according to this analysis, ‘John killed Mary’ does express a relation between John and Mary; viz., the relation which holds between x and y just in case x does something to y which causes y’s death).

We think that there are decisive difficulties with this suggestion. We are going to examine them in some detail, not only because undermining the analysis is essential to motivating our experimental program, but also because the analysis offers an interesting case study in the difficulty of
constructing defensible definitions. Prima facie plausible proposals are forever leading to unforeseen troubles when their consequences are seriously pursued.

To begin with, it may seem that the analysis shown in Fig. 8 can be supported on philosophical grounds since, on certain metaphysical views (see, for example, Davidson (1970)) “cause” and other causatives express relations between events. If such views are written into the logical syntax, then the underlying subject of a causative verb ought to be a sentence, and that is indeed the case according to the analysis in Fig. 8. This is not, however, a persuasive argument in favor of the analysis, since we could get the same effect with Fig. 9, according to which ‘John killed Mary’ means ‘John did something which caused Mary to die’, and in which ‘John’ and ‘Mary’ are, once again, not co-causal. It may be that there are constructable examples which decide between the analysis in Figs. 8 and 9, but the metaphysical considerations per se do not.

Figure 9. Semantic analysis schema for “John killed Mary”.

But lack of metaphysical motivation is hardly the major problem with the proposal. What’s more serious is that it is incompatible with the geometrical treatment of adverb scope discussed above; since we now have a three clause structure for ‘John killed Mary’, we presumably predict a three-way ambiguity for ‘John almost killed Mary’, and this prediction is not sustained by intuition.

The following difficulties are more serious still. Consider the sentence A (= ‘the wind moved the leaves’); “move\text{transitive}” is a causative so, according to the present proposal, A is synonymous with (and hence entails) sentence B (= ‘the wind did something to the leaves which caused them to move’). It follows that whenever A is true, there will have to be a (true) answer to the question: ‘What was it that the wind did to the leaves such that it was the wind’s doing that to the leaves which caused them to move?’ Suppose that, in a given case, the answer is C (= ‘the wind exerted force upon the leaves’).
In this case, A is true because C is true. But now consider that C explains the leaves' moving only if D is true: (D = 'the wind's exerting force upon the leaves moved them'). But D itself contains a causative, and is thus itself in need of analysis. According to the analysis proposed, D is synonymous with (and hence entails) E (= 'the wind's exerting force upon the leaves did something to the leaves which caused them to move'). Notice, however, that whenever E is true there will have to be a (true) answer to the question: 'What was it that the wind's exerting force upon the leaves did to the leaves which caused them to move?' And, whatever the answer to that question is, it will give rise to a sentence with a gerundive subject and a causative main verb in just the way that C gave rise to D. Patently, the argument iterates indefinitely. Since this consequence is obviously unsatisfactory — there can't be indefinitely many events between a cause and its effect — we have a reductio ad absurdum of the proposed analysis. Contrary to Fig. 8, causative's don't contain an existentially quantified variable over events.

We can think of only two plausible replies to this point. First, one might argue that causatives with gerundive subjects don't lexically decompose (though causatives with non-sentential subjects do). This suggestion will save the analysis, but it seems totally ad hoc. Notice that the same sort of semantic considerations that are taken to favor decomposition in the case of causatives with NP subjects also obtain in the case of causatives with gerundive subjects: 'the wind's exerting force on the leaves moved them' entails 'the wind's exerting force on the leaves caused them to move' just as 'the wind moved the leaves' entails 'the wind caused the leaves to move'.

Second, it might be argued that, though A can't be true unless B is, still, the answer to the question that B invites (viz., 'what was it that the wind did to the leaves which caused them to move?') could just be 'it moved them'. This avoids the problem of having to manufacture an indefinite string of effects which, as it were, intervene between the wind's blowing and the leaves moving. But it invites troubles of its own. For, if we accept this move, then we accept the following dialogue as well-formed (i.e., we accept that A is an answer to Q):

Q) What did the wind do to the leaves which caused them to move?
A) The wind moved the leaves.

And if we accept that dialogue as well-formed, then we must be able to translate it at the semantic level preserving the question/answer relation. Notice, however, that what we get at the semantic level is:

Q') What did the wind do to the leaves that caused them to move?
A') The wind did something to the leaves that caused them to move.
We are prepared to stretch intuition to the point of believing that A is an answer to Q, but not to the point of believing that A' is an answer to Q'.

In the light of these considerations, we shall continue to assume that if a decompositional analysis of causatives can be sustained, it will have to be one of the 'John killed Mary' – ‘John caused Mary to die’ variety; i.e., one which differs from both Fig. 8 and Fig. 9 in avoiding existential quantification inside the analyzed verbs. It is, in particular, the former kind of analysis that is presupposed in the experiments presently to be reported.

We turn now to a discussion of the sentence types used in the first phase of the experiment to validate the test instrument. 29

**Phase 1, Comparison 1: ‘expect-verbs’ versus ‘persuade-verbs’**

Consider sentence pair 11a, b. It seems plausible to say that these sentences

11a John expected Mary to leave
11b John persuaded Mary to leave

have the same surface analysis, perhaps the one shown in Fig. 10. Whereas it seems clear that the sentences must differ significantly in their semantic representations. This is because, as we saw in 1.b, semantic representations are supposed to provide domains for inferential operations, and 11a and b differ strikingly in the sorts of (informally) valid arguments they enter into. Notice, for example, that 11b entails “John persuaded Mary”, whereas 11b does not entail “John expected Mary”. One might put it, very approximately, that 11a expresses a relation between John and an event (Mary’s leaving), whereas 11b expresses a relation between John and Mary. 30

These sorts of considerations have led practically everybody to agree that 11a and b have different abstract representations. 31 The standard proposal is that ‘expect-verbs’ enter into abstract configurations like the one in Fig. 11, whereas ‘persuade-verbs’ enter into abstract configurations like the one in Fig. 12.

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29 The actual stimulus sentences employed are given in the materials section of the Appendix, this discussion will treat examples of each sentence type that are simplified for purposes of clarity. The distinction between the two ‘phases’ of the experiment is likewise expository. In fact, barring one case, all the stimulus materials were tested together and on the same population of subjects; see the methods section of the Appendix.

30 What makes this analysis very approximate is, of course, that both sentences are intensional for “Mary leave”.

31 There is not, alas, perfect consensus that they have the same surface representations. We’ll return to this problem presently.
Notice that if Fig. 10 is right, the present analysis has the consequence that ‘expect-verbs’ (but not ‘persuade-verbs’) are shifters. In particular, the abstract representation of 11b contains a verb (viz. “persuade”) of which “John” and “Mary” are respectively subject and object in both underlying
and surface representations. Whereas, in the case of ‘expect-verbs’, the grammatical relations shift in a manner precisely analogous to the shift that the definitional analysis posit in causal verbs. In particular, “John” and “Mary” are the subject and object of “expect” in Fig. 10, but they exhibit no grammatical relations to each other in the structure shown in Fig. 11; rather, while “John” is subject of “expect”, “Mary” is subject of “leave”. Notice, too, that though ‘expect-verbs’ are shifters according to this analysis, the occurrence of the shifts does not depend upon a presumption of definitional analysts; the present analysis is compatible with (though it does not demand) the assumption that ‘expect-verbs’ are semantic primitives. Comparisons like expect/persuade thus dissociate the issue of shifting from the issue of definitional decomposition; they permit us to determine the construct validity of a test for shifting without prejudicing the question of the psychological reality of definitions. Analogous remarks apply for all the following comparison sets tested in Phase I.

Phase I, Comparison 2: ‘easy-adjetives’ versus ‘eager adjectives’

Consider the sentence pair 12a and b. Once again, it seems plausible that they share a surface structure (see Fig. 13). And, once again, the surface similarity masks a radical difference in logical form. Thus, while 12a attributes a property (easiness) to an event type (pleasing John), 12b attributes a property (being eager to please) to John. The standard analysis marks

12a John is easy to please
12b John is eager to please

Figure 13. Surface structure for ‘easy’ and ‘eager’ adjectives
this distinction by assigning 12a the abstract representation in Fig. 14 while assigning to 12b the representation in Fig. 15. If this analysis is right, then “John” is a shifter in 12a but not in 12b. That is, while “John” is the subject of “eager” in both the surface and the semantic representation of 12b, it is the object of “please” in the abstract representation of 12a. Hence, “John” and “easy” are grammatically unrelated in Fig. 13, while they are related as subject and predicate in Fig. 12. This pattern of assumptions is presumed to explain the fact that, while 12b entails “John is eager”, 12a does not entail “John is easy”. A test sensitive to shifting should, therefore, distinguish 12a from 12b.

Figure 14. Underlying structure for ‘easy’ adjectives

Figure 15. Underlying structure for ‘eager’ adjectives.
Phase I. Comparison 3: sluicing

Consider the sentence pair 13a and b. Presumably they share the surface structure in Fig. 16. However, it's plausible that "know" has different relations to its surface object in the corresponding deep representations. In particular, the sense of 13a is: John married somebody but we don't know who John married, which in turn has the structure: John married somebody but we don't know (John married wh + someone). The interrogative pronoun in 13a is thus, abstractly, not the object of "know" but the object of

Figure 16. Surface structure for 'sluicing' sentences; e.g., ("John wants to marry someone, but we don't know [who].")

“married”. Whereas it's plausible that “her” in 13b is the direct object of “know” at all relevant levels of representation.32 If this is correct, then a test for shifts should distinguish 13a from 13b; in particular, it should exhibit the know-who relation as shifted and the know-her relation as unshifted.

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32 We are assuming both that the subordinated S is pruned in the derivation of 13b and that "who" ends up inside the matrix VP, yielding 13a and b as true minimal pairs. However, if the interrogative element is inside the VP in 13a, we would expect such passives as "John married somebody, but who isn't known (by us)", which strikes us as marginal. We are, to this extent, uncertain about the proposed analysis.
Consider the sentence triplet 14a, b, c. Once again, it seems plausible that

14a There is a man I want you to meet
14b There is the man I want you to meet
14c Where is the man you want me to meet?

the surface structures are congruent, and once again it appears that the logical structures are quite different. In particular, 14a is the sort of formula that logicians represent with an existential quantifier and bound variables; something along the lines of 15. Whereas “there” in 14b is most naturally

$$\exists x (x \text{ is a man and I want you to meet } x)$$

read as a locative adverbial. 14c is like 14b except that the locative adverbial is interrogative; (“where” = “wh + somewhere”).

According to standard treatments, quantifiers are transformational constants; that is, they are introduced by insertion rules and are not elements of abstract representation. Whereas locative adverbs presumably are available to semantic structures. If these assumptions are right, then the abstract representation of 14a is something like 16, whereas plausible abstract representations for 14b and c are 17 and 18 respectively. Notice that this means that the expressions “there” and “man” are grammatically related in the abstract representations of 14b and 14c (viz. as subject and predicate):^33

16 A man (I want you to meet a man) is
17 The man (I want you to meet the man) is there
18 The man (I want you to meet the man) is wh + somewhere

whereas “there” and “man” are not so related in the abstract representation of 14a; “there” has no source in that representation at all. A valid test for shifting should therefore detect a shift in the relation ‘there-man’ in 14a, whereas ‘there-man’ should be unshifted in 14b and ‘where-man’ should be unshifted in 14c.^34

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^33Strictly speaking, they form possibly proper parts — typically heads — of grammatically related constituents. We won’t bother observing this distinction in what follows since it turns out to be irrelevant to the empirical outcomes; subjects are apparently willing to regard heads of constituents as equivalent to constituents for purposes of the experimental task.

^34It’s possible to read “there” as an adverb in 14a (vide “There is a man I want you to meet”) and it’s also possible to read “there” as a quantifier in 14b. (“There is the man I want you to meet”). Neither reading is preferred. Subjects who choose them would provide “spurious” disconfirming data since the experimental prediction is that results for the two types of sentence are asymmetric.
There are two possible objections to the test materials thus far discussed. One might claim that the analyses are wrong (hence that a test which produced the predicted asymmetries would not be detecting shift but something else); or one might claim that the abstract representations proposed are not semantic (hence that a test might distinguish all these cases and still not be sensitive to the kind of representations in which definitions occur.) We need to expand briefly on both these worries.

It's conceivable that the assumption that surface structures are shared in each of the pair-types just enumerated is wrong. In the case of expect-persuade, in particular, Chomsky has argued that there is a surface difference; in fact, that Figs. 9 and 10 would be appropriate as surface representations for 11a and b respectively. If this is correct, then sentences containing 'expect-verbs' are not shifters and a test could distinguish 11a from 11b even if it were insensitive to semantic relations; viz. by being sensitive (solely) to surface relations. What's involved here is the status of transformations which raise NPs, and we don't propose to commit ourselves on the issue which is, as it turns out, extremely complicated. Suffice it, for the moment, to make the following three remarks: (a) it's extremely unlikely that this sort of problem infects all of the four cases; (b) even if 11a and b differ in surface structure, they surely also differ in semantic representation, so that a test which distinguishes them might be sensitive to surface structure, or semantic structure, or both; (c) generative semanticists form a substantial sub-population of linguists committed to definitions, and they do accept the traditional (raising) analysis of 'expect-verbs' which, indeed, they take as supplying a precedent for the operation of predicate raising (the latter occurs essentially in the generative semantic treatment of causatives). What emerges is that we need to show that our test vehicle is sensitive at least to semantic relations, whatever else it may respond to. We'll return to this presently.

Some theorists ('interpretive' semanticists) argue that there is a principled distinction between semantic representations and deep syntactic ones. It's open to such a theorist to claim that all the abstract representations thus far discussed are merely syntactic, hence that a test could be sensitive to shift in all these cases and still be insensitive to specifically semantic properties of sentences. Such a theorist could further claim that definitional analyses are displayed only at the semantic level (≠ to the level of deep syntax). Hence, a test could be validated for all the types so far discussed and fail to show causatives to be shifters, even if the definitional analysis were true. (Notice that this line of argument is not available to a 'generative' semanticist, for whom the deep syntactic and semantic levels are identical.)
Once again, it appears that what’s needed to meet the objection is a demonstration that the test instrument is sensitive at least to semantic representations, even if it is sensitive to surface (and/or deep) syntactic relations as well. To meet this requirement, we have introduced two further types of validating materials. In both these cases it seems clear that there is a difference in semantic relations between superficially similar sentences, and that the difference turns crucially upon the meaning of one of the constituent words: just as the difference in semantic structure between, e.g., “John killed Mary” and “John bit Mary” is supposed to turn crucially upon differences in the meanings of “killed” and “bit”. Here again, though the logical differences seem patent, and though they turn precisely upon the meanings of lexical items, they do not involve definitional decompositions.

Phase I, Comparison 5: negative quantifiers

Consider the sentence pair 19a, b. It seems plausible to treat such sentences

19a  All of the men left.
19b  None of the men left.

as syntactic minimal pairs, but they differ crucially in their semantic properties in virtue of the meanings of “all” and “none”. In particular, in 19a, but not in 19b, the property left is attributed to the men. A test which is sensitive to semantic relations ought, therefore, to distinguish 19a from 19b in respect of the expression “men left”; conversely, it’s hard to believe that a test which does make that distinction could nevertheless be insensitive to semantic relations.

Phase I, Comparison 6: intensional verbs

Consider the sentence pairs 20a, b. It seems clear that the sentences differ in respect of whether a relation is asserted between John and an apple: all the

20a  John wanted an apple
     imagined
     needed
     etc.
20b  John ate an apple
     bit
     had
     etc.
sentences in 20a are intensional for the occurrence of "an apple", whereas none of those in 20b are. In particular, you can 'quantify in' to the forms of 20b, yielding such entailments as "there is an apple that John ate", but you can't (validly) infer such existential conclusions from 20a. It's accepted, therefore, that sentences like those in 20b express relations which implicate the surface subject and object, while those in 20a do not.

The difference between intensional verbs and their relational counterparts is a paradigm of the sort of thing that is traditionally supposed to be captured at the semantic level. In all probability, it is not reducible to a structural difference, but is an intrinsic property of the verbs; rules of inference simply have to be 'told' whether a given verb is intensional. In any event, it seems exceedingly plausible that a test which distinguishes 20a from 20b is sensitive to semantic representations in any coherent sense of that notion.

Phase II: causative verbs

Assuming a test validated in Phase I, the next objective is to test for semantic relatedness between (e.g.) "John" and "Mary" in "John killed Mary". (It will be recalled that, according to the definitional analysis, such sentences do not express semantic relations between the subject and object of the surface verb. On the contrary, "John killed Mary" expresses a relation between John and an event.) Equivalently, for our purposes, we want to use the test to determine whether surface subjects and objects of causative verbs are shifters.

To do this, we must find minimal pair controls in which the surface verb does not shift (a fortiori is not causative) according to definitional treatments. In effect, this means finding verbs which can be plausibly viewed as expressing primitive relations even if it assumed that some verbs (like causatives) are defined.

Since nobody is very clear what the primitive verbs of English are, we used two rough tests. (a) We chose surface transitive verbs for which we could not conjure up reasonable multiplex definitions; or where, if we could think of such a definition, it did not involve shifts of relations for the constituents which form the surface arguments of the verb. Second, we generally chose cases for which our dictionary (the complete Webster's) gave synonyms rather than definitions. Finally, we ran versions of the experiment several times, varying both the selection of causatives and the selection of the (putative) primitive controls. As it turned out, these variations of the materials made no detectable difference to the outcome, suggesting that the results were not due to materials artifacts. (See the materials section of the Appendix.)
Paradigmatically, then, phase II consists of comparing sentences like 21a and b. Assuming the validity of the test instrument, “John” and “Mary”

21a John killed Mary
21b John bit Mary

should be shifted in 21a and unshifted in 21b if, but also only if, the definitional account of causatives is true.

We turn now to a description of the test instrument, pausing only to remark that the Phase I stimulus types we’ve discussed include literally all the kinds of constructions we have been able to think of which might plausibly be relevant to assessing the construct validity of a test of the definitional analysis of causatives. (We regard this work — indeed this entire paper — as exploratory, and we should be glad to hear from readers who think of other constructions that it might be useful to examine.)

II.b. Methods

Whatever else definitions are supposed to be, they must be linguistic constructs in good standing if TSP is true. It would therefore obviously be desirable to test the psychological effects of definitions by using an instrument that is relevantly similar to the manner in which linguists gather the primary data which control their theories: viz., the elicitation of intuitions about sentence acceptability and sentence structure. The least that could be said for such procedures is that, unlike chronometric measures, they place no explicit time constraints upon a subject and are correspondingly unlikely to tempt him to “heuristic short-cuts”. We stress this in light of the suspicions Katz and others have voiced about the use of “on line” tests in validating semantic theories. If the subject’s considered intuitions about sentence structure aren’t relevant to the confirmation of claims about the mental representations which mediate sentence comprehension, then most of the results in linguistics must be similarly beside the point.

Psycholinguists have, by and large, avoided considering intuitional data almost as single-mindedly as linguists have avoided chronometrics. Among the exceptions, however, is an important paper by Levelt (1970). Levelt presented his subjects with sentences and lists of word pairs. The word pairs consisted of the lexical items of the sentence taken regardless of order. So, a Levelt-stimulus might be the sentence “John went to the store” together with the list of word pairs “John went; store went; John to; the store; etc.”. S’s task was to assign numbers to each of the pairs indicating his judgment of the relative degree of relatedness of the pair in the sentence. Thus, if it’s S’s intuition that the pair “the store” is more intimately related
to than any of the others, he assigns it number 1. If it’s his intuition that the pair “John went” is relatively less related, he assigns it a correspondingly lower rank... etc. Levelt subjected these scaling data to a statistical procedure called “Hierarchical Clustering Analysis”. HCA, in effect, uses S’s rankings to construct an analysis tree according to the principle: pairs with the closest rated relationship are dominated by the lowest nodes, and so on up.

The result of primary interest to Levelt was that the trees which emerged from his data were in many respects congruent to linguistic surface structures. Since S’s intuitions apparently respect the grouping of words into surface constituents, the scaling procedure could be viewed as providing a demonstration of the ‘psychological reality’ of derived trees: the general features of surface constituency are not the products of a sophisticated linguistic sensitivity tutored in some particular theoretical tradition, but are rather the consequence of structure which guides even the naïve contemplation of sentences.

However, Levelt also reports a further result that is closer to our present concerns. If S was presented a sentence like “John drove to the store and walked home”, he typically indicated the same level of intuitive relatedness for the pairs “John drove” and “John walked”. These pairs are not, of course, similarly represented in a standard surface tree. Rather, the subject appears to be responding to some more abstract (syntactic and/or semantic) relation of the kind that is represented at deeper levels in generative grammars. What determines such intuitions is either that “John” is the deep subject of “walk” or that “John” is the agent of “walk” (or both, assuming that these facts are indeed distinct).

This suggests, in turn, that given a pair of sentences which have the same surface structures, but which differ in the abstract relations among their constituents, S’s scalings might well reflect the distribution of underlying relations. This is precisely what is required of a test for shifting. So, for example, if “expect” is a shift verb in “John expected Mary to leave”, and if “persuade” is not a shift verb in “John persuaded Mary to leave”, and if the Levelt procedure is sensitive to the underlying relations in these sentences, then we might reasonably predict subjects to scale “John” and “Mary” as more closely related in the ‘persuade’ sentences, than in the ‘expect’ sentences. Precisely similar predictions apply in the case of all the other sentence types compared in Phase I. Moreover, if the test is demonstrably sensitive to shifting (as would be witnessed by the success of the Phase I predictions), then we ought also to expect that “John” and “Mary” will be scaled as more closely related in “John bit Mary” than in “John killed Mary” unless the definitional account of the causatives is false. If it is indeed false, then we should find no systematic difference for the “kill/bite” comparison.
These ratings procedures also permit a slightly more refined way of looking at the validating materials than we have thus far described. Consider a sentence pair like 22 (taken from actual materials of the experiment). Not all the relations between constituents are affected by the difference in abstract structures between the two versions. For example, such pairs as “storm/predicted” are not implicated in this difference. If we choose such pairs throughout the range of Phase 1 comparisons, and if the Levelt test is, indeed, affected by shift, we can predict that the differences between the ratings for pairs like “storm/predicted” (referred to as “control pairs” hereafter) should be systematically smaller than those for pairs of words whose relations differ in the two versions (e.g., pairs like “captain/passengers” in 22, referred to as “experimental pairs” hereafter).

Our initial experimentation on Phase 1 and Phase 2 sentences was conducted with a (slightly modified) version of the Levelt paradigm (see Appendix, Ratings task). In the final set of experiments the procedure was further revised; a simpler format was used since, for our purposes, we do not require data for most of the possible comparisons of word pairs from the stimulus sentences (see Appendix, Forced Choice Task). In this latter procedure a subject is presented with both versions of a sentence, with a pair of words underlined in each (italicized words in this text were underlined in the stimulus sentences). Typically, it’s the same pair of words in both versions except for comparisons like ‘there-quantifier’ versus ‘where-interrogative adverb’. So, for example, the stimulus for 22 would be as follows:

22a Even though a bad storm was predicted, the captain expected the passengers to remain calm.
22b Even though a bad storm was predicted, the captain persuaded the passengers to remain calm.

The subject is forced to choose whether the designated pairs are more closely related in sentence A or sentence B. Judgments of no-difference are not allowed, but the subject is asked to indicate his degree of confidence in the judgment on a five-point scale. Most sentence types were tested with both forced choice and ratings procedures.

II.c. Results

The experimental findings are summarized in Table 1 and reported in detail in the Appendix. For present purposes, the outcomes can be stated quite briefly.
a) There are few differences between the pattern of results for the ratings procedures and that for the forced choice paradigm. Such differences as did appear are of some methodological interest, however, and are discussed in the Appendix.

b) The Phase I predictions are consistently confirmed. In Phase I comparison sets 1–4 in both tasks, shifted constituents are judged to be less related than their unshifted counterparts. In phase 1, comparison sets 5 and 6, forced choice task only, semantically unrelated constituents (subjects and predicates in the scope of negative quantifiers and the subjects and objects of intensional verbs) are judged to be less related than the corresponding constituents of their paired sentences (subjects and predicates in the scope of positive quantifiers, and the subjects and objects of non-intensional verbs). See Table 1 (Table 1 includes distinctions among sub-types not discussed here; see Appendix).

c) Across sentence types, the control pairs exhibit smaller differences in judged relatedness than the experimental pairs. That is, if a pair of constituents is not affected by the structural asymmetries between the two versions of a sentence in a Phase I comparison, then the difference between subjects’ responses for that pair of constituents is, in general, less than the corresponding difference for constituents which are implicated in the structural asymmetries.

d) In no case is there a detectable asymmetry between causative verbs and their (putatively) primitive counterparts. This finding of no difference holds in both test procedures (see Table 1, comparison set 5 for the ratings and comparison set 7 for the forced choice task). Variation in the choice of verbs used in the comparison sets for causatives did not affect the outcome. Moreover, we stress, it is not the case that the failure of the causative predictions is a “statistical” one — e.g., smaller effects that just fail to be significant, perhaps because of a greater response variability. On the contrary, the responses to the causatives were quite consistent across subjects and items, more so perhaps than some of the validating cases. There were no meaningful trends even when the power of the tests was increased by collapsing across different stimulus sets. There is, in short, no hint in these data that “kill, break” etc. are shift verbs, or, put more generally, there is no indication that the intuitive relatedness between “John” and “Mary” in “John killed Mary” differs measurably from that between “John and Mary” in “John bit Mary”.

Note: results for comparison set 6, negative quantifiers, are preliminary only; the full range of test comparisons used in other sentence types for Phase I have not been completed.
Table 1. Summary of results of Ratings and Forced Choice procedures for evaluation of syntactic and semantic relations

<table>
<thead>
<tr>
<th>Ratings task</th>
<th>Differences between scores for sentence versions, experimental pairs: B−A</th>
<th>Differences between scores for control pairs and experimental pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td>Phase I</td>
<td>Phase II</td>
</tr>
<tr>
<td></td>
<td>Items</td>
<td>Ss</td>
</tr>
<tr>
<td>Set 1 (“expect-persuade”)</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Set 2 (“eager-easy”)</td>
<td>ns</td>
<td>*</td>
</tr>
<tr>
<td>Set 3 (“sluicing”)</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Set 4A (existential “there”)</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Set 4B (existential “there”)</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Set 5A (causatives, marked)</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Set 5B (causatives, unmarked)</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Set 5C (causatives, mixed)</td>
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<td>ns</td>
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Forced choice task

Set 1 (“expect-persuade”)

<table>
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<th>Forced choice</th>
<th>Confidence</th>
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Set 2 (“eager-easy”)

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Set 3 (“sluicing”)

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<th>Forced choice</th>
<th>Confidence</th>
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Set 4 (existential “there”)

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<th>Confidence</th>
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Set 5 (quantifiers)

<table>
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<tr>
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<th>Confidence</th>
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Set 6 (intensional verbs)

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<th>Confidence</th>
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<td>*</td>
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Set 7 (causatives)

<table>
<thead>
<tr>
<th>Forced choice</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

*p < 0.05; t, one-tailed.

II.d. Discussion

a) It appears from the Phase I results that our version of Levelt’s paradigm and its forced choice variant are sensitive (at least) to patterns of semantic
relatedness among sentential constituents. At the very least, the findings offer a striking demonstration of effects of linguistic levels of representation distinct from surface constituent structures.

b) The Phase II results clearly indicated that "kill", "break", etc. are deep simplex verbs if any verbs are; viz. that the semantic representation of "John killed Mary" is something like "John killed Mary".

c) This indicates, in turn, that causative verbs are undefined; psychological reality apparently cannot be claimed for the definitional structures that have been widely alleged to underlie such verbs.

d) Since causatives seem to be 'best cases' for definition, the results suggest that there may be few or no cases of psychologically real definitions.

e) Since the present results are quite compatible with those of Kintsch (op. cit.), Fodor, Fodor and Garrett, (op. cit.), etc., it appears that previous negative findings on the psychological reality of definitions are quite probably not artifacts of the use of chronometric measures.

Part III. TSP revised

What does all this show? We review the situation in respect of each of the four aspects of TSP discussed in Part I.

III.a. Language and the world

TSP never did provide a plausible theory of the relation between terms and their extensions. It still doesn't.

As we saw in I.a, the appeal to definitions would provide for such a theory only modulo an account of the interpretation of the primitive basis. Only the Empiricist version of TSP does offer a reconstruction of the relation between primitive terms and their extensions, and it seems quite certain that the Empiricist version of TSP is indefensible. Even if there are definitions, it is wildly unlikely that they can be couched in a vocabulary of sensory/motor terms in any important number of cases.

This leaves us without a theory of language and the world. The best current hope for such a theory is perhaps to accept that aspect of the Empiricist treatment of primitive terms which claims that the relation between words and their extensions is somehow mediated by causal chains, but to abandon the condition that the relevant chains are exhaustively specifiable by reference to the behavior of sensory/motor mechanisms. (For contemporary discussions of 'causal theories' of reference, see Schwartz (1977)). What is left is thus the very weak suggestion that the relation
between, say, "Chicago" and Chicago, in virtue of which tokens of the one refer to the other, involves some sort of causal connection between the tokens and the city. This kind of view seems reasonably plausible for names, intriguing but underwhelming for some kinds of descriptions, and only possibly defensible for kind terms. It clearly has deep troubles with abstract reference, reference to fictions and the like. Nor will a psychologist find it really satisfying even where it works best. What a psychologist wants to understand is what kind of causal chains fix extensions, and what the nomologically necessary and sufficient conditions for the existence of such chains are. About these questions, nothing worth reporting is known.36

To summarize: psychologists have wanted very much to have a theory of language and the world. Many of them have thought that appeals to definitions contribute substantially to the development of such a theory, but that was largely — perhaps solely — an Empiricist illusion. There is, as things now stand, no theory of language and the world and it seems most unlikely that one will be forthcoming in the foreseeable future. A methodological principle first enunciated by the philosopher Frank Ramsey applies here: what can't be said can't be said, and it can't be whistled either.

III. Informally valid arguments

In I.b we saw reason to believe that at least some informally valid inferences are inherently asymmetric; hence that meaning postulates will have to play a role in theories of informal validity even if definitions are endorsed. There is, however, a deeper point to be made in the light of such results as those in Part II.

Definitional theories of informal validity start out as attempts to break down the distinction between the logical and non-logical vocabularies. Paradoxically, however, they end up by exalting it. For, according to such accounts, the difference between a form of argument like, say, $P \rightarrow \neg (\neg P)$ and a form of argument like bachelor $\rightarrow$ unmarried actually implicates a difference of linguistic levels; whereas the validity of the former turns on the

36Though many false accounts are widely believed. For example, the kindest way of thinking about the Skinnerian account of language is perhaps to view it as an attempt to provide a model of just such causal connections. "Chicago" refers to Chicago because the latter is a discriminative stimulus for the production of tokens of the former; the laws of operant conditioning determine when, in general, a given discriminative stimulus controls a given discriminated response. This would appear to be the right kind of story to flesh out a causal theory of reference; all we have against it is its palpable untruth.
logical apparatus, the validity of the latter is determined by relations (e.g., of 'containment'; see (Katz (1972))) among semantic representations. No wonder theorists committed to definitions have claimed a basic intuitive distinction between 'analytic' (viz. definitional) truths and mere truths of logic.

In fact, we doubt that the intuitions are actually there. Even if they are, however, the results of Part II suggest that they are not intuitions of relations specified over definitional representations. If Part II is right, subjects don't compute definitional relations in situations where linguistic intuitions are elicited; not even when the intuitions elicited implicate semantic properties of the stimulus.

If intuitions of informal validity aren't intuitions of definitional relations, what are they intuitions of? There is a plethora of possibilities, all about equally plausible and all about equally unattractive. We mention a few by way of a shopping list.

1. Intuitions of informal validity are just reports of empirical beliefs. This view has the virtue of compatibility with a post-Quineian epistemology. It explains why we seem to be able to imagine rejecting putative informally valid arguments, given suitably bizarre contingencies. (Cats are animals is supposed to be informally valid; but suppose cats turned out to be robots manipulated by Martians; suppose they turned out to have a silicon-based biochemistry; etc.)

2. Intuitions of informal validity are not just reports of empirical beliefs; they're intuitions of deductive relations determined by the logical apparatus. On this story, there will have to be standard logical rules and meaning postulates, and the distinction between the logic (which contains both) and the body of empirical generalizations (which contains neither) will have to be principled. The putative counter-examples to informal validities will have to be explained away somehow (presumably by appeal to notions like change of meaning; to discover that cats are Martian robots would be to discover that there are no cats. To claim that cats are Martian robots would be implicitly to recommend redefining "cat").

3. The distinction between empirical generalizations and informally valid ones is principled, and so is the distinction between informal validity and formal validity. This might be the case if, for example, the distinction between meaning postulates and standard logical rules is itself principled. Then informally valid arguments might be ones which involve only the meaning postulates (or only the meaning postulates together with some designated subset of the logical rules.) This is apparently the view that Carnap held; but see Quine (1963).
4. The distinction between informally valid arguments and analytic arguments is also principled. Analytic arguments might, for example, be the ones which implicate no more than precisely $n$ of the meaning postulates under some canonical formalization.

5. The distinction between informally valid arguments and analytic arguments is not principled; there are degrees of analyticity with very analytic arguments corresponding to very short routes through the meaning postulates (and, perhaps, designated logical rules as per 3 above).

Etc.... The reader who finds himself not much caring which, if any, of 1–5 is true has all our sympathy. There is, however, one point we want to emphasize: what all the non-definitional approaches to informal validity have in common is that they assume that the domain for the logical apparatus (including meaning postulates) is the output of the syntax; there is no semantic level (no level of logical form) except what may be required for the representation of such relations as quantifier binding, operator scope, etc. In particular, there is no logical form inside lexical items. It seems to us that the weight of the current evidence is that this latter claim is plausible.

If we had to bet, we'd bet on the following story and we'd stick to small sums:

a) The logical apparatus is defined over representations of logical form in something like the traditional sense (scope, binding, etc. are formally specified in the domain of the logical rules.)

b) The logical apparatus contains standard rules and meaning postulates indifferently.

c) There is no semantic level in the sense of 'linguistic semantics'; the logical apparatus has access to the surface morphological inventory of the language.

This picture comports nicely with the results of Part II; it's compatible with the notion that logical form is determined solely or in large part by surface structure; it permits ambiguities of quantifier order (and other phenomena of traditional logical syntax) to be psychologically real; it provides room for a principled notion of informal validity in case somebody should happen to find a use for one; there appears to be no solid a priori or a posteriori reason for supposing that it is false. We are available for small wagers.

III.c. Sentence comprehension without definitions

Understanding a sentence is recovering a representation that provides a domain for relevant inferential processes. If there are no definitions, then understanding a sentence is recovering its logical form. If there are no logical
forms, then understanding a sentence is recovering its syntactic structural descriptions. There must be syntactic structural descriptions; the ambiguity arguments prove it. In short, you won’t be far wrong, on the present view, if you think of a sentence comprehension system as a function from tokens to types.

Here are two possible objections:

1. How could understanding a sentence be recovering a type-individuating representation of that sentence? Such representations are just formulae in some other (e.g., meta-) language. Answer: we doubt that this objection buys much in this context. What’s certain is that it buys nothing in aid of the definitional account: DEFINITIONS ARE ALSO JUST REPRESENTATIONS IN SOME OTHER LANGUAGE! The disagreement over the psychological reality of definitions is a dispute within versions of the representational theory of mind.

2. Understanding is a graded notion; different performances count as understanding depending on the circumstances; understanding can’t be formally defined. Answer: if this is an argument at all, it’s an argument against both definitional and non-definitional accounts. Both claim that there is a level of representation whose recovery is constitutive of (or at least necessary for) sentence comprehension. They disagree only about which level it is.

No doubt the ordinary notion of understanding is graded for all that. This is primarily because nobody (except academics) is ordinarily interested in understanding sentences; what we ordinarily want is to understand what people say and what they meant by saying it, and it’s perfectly clear that all sorts of contextual, background and inferential apparatus is brought to bear in this latter undertaking.

This is not, however, an argument for studying understanding what people say and what they mean instead of studying understanding sentences. On the contrary, you can’t do the former without doing the latter, since it’s patent that the computational apparatus involved in understanding sentences is normally used in understanding people. That’s why it is, in general, easier to understand somebody who’s talking a language you know than to understand somebody who’s talking a language you don’t. A theory of understanding sentences is thus part of a theory of understanding people and, for all we now know, it may be the only part that’s sufficiently systematic to reward specifically scientific scrutiny.

What it does is force a distinction between theories of sentence comprehension and semantic theories. Since the failure to grasp this distinction is epidemic among procedural semanticists, this is no small matter. See J. A. Fodor (1978).
Briefly: if the ordinary notion of understanding is graded, so much the worse for the ordinary notion of understanding. We don’t make physics out of the ordinary notion of energy.

**III.d. The innateness controversy**

Whatever is not *definable* must be innate. This is, however, weaker than: whatever is not internally represented by its definition must be innate. For example, it may be that while *adults* represent “kill” as *kill*, children learn “kill” as *cause to die*. After a while, one might imagine, *cause to die* consolidates and *kill* comes to act as a *derived* primitive. Derived primitives are representations which (a) have no computationally relevant internal structure, but (b) are introduced into the representational system by adding eliminative bi-conditionals to the logic. Rules which introduce derived primitives are, as it were, the diachronic equivalents of definitions.

This suggests (what we believe to be correct) that the case for a rich, innate primitive conceptual system can’t be made just by demonstrating the psychological unreality of definitions in adults. The psychological reality of definitions in the adult provides a sufficient, but not a necessary, condition for the analyzability of concepts.

If you want to show that a concept which is psychologically unanalyzed for the adult is, nevertheless, only a *derived* primitive (hence definable, hence presumably, not innate) there are at least three things you can try.

1. **Show that the concept is, in principle, analyzable.** The existence of a possible analysis is *prima facie* evidence that the concept actually is analyzed somewhere in ontogeny. This card is not, however, easy to play; there are, as we have several times remarked, very few examples of plausible definitions.

2. **Show that the concept is internally complex for the child; e.g., show that the child represents “kill” as *cause to die*.** We think that the developmental literature which purports to demonstrate that the child’s concepts are typically learned by assembling complex arrays of primitives (e.g., of semantic features) is thus far unpersuasive; if one approaches the data without Empiricist preconceptions, the striking fact is the lack of evidence for ‘bottom up’ processes in concept acquisition. We won’t argue this here, however; our present concern is just to acknowledge the relevance of such data to the sorts of issues we have raised.

3. **Show that the concept is expressed by a phrase (rather than a morphemically simple expression) in some natural language or other.**

   We’ve argued that morphemically simple expressions are typically undefined, that undefined expressions typically express primitive concepts;
and that primitive concepts must be innate. The presumption that a concept expressed by a morpheme is primitive cannot, however, be right if there are actually languages in which that same concept is expressed by a phrase. For (a) if a concept can be expressed by a phrase, then it is ipso facto definable; and (b) if a concept is in fact primitive (hence innate) for any human, it must surely be primitive (hence innate) for all humans.

It would thus be extremely interesting to know how much different languages agree as to which concepts are expressed by morphemically simple expressions. Given, however, the notorious difficulty of making sense out of the translation relation, we aren't likely to find out by, say, next week.

All this should suggest — what is clearly true — that if you don't like Crumpet being innate, you still have plenty of room to wriggle. Dismantling TSP, if it is to be done at all, will surely be the work of generations, just as constructing it was. Since, however, TSP has been so widely endorsed, and since even the possibility that it is deeply wrong opens such startling vistas of speculation, it may be a good idea to end with the following considerations:

1. TSP has never worked. The appeal to definitions has been central to projects ranging from the theory of visual perception to axiomatic ethics; from linguistic semantics to the operational analysis of theoretical terms in science; from theories about how children might learn concepts to theories about how computers might understand newspapers. In each case, the underlying assumption has been that the primitive conceptual repertoire cannot be as rich as the available repertoire of categories; hence that many concepts must be analyzable. These assumptions have governed research in the Anglo-American tradition for some three hundred years; almost, in our view, totally without success. The definitions and analyses haven't been forthcoming and there is no prospect that they will turn up in the foreseeable future. Perhaps the world is trying to tell us something. Perhaps there is something wrong with our assumptions.

2. If we are finally forced to the view that people have a rich endowment of innate (e.g. triggered) concepts, that ought not to outrage intuition all that much; it would only be to accept for us a kind of doctrine that we take to be quite plausible for most of the rest of animate creation.

3. The true theory doesn't have to be boring. The theoretical reach of physics stretches to embrace the possibility of worlds in which the time arrow points backwards. Surely a little nativism ought not be more than psychologists can bear.
References


Résumé

Cet article porte sur les analyses définitionnelles de la structure du langage. Plusieurs classes d'arguments ayant trait aux définitions sont passées en revue, entre autres, celles liées aux théories classiques de la référence, aux théories de validation informelles, aux théories de la compréhension de phrases et aux théories de l'apprentissage de concept. On suggère que, dans chacun de ces domaines, les travaux qui s'appuient sur une définition ne sont pas plus justifiés par les preuves qu'une alternative plausible non-définitionnelle. On présente, en outre, une série d'observations expérimentales portant sur un de ces domaines: celui de la compréhension de phrase.

On étudie la classe des verbes causatifs, classe souvent citée en exemple de structure définitionnelle. Cette classe d'exemples n'influence pas les jugements que le sujet porte sur celles des relations entre mots des phrases causatives qui dépendent des structures définitionnelles suggérées. De façon indépendante, on montre que les jugements du sujet sont sensibles aux relations structurales de type comparable dans des formes linguistiques.
Part IV: Appendix

Introduction

Levelt (1970, 1974) has shown that speakers' ratings of the relatedness among the words of a sentence systematically reflect aspects of its surface and underlying syntactic structure. The experimental work we have discussed uses variants of Levelt's procedures for tests of both syntactic and semantic relations. The efficacy of these procedures was assessed by measures of a number of relatively uncontroversial structural and semantic distinctions and they were then applied to sentence types whose analysis is at issue in the dispute over lexical decomposition. The general implications of these experiments were discussed at length in parts I–III of this paper; in this section, we wish to make clear the nature of the test materials and test procedures we have used, and to describe the analyses made, with details of the results obtained.

We carried out two related types of experimental procedures; in each, native speakers of English were queried for their judgments of the relations among words in a variety of types of sentences.

Both tests employed very similar sets of sentences, and in both tests the criterion for subjects' responses was their estimate of the degree of relatedness holding between a particular pair of words taken from a particular sentence or pair of sentences. In the first type of test, the Ratings task, subjects were asked to rate on a five point scale how related a particular pair of words was in a given test sentence; in the second type, the Forced choice task, the subjects were forced to choose in which of two sentences a pair of words seemed more related.

The ratings tests were used primarily to examine the effect on perceived relatedness of two words being in the same simple underlying clause. The materials labelled “Stimulus Sentences Used in the Ratings Task” test the sensitivity of ratings of relatedness to the four structural contrasts detailed in Comparison Sets 1–4 (see discussion of Phase I in Part II). In the ratings task, the materials in Comparison Set 5 test the putative contrast in the underlying structures of causative verbs and simple transitive verbs (see discussion of Phase 2 in Part II of the main body of the paper).

The forced choice tests were used both for (modified) replication of the ratings task and for examining a more general interpretation of the effective relation between test word pairs. The relations subsumed by common clause membership in the materials for the ratings task might be construed in either syntactic or semantic terms (see the discussion in Part II). Therefore, to the stimulus sentences used for the forced choice task, we added sentence types
which can plausibly be claimed to contrast only in the semantic relatedness of the critical word pair; these are in Forced-choice Comparison Sets 5 and 6. For these sentences, the syntactic structure of the underlying clause containing the test pair is assumed to be virtually identical in both members of a pair. In the Forced Choice materials, Comparison Sets 1–4 and 7, we also included sentence pairs adapted from the corresponding types in the Ratings task to permit informal comparison results of the two procedures.

In both lists of materials, we have underlined and labelled the words involved in the pairs we tested. These same labels are used in the discussion of results and in the Tables as indicated.

Ratings task: Phase I, Validation

Construction of Materials

The sentences used for validation in the ratings experiments are listed here. The materials in sentence types 1, 2 and 3 were tested together (Ratings Experiment 1). The materials in 4A and 4B were tested subsequently (Ratings Experiment 2). In each experiment, subjects who rated validation sets rated causative sentence sets as well.

**COMPARISON SET 1: RATINGS TASK**
**EXPECT(A)/PERSUADE(B) SENTENCES**

1. (A) During the stormy Atlantic crossing the captain expected the passengers to be frightened.
   (B) During the stormy Atlantic crossing the captain persuaded the passengers to remain calm.

2. (A) During the fire drill the principal discovered the boy to be missing.
   (B) During the fire drill the principal told the boy to be quiet in the hall.

3. (A) On the basis of the dress rehearsal the director announced the actress to be a success.
   (B) At the dress rehearsal the director reminded the actress to speak with feeling.
4. (A) According to a syndicated \textit{columnist}, Congress \textit{believes} the President to be an honest man.

(B) According to a syndicated \textit{columnist}, Congress \textit{advised} the President to curtail military spending.

5. (A) Undoubtedly, many \textit{authors} \textit{suppose} editors to be capricious about accepting \textit{stories}.

(B) Undoubtedly, many \textit{authors} \textit{convince} editors to accept \textit{stories} that have no substance.

6. (A) Before the NFL championship playoff the coach reported the players to be in top shape.

(B) Before the NFL championship playoff the coach \textit{warned} the players to be in top shape.

\begin{center}
\textbf{COMPARISON SET 2: RATINGS TASK}
\textbf{EASY(A)/EAGER(B)}
\end{center}

1. (A) Marriage \textit{counselors} believe that wives are difficult to control in the home.

(B) Marriage \textit{counselors} believe that wives are \textit{eager} to control in the home.

2. (A) According to \textit{managers}, boxers are \textit{impossible} to \textit{train} too much.

(B) According to \textit{managers}, boxers are \textit{afraid} to \textit{train} too much.

3. (A) Most \textit{dogs} know snakes are \textit{dangerous} to bite when stretched out.

(B) Most \textit{dogs} know snakes are \textit{unable} to bite when stretched out.

4. (A) After a defeat, the generals are easy to \textit{retire} on a pension.

(B) After a defeat, the generals are content to \textit{retire} on a pension.
5. (A) African game *wards* believe *elephants* are *simple* to *move* to new ranges.
(B) African game *wards* believe *elephants* are *hesitant* to *move* to new ranges.

6. (A) When the *water* is cold, *girls* are *delightful* to *watch* from the shore.
(B) When the *water* is cold, *girls* are *content* to *watch* from the shore.

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**COMPARISON SET 3: RATINGS TASK**

**WHO(A)/NOUN(B) SLUICING SENTENCES**

1. (A) According to the gossip columns, the *heiress* married someone but only the *family knows who.*
(B) According to the gossip columns the *heiress* married someone but only the *family knows him.*

2. (A) The *winner* of the travel lottery will go somewhere for two weeks and a *computer* has *determined where.*
(B) The *winner* of the travel lottery will go somewhere for two weeks and a *computer* has *determined the place.*

3. (A) Although the ticket agent knew the *plane* left from Gate 7, the *traveller* couldn’t *find out when.*
(B) Although the ticket agent knew the *plane* left from Gate 7, the *traveller* couldn’t *find out the time.*

4. (A) The Bermuda Triangle is known to be *dangerous* and a recent *book explains why.*
(B) The Bermuda Triangle is known to be *dangerous* and a recent *book explains the reasons.*
5. (A) Pottery and other ancient artifacts are known to be buried in the Northern Hemisphere and the archeologists are trying to discover where.

(B) Pottery and other ancient artifacts are known to be buried in the Northern Hemisphere and the archeologists are trying to discover the sites.

6. (A) San Francisco is supposed to slide into the sea and the seismologists are attempting to predict when.

(B) San Francisco is supposed to slide into the sea and the seismologists are attempting to predict the date.

COMPARISON SET 4A: RATINGS TASK
THREE(A)/WHERE(B) SENTENCES

1. (A) There is an island in the Caribbean which has a free port.

(B) Where is an island in the Caribbean which has a free port?

2. (A) There is a doctor who makes house calls on Sundays.

(B) He is a doctor who makes house calls on Sundays.

3. (A) There is this friend of hers who lives in New York and always has room for guests.

(B) Who is this friend of hers who lives in New York and always has room for guests?

4. (A) There was a person playing Chopin on the lobby piano for hours.

(B) Who was the person playing Chopin on the lobby piano for hours?
5. (A) There was a man who whistled when the voluptuous model entered.
   (B) Who was the man who whistled when the voluptuous model entered.

6. (A) There were students who said the exam was too easy.
   (B) Who were the students who said the exam was too easy?

7. (A) Is there a marina on the Charles that has a gas pump?
   (B) Where is a marina on the Charles that has a gas pump?

8. (A) Is there an author who does not dream of instant success?
   (B) Who is the author who does not dream of instant success?

9. (A) There is an inventor who designed a new burglar alarm.
   (B) Who is the inventor who designed a new burglar alarm?

10. (A) There was an old woman who lived in a shoe.
     (B) Who was the old woman who lived in a shoe?

COMPARISON SET 4B: RATINGS TASK
THERE(A)/THERE(B) SENTENCES

1. (A) According to the angry tenants, there are some mice that live behind the kitchen walls.
    (B) “Look,” said the angry tenants, “there are the mice that live behind the kitchen walls.”

2. (A) According to the Scientific American, there is a proof that you never need more than four colors to draw a map.
2. (B) Waving at the blackboard, the mathematician shouted, "There is the proof that you never need more than four colors to draw a map."

3. (A) You may find it hard to believe, but there is a professor who is trying to recover solar energy from mushrooms.

   (B) If you want to meet someone interesting, over there is the professor who is trying to recover solar energy from mushrooms.

4. (A) The secretary believes there is a copy of the letter somewhere, but she can't find it.

   (B) The secretary said, "There is the copy of the letter," but her boss didn't hear her.

5. (A) Looking worried, the professor said, "I doubt that there is a good book on relativity theory for laymen."

   (B) Pointing to the shelf, the professor said, "There is a good book on relativity theory for laymen."

6. (A) On the top shelf of the refrigerator there is a kind of pie that all the children like.

   (B) Smiling proudly, the cook remarked, "Here is a kind of pie that every child will like."

7. (A) The tourists think that there is a place in Florida where Blackbeard buried his treasure.

   (B) The tourists think that this is the place in Florida where Blackbeard buried his treasure.

8. (A) "There is a most amazing statue in Rheims," gushed Jack Parr.

   (B) "Here is the most amazing statue in Rheims," gushed Jack Parr.
COMPARISON SET 5A: RATINGS TASK
CAUSATIVE(A)/TRANSITIVE(B) – UNMARKED

1. (A) Despite protests from the manager the owner closed the theater.
(B) Despite protests from the manager the owner sold the theater.

2. (A) Sitting in his high chair the baby spilled the juice in his cup.
(B) Sitting in his high chair the baby drank the juice in his cup.

3. (A) In the orchard the children bent the branches to get the apples.
(B) In the orchard the children pulled the branches to get the apples.

4. (A) Despite the wind the firemen stopped the fire quickly.
(B) Despite the wind the firemen controlled the fire quickly.

5. (A) At the end of the day the guard locked the gate in the yard.
(B) At the end of the day the guard bolted the gate in the yard.

6. (A) Nimbly the squirrel cracked the nut on a high branch.
(B) Nimbly the squirrel ate the nut on a high branch.

COMPARISON SET 5B: RATINGS TASK
CAUSATIVE(A)/TRANSITIVE(B) – MORPHOLOGICALLY MARKED

1. (A) After the meat was sliced the chef thickened the sauce.
(B) After the meat was sliced the chef tasted the sauce.

2. (A) Many years ago the contractors deepened the channel in the Panama Canal.
(B) Many years ago the contractors planned the channel in the Panama Canal.
3. (A) While working in the shop the carpenter straightened the nails.
   (B) While working in the shop the carpenter discarded the nails.

4. (A) In setting up the tent the scouts loosened the lines on the center pole.
   (B) In setting up the tent the scouts tied the lines on the center pole.

5. (A) In colonial times blacksmiths hardened the steel to make an axe.
   (B) In colonial times blacksmiths cut the steel to make an axe.

6. (A) After the operation the nurse darkened the room so the patient could sleep.
   (B) After the operation the nurse left the room so the patient could sleep.

COMPARISON SET 5C: RATINGS TASK
CAUSATIVE(A)/TRANSITIVE(B) SENTENCES

1. (B) While patching up the old house the workers found some paint in the basement.
   (A) While patching up the old house the workers spilled some paint in the basement.

2. (B) When the police reached the demonstration, they told the people to go home.
   (A) When the police stopped the demonstration, they told the people to go home.

3. (B) Nobody noticed that during the poker game the gambler used a card from his sleeve.
   (A) Nobody noticed that during the poker game the gambler dropped a card from his sleeve.

4. (B) The cautious hunters heard the cougar that was hiding in the tree.
   (A) The cautious hunters killed the cougar that was hiding in the tree.
5. (B) In the middle of a quiet afternoon the students found a fire in the chemistry laboratory.

(A) In the middle of a quiet afternoon the students started a fire in the chemistry laboratory.

6. (B) Against the recommendation of his advisors the mayor supported the project for redevelopment.

(A) Against the recommendation of his advisors the mayor ended the project for redevelopment.

7. (B) The Sunday paper repeated the story that the senator was about to resign.

(A) The Sunday paper spread the story that the senator was about to resign.

8. (B) The retiring chairman attended the meeting of the Board of Trustees for the last time.

(A) The retiring chairman convened the meeting of the Board of Trustees for the last time.

9. (B) Before going on camera, the chef added the ingredients according to the recipe.

(A) Before going on camera, the chef combined the ingredients according to the recipe.

10. (B) With only fifteen seconds left, the fullback got the football on the one-yard line.

(A) With only fifteen seconds left, the fullback put the football on the one-yard line.

To determine the sensitivity of the ratings task to the relevant structural features, we asked subjects to rate the relatedness of word pairs formed by using the items in italics in the materials lists; for the four words in italics, all six possible pairs were rated (though not all are relevant to our concerns). The relevant word pairs are determined by the structural analyses of each of the sentence types. Those analyses and their application to the ratings pairs are described in Part II of the main body of the paper.
The first two types of sentences (expect/persuade sentences: Set 1, and eager/easy sentences: Set 2) have been the object of earlier experimentation using other experimental techniques, both in our laboratory and those of other researchers (see e.g., Walker, 1976; Fodor, Bever and Garrett, 1974; Cooper, 1976). Those experimental enquiries all indicate that the structural contrasts of these sentences are effective in immediate memory, perception and production. We have no such prior experimental assurances for the types in Sets 3 and 4.

In each of these four sentence types, there are word pairs in the A versions which do not share underlying clause membership, while in B versions, they do. Assuming the characterizations of underlying clause structure given in Part II, the judgments of the degree of relatedness in the several sentence types should show the relation A < B; for example, word pairs taken from the stimulus sentences indicated should display the following pattern:

1,1) ... captain expected passengers < captain persuaded passengers
2,4) ... generals are easy < generals are content
3,1) ... family knows who < family knows him
4A,1) ... there is an island < where is an island
4B,2) ... there is a proof < there is the proof

These comparisons involving the surface subject and object (or predicate adjective, in Set 2) are designated the primary pairs of our analysis; this is because they are the pairs in the sentences for sets 1–4 which most precisely parallel the word pairs in Set 5, the causatives, for which the definitional analysis makes the clearest prediction. Note that, unlike the primary pairs, the prediction of an A–B difference for subject verb pairs in the causatives is complicated by the fact that a “feature” of the putatively decomposed surface verb (namely, the deep verb “cause”) is associated with the subject noun in underlying structure (see Part II, Fig. 4). The verb and object-noun pairs in the causatives do not, of course, yield any prediction of differences on the grounds of underlying clausal membership. Hence, the subject, object pair provides the only clear test case for the causatives.

However, in Sets 1 and 3, we can make an additional prediction: the verb and object-noun pairs (“secondary pairs”) should show the same pattern as the primary pairs. In both these sentence types, these words are assigned to distinct underlying clauses in the A versions and to common underlying clauses in the B versions. Note that sentence Sets 2 and 4 do not lend themselves to such a prediction; the sentences of 2 do not contain an explicit surface object, and those of 4 do not contain appropriate verbs.

In addition to the words directly involved in the relevant structural contrast, we also obtained judgments involving a fourth unrelated word. This
was done in order to test for the specificity of the manipulated structures as the determinant of the judgments obtained. One might well imagine that the structural differences between the A and B versions could create some "whole sentence" effects on relatedness judgments; the structural change might affect all words in the sentences regardless of clausal membership. To evaluate this possibility we tested word pairs involving, e.g., the subject noun and a nearby extra-clausal word, such as "crossing" in (1,1) or "defeat" in (2,4), etc., whose relations do not change from A to B versions. Such pairs should not differ in their ratings in the two versions of the sentences. The relevant words (labelled "C") for "control" are marked in the stimulus lists and again in the tables of results. Wherever feasible, the control pairs use a neutral word plus the pivotal noun whose clausal relations change from A to B in the manipulated portions of the test sentences. (Note that the control pairs for sentence set 2 are somewhat complicated by the involvement of the surface subject in different underlying grammatical relations.)

One further control problem is relevant. That is the possibility that intrinsic relations between the particular words of a test pair may obscure or contribute to the structurally induced variations. On this point, note first that for the primary comparison (the subject, object pairs) identical words are tested in Sets 1 and 4 among the validating cases and also in Set 5, the causative test case; similarly for the control pairs. Thus, frequency effects, length effects, imageability, etc., as well as the intrinsic relation between the pair members is controlled for that comparison. It was not always possible to maintain identity from version to version of the sentences, but where feasible, we adhered to a minimal pair principle in sentence construction. In the ideal case, only one word changes from version A to version B. In others, some additional changes made to material surrounding the critical contrast were motivated by a desire to render both sentence versions comparably plausible or natural expressions.

Beyond the matching of compared items, we have taken one further step to assess the effects of variation from A to B versions: All the test word pairs which were rated in sentence contexts were also rated in isolation. A randomly ordered list of A version pairs and a matched list of the B version pairs was rated by independent groups. This provides some measure of the effect of intrinsic relations between the members of word pairs which do differ in their lexical content.

Finally, we note that in both experiments a variety of sentences representing each of the structural types were used; we have not relied upon only two or three exemplars of each type. By so doing, we reduce the possibility that observed differences depend upon the idiosyncrasies of particular sen-
tences. In the ratings experiment, the numbers of sentences representing a given type is smaller \((n = 6)\) than that for the forced choice experiment \((n = 20)\). The ratings task is more time consuming, hence the conservatism in numbers compared to the forced choice tests. This was, as the tests indicate, not the best accommodation, for it weakened item based tests for ratings. In both experiments an evaluation of effects based upon items is reported, as well as an evaluation based on subjects.

**Procedures and Analysis**

In the ratings task, a given subject saw only one version of any given sentence pair, and each subject saw equal numbers of A and B versions. Experiment 1 subjects saw a randomly ordered series consisting of A or B versions of sentences in Comparison Sets 1, 2, 3, 5A and 5B; experiment 2 subjects saw a randomly ordered series from Comparison Sets 4A and 5C; 4B sentences were separately run. A new randomization was used for each subject. Presentation and response were written (computer-printed test booklets), with a sentence typed above the list of six word pairs, and each pair associated with a five point rating scale. Subjects were instructed to rate the degree of relation holding between each pair of words, using their understanding of the printed sentence as their basis of judgment. 60 MIT undergraduates who were paid for their voluntary participation were run as subjects in experiment 1, and 40 in experiment 2.

The ratings obtained were adjusted for idiosyncratic subject and item variability. Item scores were expressed as deviations from each subject’s mean rating score across all his rating judgments, thus removing differences in subjects’ use of the rating scale from the comparison of A and B versions of given sentences. Similarly, subject scores were expressed as deviations from each (paired) item’s mean rating across all judgments. These scores were tested for A–B differences on experimental word pairs (those which differ in clausal relations in the two versions) and control word pairs (those whose structural relation is constant across versions). Separate analyses are reported for each structural type, for the primary test pair and its control; where available, results for secondary test pairs are reported.

**Results**

For sentence type 1, the primary pair is the subject-object pair (e.g. “captain” and “passengers” in the illustrative sentence pair in Table 2) and the control pair is the subject noun and an unrelated control word (e.g. “captain” and “crossing” in the illustrated pair). Table 2 provides results.
Table 2.  Sentence Set I, Rating Scales. Tests for common clause membership in VP complements (B versions) versus disjoint membership in NP complements (A versions)

Example sentence pair with target words in italics:

<table>
<thead>
<tr>
<th></th>
<th>control</th>
<th>subject</th>
<th>verb</th>
<th>object</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During the stormy Atlantic crossing the captain expected the passengers to be frightened.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During the stormy Atlantic crossing the captain persuaded the passengers to remain calm.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analysis type</th>
<th>Items (n = 6)</th>
<th>Subjects (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean B-A differences for primary word pairs</td>
<td>0.333 t = 2.185 (df = 5) p &lt; 0.040</td>
<td>0.332 t = 2.926 (df = 59) p &lt; 0.002</td>
</tr>
<tr>
<td>(subject-object)</td>
<td></td>
<td>min F' ns</td>
</tr>
<tr>
<td>mean B-A differences for control word pairs</td>
<td>0.025 t = 0.109 (df = 5) p &lt; 0.459</td>
<td>0.029 t = 0.203 (df = 59) p &lt; 0.420</td>
</tr>
<tr>
<td>(subject-control)</td>
<td></td>
<td>min F' ns</td>
</tr>
<tr>
<td>primary pairs versus control pairs</td>
<td>t = -1.119 (df = 5) p &lt; 0.148</td>
<td>t = -1.540 (df = 59) p &lt; 0.064</td>
</tr>
<tr>
<td>mean B-A differences for secondary word pairs</td>
<td>0.775 t = 2.747 (df = 5) p &lt; 0.020</td>
<td>0.776 t = 5.994 (df = 59) p &lt; 0.001</td>
</tr>
<tr>
<td>(verb-object)</td>
<td></td>
<td>min F' = 6.236 p &lt; 0.05</td>
</tr>
<tr>
<td>mean B-A differences for secondary control pairs</td>
<td>-0.067 t = -0.268 (df = 5) p &lt; 0.399</td>
<td>-0.069 t = -0.505 (df = 59) p &lt; 0.307</td>
</tr>
<tr>
<td>(verb-control)</td>
<td></td>
<td>min F' ns</td>
</tr>
<tr>
<td>secondary pairs versus control pairs</td>
<td>t = -2.239 (df = 5) p &lt; 0.037</td>
<td>t = -4.538 (df = 59) p &lt; 0.001</td>
</tr>
</tbody>
</table>

If common clausal membership is an effective determinant of relatedness judgments, we would expect the ratings for B versions to be higher than ratings for the corresponding A versions of these sentences: e.g., "captain" and "passengers" should be judged more closely related when they are connected by the verb "persuaded" than when connected by the verb "expected". The relation between "captain" and "crossing" should, by contrast, remain constant; and similarly for the verb-object pair and its control.
As Table 2 indicates, this seems to be the case: B–A differences depart significantly from zero for both subject and item based analyses. The control pair for the subject-object comparison does not reach significance for either analysis. The direct comparison of the subject-object pair differences and the subject-control pair differences does not reach significance, though the difference is of the expected type. The result for the verb-object pair and the verb-control pair shows exactly the same pattern, but in this case, the direct comparison of experimental and control pairs is significant.

We note here that these and subsequent comparisons are, as the tables indicate, evaluated by min F' statistic as well. Rarely do the differences for the ratings experiment achieve significance by this test.

Table 3. *Sentence Set 2, Rating Scales. Tests for predicate adjective constructions, common clause membership (B versions) versus disjoint membership (A versions)*

<table>
<thead>
<tr>
<th>Analysis type</th>
<th>Items (n = 6)</th>
<th>Subjects (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean B-A differences for primary word pairs (subject-adjective)</td>
<td>0.600</td>
<td>0.602</td>
</tr>
<tr>
<td>t = 1.223 (df = 5)</td>
<td>t = 3.321 (df = 59)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.138</td>
<td>p &lt; 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
<tr>
<td>mean B-A differences for control word pairs (subject-control)</td>
<td>0.200</td>
<td>0.201</td>
</tr>
<tr>
<td>t = 0.529 (df = 5)</td>
<td>t = 1.793 (df = 59)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.310</td>
<td>p &lt; 0.039</td>
<td></td>
</tr>
<tr>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
<tr>
<td>primary pairs versus control pairs</td>
<td>t = -2.054 (df = 5)</td>
<td>t = -3.529 (df = 59)</td>
</tr>
<tr>
<td>p &lt; 0.240</td>
<td>p &lt; 0.046</td>
<td></td>
</tr>
<tr>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
</tbody>
</table>

In the cagey/easy sentences of Comparison Set 2, the primary test pair is the subject, adjective pair (e.g. "generals" and "content" versus "generals" and "easy" in the illustrative sentence pair of Table 3). As Table 3 shows, the means for B versions were significantly higher than those for A versions for the subject based analysis in both the experimental and control pairs.
Direct comparison of the differences shows the experimental pair differences to significantly exceed those for the control pairs. Item based analyses, though in the expected direction, do not reach significance. Note that for this case, we have used as a control pair two words which are in the same underlying clause in both versions ("generals" and "retire"), but which have differing grammatical roles in that clause—e.g., "generals" is an underlying subject in the A version and an underlying object in the B version. This difference may have compromised the control pair; a better choice for a control pair would perhaps have been "retire", "pension".

For the "sluicing" sentences of sentence Set 3, the primary comparison is again the subject, object pair (e.g., "family" and "who" versus "family" and "him" in the illustrative pair). Table 4 presents the results.

Table 4.  **Sentence Set 3, Rating Scales. Tests for sluicing construction, common clause membership (B versions, direct object) versus disjoint membership (A versions, sluiced object)**

Example sentence pair with target words in italics:

A. According to the gossip columns the *heiress* married someone but only the *family* knows
   object *who*.

B. According to the gossip columns the *heiress* married someone but only the *family* knows
   object *him*.

<table>
<thead>
<tr>
<th>Analysis type</th>
<th>Items (n = 6)</th>
<th>Subjects (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean B-A differences for primary word pairs</td>
<td>0.398</td>
<td>0.409</td>
</tr>
<tr>
<td>(subject-object)</td>
<td><em>t</em> = 2.359 (df = 5)</td>
<td><em>t</em> = 2.621 (df = 59)</td>
</tr>
<tr>
<td></td>
<td><em>p</em> &lt; 0.033</td>
<td><em>p</em> &lt; 0.005</td>
</tr>
<tr>
<td>mean B-A differences for control word pairs</td>
<td>-0.027</td>
<td>-0.020</td>
</tr>
<tr>
<td>(subject-control)</td>
<td><em>t</em> = -0.096 (df = 5)</td>
<td><em>t</em> = -0.100 (df = 59)</td>
</tr>
<tr>
<td></td>
<td><em>p</em> &lt; 0.463</td>
<td><em>p</em> &lt; 0.461</td>
</tr>
<tr>
<td>primary pairs versus control pairs</td>
<td><em>t</em> = -1.293 (df = 5)</td>
<td><em>t</em> = -1.549 (df = 59)</td>
</tr>
<tr>
<td></td>
<td><em>p</em> &lt; 0.123</td>
<td><em>p</em> &lt; 0.063</td>
</tr>
</tbody>
</table>

(Continued on facing page)
Table 4. (Continued)

<table>
<thead>
<tr>
<th>Analysis type</th>
<th>Items (n = 6)</th>
<th>Subjects (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean B-A differences for secondary word pairs (verb-object)</td>
<td>0.945</td>
<td>0.015</td>
</tr>
<tr>
<td>( t = 0.072 ) (df = 5)</td>
<td>( t = 0.113 ) (df = 59)</td>
<td></td>
</tr>
<tr>
<td>( p &lt; 0.003 )</td>
<td>( p &lt; 0.455 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
<tr>
<td>mean B-A differences for secondary control pairs (verb-control)</td>
<td>-0.311</td>
<td>-0.299</td>
</tr>
<tr>
<td>( t = -4.098 ) (df = 5)</td>
<td>( t = -2.108 ) (df = 59)</td>
<td></td>
</tr>
<tr>
<td>( p &lt; 0.004 )</td>
<td>( p &lt; 0.019 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
<tr>
<td>secondary pairs versus control pairs</td>
<td>( t = -2.828 ) (df = 5)</td>
<td>( t = -1.466 ) (df = 59)</td>
</tr>
<tr>
<td>( p &lt; 0.020 )</td>
<td>( p &lt; 0.074 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
</tbody>
</table>

Again, we find that for both subject and item based analyses the B versions yield higher relatedness scores than do the A versions for the subject, object test pairs. By contrast, the control pairs show no indication of an A, B difference. As with the type 1 sentences, the direct comparison approaches, but does not reach significance.

The secondary comparison (verb, object pairs) in these sentences does show a significant contrast (on the item based analysis), between experimental and control differences. This contrast should not be interpreted, however, because it arises from a significant negative difference between A and B versions for the control pair, as well as a significant positive difference for the experimental pair. The subject based analysis for the experimental pair differences is also non-significant. Given these facts, the secondary comparison, though significant for items, should be discounted.

Sentence types 1, 2 and 3 all show, for the primary comparisons, the pattern of results expected on the assumption that common underlying clause membership increases judged degree of relatedness for the words of a sentence. Though the patterns in each case are the same, and for the most part statistically significant in themselves, direct comparisons with control pairs are usually not significant. However, if one collapses the three sentence types for a single test of the contrast between experimental and control pairs, one finds a significant difference between the primary pairs and control pairs for both subject and item based analyses though not by the min F' test. The mean B-A difference across the three sets is 0.448 for subjects and 0.444 for items on the experimental pairs; by contrast, the mean differences for control pairs are 0.070 for subjects and 0.066 for items.
Though ratings experiment 1 also included tests of causative verbs, we will postpone their report until after the report of a further validation of the test instrument using sentences of types 4A and 4B from experiment 2. These sentences, though they also contrast word pairs in terms of underlying clausal membership, do so in a different way from sentences in types 1, 2, and 3. In 4A and 4B, on the analyses we described for these sentences, the existential “there” of the primary test pairs is transformationally introduced, and simply is not present in underlying representations of the test sentences. We also changed from five point scales to seven point scales for these tests.

Table 5.  

<table>
<thead>
<tr>
<th>Example sentence pair with target words in italics:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A. There is an island in the Caribbean which has a free port.</td>
<td></td>
</tr>
<tr>
<td>B. Where is an island in the Caribbean which has a free port?</td>
<td></td>
</tr>
</tbody>
</table>

Analysis type

<table>
<thead>
<tr>
<th>Items (n = 10)</th>
<th>Subjects (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean B-A differences for primary word pairs (subject-object)</td>
<td>1.670</td>
</tr>
<tr>
<td>t = 10.167 (df = 9)</td>
<td>t = 8.647 (df = 39)</td>
</tr>
<tr>
<td>p &lt; 0.001</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>mean B-A differences for primary control pairs (control-control)</td>
<td>0.095</td>
</tr>
<tr>
<td>t = 0.561 (df = 9)</td>
<td>t = 0.556 (df = 39)</td>
</tr>
<tr>
<td>p &lt; 0.294</td>
<td>p &lt; 0.291</td>
</tr>
<tr>
<td>primary pairs versus control pairs</td>
<td>t = 6.143 (df = 9)</td>
</tr>
<tr>
<td>p &lt; 0.001</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>min F' = 43.387</td>
<td>min F' = 19.785</td>
</tr>
<tr>
<td>p &lt; 0.01</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>

Tables 5 and 6 give the results for tests on these two sentence sets. The results are quite uniform and very robust. Differences between the A and B versions are large (and significant) for the experimental pairs in type 4A (“there”/“where”) sentences, while those for the control pairs are small and nonsignificant. Direct comparison of the experimental and control pair differences is significant for both subjects and items, and by min F’.
Table 6.  *Sentence Set 4B, Rating Scales. Tests for existential 'there' constructions, common clause membership (B versions, demonstrative pronoun) versus disjoint membership (A versions, existential 'there')*

Example sentence pair with target words in italics:

**A.** According to the Scientific American, *there* is a *proof* that you never need more than *four colors* to draw a map.

**B.** Waving at the blackboard, the mathematician shouted, "*There is the proof* that you never need more than *four colors* to draw a map."

<table>
<thead>
<tr>
<th>Analysis type</th>
<th>Items (n = 8)</th>
<th>Subjects (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean B-A differences for primary word pairs (subject-object)</td>
<td>0.639</td>
<td>0.643</td>
</tr>
<tr>
<td></td>
<td>( t = 1.893 ) (df = 7)</td>
<td>( t = 4.121 ) (df = 39)</td>
</tr>
<tr>
<td></td>
<td>( p &lt; 0.050 )</td>
<td>( p &lt; 0.001 )</td>
</tr>
<tr>
<td>mean B-A differences for primary control pairs (control-control)</td>
<td>-0.244</td>
<td>-0.244</td>
</tr>
<tr>
<td></td>
<td>( t = -1.973 ) (df = 7)</td>
<td>( t = -1.288 ) (df = 39)</td>
</tr>
<tr>
<td></td>
<td>( p &lt; 0.045 )</td>
<td>( p &lt; 0.103 )</td>
</tr>
<tr>
<td>primary pairs versus control pairs</td>
<td>( t = -2.629 ) (df = 7)</td>
<td>( t = -3.577 ) (df = 39)</td>
</tr>
<tr>
<td></td>
<td>( p &lt; 0.017 )</td>
<td>( p &lt; 0.001 )</td>
</tr>
</tbody>
</table>

*Note:* min F', ns

The pattern for the type 4B ("there"/"there") sentences is essentially the same. The only pause one might take is over the negative difference between versions for the 4B control pairs. This makes the experimental/control comparison less useful. It seems likely that this effect may have arisen as a contrast effect because of the strongly felt differences for the B versions of the primary pairs. The 4B sentences were run separately from the other sets and hence the "padding" effect of other pairs and other sentence types was lacking. However, given the significance of the A/B differences for the primary test pair, and the outcome of the tests for type 4A, there does not seem much room for doubt that the test is strongly sensitive to the relevant structural feature, even though there is some indication that it may be sensitive to other aspects of sentence organization as well.
Phase 2: Tests of causatives with the Ratings Task

Results

We now turn our attention to the results for the tests on causative verbs in the two ratings experiments (Comparison Sets 5A, 5B and 5C). Here we find a quite different outcome from that for Phase 1. As Tables 7, 8 and 9 indicate, the contrast of causative verbs with simple transitive verbs in these sentences gives no evidence of an effect like that just described for sets 1, 2, 3 and 4.

Table 7.  *Sentence Set 5A. Rating Scales. Tests for causatives, common clause membership (B versions, transitive verb) versus disjoint membership (A versions, unmarked causative verb)*

<table>
<thead>
<tr>
<th></th>
<th>Analysis type</th>
<th>Items (n = 5)</th>
<th>Subjects (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>mean B-A differences</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>for primary word pairs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(subject-object)</td>
<td>0.002</td>
<td>0.091</td>
<td></td>
</tr>
<tr>
<td></td>
<td>t = 0.012 (df = 4)</td>
<td>t = 0.577 (df = 59)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.496</td>
<td>p &lt; 0.283</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
<tr>
<td>for primary control pairs</td>
<td>0.172</td>
<td>0.199</td>
<td></td>
</tr>
<tr>
<td>(subject-control)</td>
<td>t = 0.661 (df = 4)</td>
<td>t = 1.247 (df = 59)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.272</td>
<td>p &lt; 0.108</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
<tr>
<td>for primary pairs versus control pairs</td>
<td>t = 0.566 (df = 4)</td>
<td>t = 0.454 (df = 59)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.170</td>
<td>p &lt; 0.325</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
<tr>
<td>for secondary word pairs</td>
<td>0.152</td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td>(subject-verb)</td>
<td>t = 0.880 (df = 4)</td>
<td>t = 0.244 (df = 59)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.214</td>
<td>p &lt; 0.404</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
<tr>
<td>for secondary control pairs</td>
<td>-0.198</td>
<td>0.074</td>
<td></td>
</tr>
<tr>
<td>(verb-control)</td>
<td>t = -1.094 (df = 4)</td>
<td>t = 0.476 (df = 59)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.167</td>
<td>p &lt; 0.318</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
</tbody>
</table>

*(Continued on facing page)*
Table 7 (Continued)

<table>
<thead>
<tr>
<th>Analysis type</th>
<th>Item (n = 5)</th>
<th>Subjects (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary pairs versus secondary control pairs</td>
<td>( t = -1.399 \text{ (df = 4)} )</td>
<td>( p &lt; 0.078 )</td>
</tr>
<tr>
<td></td>
<td>( t = 0.208 \text{ (df = 59)} )</td>
<td>( p &lt; 0.252 )</td>
</tr>
<tr>
<td></td>
<td>( t = 0.064 \text{ (df = 4)} )</td>
<td>( p &lt; 0.480 )</td>
</tr>
<tr>
<td>Secondary pairs versus primary control pairs</td>
<td>( t = 0.748 \text{ (df = 59)} )</td>
<td>( p &lt; 0.229 )</td>
</tr>
<tr>
<td></td>
<td>( t = 0.064 \text{ (df = 4)} )</td>
<td>( p &lt; 0.500 )</td>
</tr>
</tbody>
</table>

Table 8. *Sentence Set 5B, Rating Scales. Tests for causatives, common clause membership (B versions, transitive verb) versus disjoint membership (A versions, marked causative verb).*

Example sentence pair with target words in italics.

<table>
<thead>
<tr>
<th></th>
<th>control</th>
<th>subject verb</th>
<th>object</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>After the <em>meat</em> was sliced the <em>chef thickened</em> the <em>sauce</em>.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>After the <em>meat</em> was sliced the <em>chef tasted</em> the <em>sauce</em>.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analysis type</th>
<th>Items (n = 6)</th>
<th>Subjects (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean B-A differences for primary word pairs (subject-object)</td>
<td>(-0.133)</td>
<td>(-0.132)</td>
</tr>
<tr>
<td></td>
<td>( t = -1.576 \text{ (df = 5)} )</td>
<td>( t = 0.745 \text{ (df = 59)} )</td>
</tr>
<tr>
<td></td>
<td>( p &lt; 0.088 )</td>
<td>( p &lt; 0.229 )</td>
</tr>
<tr>
<td>Mean B-A differences for primary control pairs (subject-control)</td>
<td>0.000</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>( t = -0.001 \text{ (df = 5)} )</td>
<td>( t = 0.006 \text{ (df = 59)} )</td>
</tr>
<tr>
<td></td>
<td>( p &lt; 0.500 )</td>
<td>( p &lt; 0.500 )</td>
</tr>
<tr>
<td>Primary pairs versus primary control pairs</td>
<td>( t = 0.526 \text{ (df = 5)} )</td>
<td>( t = 0.590 \text{ (df = 59)} )</td>
</tr>
<tr>
<td></td>
<td>( p &lt; 0.303 )</td>
<td>( p &lt; 0.279 )</td>
</tr>
<tr>
<td>Mean B-A differences for secondary word pairs (subject-verb)</td>
<td>0.042</td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td>( t = -0.222 \text{ (df = 5)} )</td>
<td>( t = -0.350 \text{ (df = 59)} )</td>
</tr>
<tr>
<td></td>
<td>( p &lt; 0.426 )</td>
<td>( p &lt; 0.364 )</td>
</tr>
<tr>
<td>Mean B-A differences for secondary control pairs (verb-control)</td>
<td>0.083</td>
<td>0.084</td>
</tr>
<tr>
<td></td>
<td>( t = 0.285 \text{ (df = 5)} )</td>
<td>( t = 0.551 \text{ (df = 59)} )</td>
</tr>
<tr>
<td></td>
<td>( p &lt; 0.393 )</td>
<td>( p &lt; 0.291 )</td>
</tr>
</tbody>
</table>

(Continued on following page)
The sentences of type 5A are not morphologically marked (i.e., surface and deep verbs differ in form) whereas those of 5B are so marked (the form of the surface transitive corresponds to that of the underlying intransitive except for the presence of the participial ending in the surface verb). No differences that are relevant to the putative clausal analysis of the causatives were manifest. Neither sentence set revealed a significant contrast of A and B versions for experimental or control pairs. This was true for both the primary test pairs (subject, object) and for the secondary test pairs (subject, verb).

For Comparison Set SC, the marked/unmarked causative distinction was eliminated, and the set of sentences enlarged (n = 10). Again, however, the primary test pairs show no hint of a difference, nor for that matter, do their controls. The secondary test pairs (subject, verb) did show a significant subject based effect, but it was in the direction opposite to that predicted by the causative analysis (e.g., "workers" and "spilled" was judged more related than "workers" and "found"). Item based analyses were not significant. The contrast of experimental and control pairs was significant because the direction of effects was opposite in the two cases. Whatever the reason for this effect, it provides no comfort for the causative analysis.

Overall, the three tests of the causatives are remarkably uniform. They indicate no distinction between A and B versions or between experimental and control pairs.

The final results we will note for the ratings task are those for test word pairs presented in isolation (i.e., with no sentence contexts). These ratings were obtained to help evaluate the effects of intrinsic relations between the members of the test pairs. For the pairs from Set 1, ("expect/persuade" sentences), Set 2 ("eager/easy" sentences), and Set 4B (existential "there" sentences, there are no significant differences between A and B version pairs. This is surely to be expected for Sets 1 and 4B, for the pairs are iden-
Table 9.  

**Sentence Set SC, Rating Scales. Tests for causatives, common clause membership (B versions, transitive verb) versus disjoint membership (A versions, causative verb)**

Example sentence pair with target word in italics:

<table>
<thead>
<tr>
<th></th>
<th>control</th>
<th>subject</th>
<th>verb</th>
<th>object</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. While patching up the old <em>house</em> the <em>workers spilled</em> some <em>paint</em> in the basement.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. While patching up the old <em>house</em> the <em>workers found</em> some <em>paint</em> in the basement.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analysis type</th>
<th>Items (n = 10)</th>
<th>Subjects (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean B-A differences for primary word pairs (subject-object)</td>
<td>0.012</td>
<td>0.009</td>
</tr>
<tr>
<td>t = 0.109 (df = 9)</td>
<td>t = 0.078 (df = 39)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.458</td>
<td>p &lt; 0.469</td>
<td></td>
</tr>
<tr>
<td>mean B-A differences for primary control pairs (subject-control)</td>
<td>0.044</td>
<td>0.038</td>
</tr>
<tr>
<td>t = 0.394 (df = 9)</td>
<td>t = 0.301 (df = 39)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.352</td>
<td>p &lt; 0.383</td>
<td></td>
</tr>
<tr>
<td>primary pairs versus primary control pairs</td>
<td>t = −0.214 (df = 9)</td>
<td>t = −0.169 (df = 39)</td>
</tr>
<tr>
<td>p &lt; 0.428</td>
<td>p &lt; 0.434</td>
<td></td>
</tr>
<tr>
<td>mean B-A differences for secondary word pairs (subject-verb)</td>
<td>−0.245</td>
<td>−0.245</td>
</tr>
<tr>
<td>t = −1.556 (df = 9)</td>
<td>t = −2.173 (df = 39)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.077</td>
<td>p &lt; 0.018</td>
<td></td>
</tr>
<tr>
<td>mean B-A differences for secondary control pairs (verb-contrb)</td>
<td>0.159</td>
<td>0.153</td>
</tr>
<tr>
<td>t = 1.077 (df = 9)</td>
<td>t = 1.161 (df = 39)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.155</td>
<td>p &lt; 0.127</td>
<td></td>
</tr>
<tr>
<td>secondary pairs versus secondary control pairs</td>
<td>t = −2.030 (df = 9)</td>
<td>t = −2.097 (df = 39)</td>
</tr>
<tr>
<td>p &lt; 0.037</td>
<td>p &lt; 0.022</td>
<td></td>
</tr>
<tr>
<td>secondary pairs versus primary control pairs</td>
<td>t = −1.224 (df = 9)</td>
<td>t = −1.385 (df = 39)</td>
</tr>
<tr>
<td>p &lt; 0.126</td>
<td>p &lt; 0.067</td>
<td></td>
</tr>
</tbody>
</table>

For the Set 2 cases, however, this provides us with some assurance that the differences observed in the sentence experiments were not the consequence of different intrinsic relations between the predicate adjectives and their subject nouns.

For the pairs from Sets 3 ("sluicing") and 4A (existential "there" versus locatives and other pronouns), there are significant differences. For the Set 3
case, the difference is of the same magnitude as that observed in the sentence experiment (mean difference in sentences: 0.501; in isolation: 0.521). It should be recalled that the sluicing cases were somewhat less clear-cut on structural grounds as well. The results with ratings in isolation, plus the structural imponderables, indicate that we should not place much weight on the results with the sluicing sentences in the ratings task.

The existential "there" case is different, however. The magnitude of the differences observed for the ratings in isolation is about half that observed for the sentence ratings (a mean B-A difference of 1.67 scale units versus 0.81 scale units). In fact, if one subtracts the values for ratings in isolation from their corresponding values for ratings in sentence contexts, the residual differences for the sentences are still significantly different in A and B versions. Given that fact and the positive results with the sentences of Set 4B, the existential "there" results seem secure.

The results summarized in Tables 2-8 indicate that subjects in the ratings task are responsive to the manipulated variable of underlying clausal membership where there are reasonably clear syntactic grounds for such assignments. The results of Table 9 indicate no variation due to the putative decomposition of causative verbs. We turn now to a discussion of the procedures and results for the forced-choice task.

Forced Choice Experiments: Phase I

Construction of materials

The sentences which were used in the forced-choice experiments are listed here. Minor changes were made in some of the sentences that were used in the ratings task and they were included among those used in the forced-choice task. To these a number of new sentences of each type were added to increase the number of test sentence pairs (n = 20 for most groups). In addition, two new structural types were added (see Comparison Sets 5 and 6) which provide a more general (semantically based) evaluation of the basis for subjects' judgments of relatedness in these tasks. Recall that in the sentence types included for Comparison Sets 5 and 6, the contrast of A and B versions is not plausibly susceptible of a syntactic construal (see Part II of the paper for discussion).

The experimental and control word pairs are in italics in the lists. We have confined our attention to the primary test pairs for the forced choice task.
COMPARISON SET 1: FORCED CHOICE TASK
EXPECT(A)/PERSUADE(B) SENTENCES

1. (A) Even though a bad storm was predicted the captain expected the passengers to remain calm.
   (B) Even though a bad storm was predicted the captain persuaded the passengers to remain calm.

2. (A) During the fire drill the principal discovered the boy to be missing.
   (B) During the fire drill the principal told the boy to be quiet.

3. (A) After the dress rehearsal the director pronounced the understudy to be ready to take over for the leading lady.
   (B) After the dress rehearsal the director reminded the understudy to be ready to take over for the leading lady.

4. (A) According to a New York Times editorial, Congress believes the President to be too flexible in his foreign policy.
   (B) According to a New York Times editorial, Congress advised the President to be more flexible in his foreign policy.

5. (A) Union leaders rarely suppose management to provide adequate health care benefits for their members.
   (B) Union leaders rarely convince management to provide adequate health care benefits for their members.

6. (A) Before the NFL championship playoff the coach reported the players to be in top shape.
   (B) Before the NFL championship playoff the coach warned the players to be in top shape.
7. (A) Because of unrest in the Middle East the general required his regiment to be ready to move out immediately.

(B) Because of unrest in the Middle East the general ordered his regiment to be ready to move out immediately.

8. (A) Since the bus was leaving at noon, the scoutmaster expected the patrol to assemble by 11:30.

(B) Since the bus was leaving at noon, the scoutmaster told the patrol to assemble at 11:30.

9. (A) His sixth grade school teacher declared James to be outstanding in mathematics.

(B) His sixth grade school teacher inspired James to be outstanding in mathematics.

10. (A) My great grandfather preferred his children to be quiet in public places.

(B) My great grandfather encouraged his children to be quiet in public places.

11. (A) The old trainer thought the young athlete to be the best prepared runner in the hundred-yard dash.

(B) The old trainer helped the young athlete to be the best prepared runner in the hundred-yard dash.

12. (A) At the beginning of the semester the professor assumed the students to be competent in English composition.

(B) At the beginning of the semester the professor advised the students to be imaginative in their writing.

13. (A) According to one source, the graduate admissions committee intended Dr. Smith to be chairman.

(B) According to one source, the graduate admissions committee elected Dr. Smith to be chairman.

14. (A) Do you think our music teacher imagines her sons to play well enough to be concert pianists?
14. (B) Do you think our music teacher taught her sons to play well enough to be concert pianists?

15. (A) The new captain of the debating team wants his team to have an answer for any question that might arise.
(B) The new captain of the debating team urges his team to have an answer for any question that might arise.

16. (A) The search party feared the children to be lost in the woods where the plane crashed.
(B) The search party directed the children to lead them to the place in the woods where the plane crashed.

17. (A) The vacationers understood the motel owner to have reserved a suite for them.
(B) The vacationers asked the motel owner to reserve a suite for them.

18. (A) Since the weatherman predicted heavy snow, some of the mothers wanted the principal to close the school early.
(B) Since the weatherman predicted heavy snow, some of the mothers told the principal to close the school early.

19. (A) During survival training the sergeant felt his soldiers to be prepared for jungle combat.
(B) During survival training the sergeant forced his soldiers to be prepared for jungle combat.

20. (A) In spite of the blizzard the conductor expects the guest violinist to be present at the recital tonight.
(B) In spite of the blizzard the conductor convinced the guest violinist to be present at the recital tonight.
COMPARISON SET 2: FORCED CHOICE TASK
EASY(A)/EAGER(B) SENTENCES

1. (A) Marriage counselors believe that wives are difficult to dominate in the home.
      (B) Marriage counselors believe that wives are afraid to dominate in the home.

2. (A) According to managers, most young pitchers are impossible to overtrain.
      (B) According to managers, most young pitchers are afraid to overtrain.

3. (A) Most naturalists know that snakes are difficult to move in cold weather.
      (B) Most naturalists know that snakes are unable to move in cold weather.

4. (A) Especially after losing his ship, a captain is easy to retire on a pension.
      (B) Especially after losing his ship, a captain is content to retire on a pension.

5. (A) African game wardens believe that elephants are simple to shift to new ranges.
      (B) African game wardens believe that elephants are hesitant to shift to new ranges.

6. (A) Because of the press of people, the police are easy to fight in a crowd.
      (B) Because of the press of people, the police are afraid to fight in a crowd.

7. (A) Senators are hard to please in an election year.
      (B) Senators are anxious to please in an election year.

8. (A) Some people claim that universities are difficult to change when the circumstances require it.
      (B) Some people claim that universities are eager to change when the circumstances require it.
9. (A) The toxic red tide makes fish dangerous to eat for several days.

(B) The toxic red tide makes fish unable to eat for several days.

10. (A) When the weather is warm the swimmers are delightful to watch from the shore.

(B) When the weather is cold the swimmers are content to watch from the shore.

11. (A) Their enormous capital investment makes large corporations almost impossible to resist by financial measures.

(B) Their enormous capital investment makes large corporations almost powerless to resist by financial measures.

12. (A) According to single women, bachelors are easy to entertain at home.

(B) According to single women, bachelors are eager to entertain at home.

13. (A) Soldiers are hard to command on the battlefield without enough rank.

(B) Soldiers are hesitant to command on the battlefield without enough rank.

14. (A) When I was in school, I always found my friends were tough to leave when summer vacation started.

(B) When I was in school, I always found my friends were anxious to leave when summer vacation started.

15. (A) Following the 1968 conventions, the mobs were difficult to disperse.

(B) Following the 1968 conventions, the mobs were reluctant to disperse.

16. (A) When it comes to asking for help, strangers are easy to offend by being too forward.

(B) When it comes to asking for help, strangers are hesitant to offend by being too forward.
17. (A) \[\text{In the summertime relatives are fun to visit on weekends.}\]
(B) \[\text{In the summertime relatives are eager to visit on weekends.}\]

18. (A) \[\text{According to the students some politicians are impossible to debate.}\]
(B) \[\text{According to the students some politicians are afraid to debate.}\]

19. (A) \[\text{Under some circumstances the police are simple to resist forcibly.}\]
(B) \[\text{Under some circumstances the police are powerless to resist forcibly.}\]

20. (A) \[\text{Just before Christmas, children are simple to please.}\]
(B) \[\text{Just before Christmas, children are eager to please.}\]

---

**COMPARISON SET 3: FORCED CHOICE TASK**

**WHO(A)/NOUN(B) SENTENCES**

1. (B) \[\text{I once read an interesting book on dodos, but I can't recall it very precisely.}\]
(A) \[\text{I once read an interesting book on dodos, but I can't recall when very precisely.}\]

2. (B) \[\text{Pottery and other ancient artifacts are thought to be buried in the Northern Hemisphere and the archeologists are trying to recover them.}\]
(A) \[\text{Pottery and other ancient artifacts are thought to be buried in the Northern Hemisphere and the archeologists are trying to discover where.}\]

3. (B) \[\text{Tom should file a claim for disaster relief, but he doesn't know the procedure.}\]
(A) \[\text{Tom should file a claim for disaster relief, but he doesn't know how.}\]

4. (B) \[\text{The winner of the travel lottery will go somewhere for two weeks and a computer has determined the place.}\]
4. (A) The winner of the travel lottery will go somewhere for two weeks and a computer has determined where.

5. (B) Orville is a bore though nobody is willing to tell him.
    (A) Orville is a bore though nobody is able to explain why.

6. (B) According to the gossip columns the heiress married someone but none of the reporters know him.
    (A) According to the gossip columns the heiress married someone but none of the reporters know who.

7. (B) There is only one good way to make soufflés, and the chef is teaching David the method.
    (A) There is only one good way to make soufflés, and the chef is teaching David how.

8. (B) The Bermuda Triangle is associated with mysterious phenomena and a recent book tries to explain them.
    (A) The Bermuda Triangle is associated with mysterious phenomena and a recent book tries to explain why.

9. (B) Joe used to know ways to get that sort of information, but he has forgotten them.
    (A) Joe used to know ways to get that sort of information, but he has forgotten how.

10. (B) A major earthquake is expected to occur in the San Andreas fault, and seismologists are trying to predict it.
10. (A) A major earthquake is expected to occur in the San Andreas fault, and seismologists are trying to predict when.

11. (B) A piece is missing from this puzzle, and I can't find it.

(A) A piece is missing from this puzzle, and I can't find where.

12. (B) The correct procedures for roping calves are tricky, but Ted is learning them.

(A) The correct procedures for roping calves are tricky, but Ted is learning how.

13. (B) You will meet a tall, dark stranger on a bus, but I cannot predict the exact day.

(A) You will meet a tall, dark stranger on a bus, but I cannot predict exactly when.

14. (B) I am sure I used to know somebody who makes violins, but I can hardly recall him.

(A) I am sure I used to know somebody who makes violins, but I can hardly recall who.

15. (B) There is a good place for cross country skiing in New Hampshire, but few people go there.

(A) There is a good place for cross country skiing in New Hampshire, but few people know where.

16. (B) One of the spark plugs is dead, but I can't find it.

(A) One of the spark plugs is dead, but I can't tell which.

17. (B) The suspect has just disappeared, and the detective can't find him.

(A) The suspect has just disappeared, and the detective can't guess how.
18. (B) The main character is actually someone well known, and any reader should recognize him after the first chapter.

(A) The main character is actually someone well known, and any reader should recognize who after the first chapter.

19. (B) It is thought that only two chemicals are attacking the ozone layer but scientists have not been able to discover them.

(A) It is thought that only two chemicals are attacking the ozone layer, but scientists have not been able to discover how.

20. (B) The experiment didn’t work and the student’s problem is to redesign it.

(A) The experiment didn’t work and the student’s problem is to explain why.

COMPARISON SET 4: FORCED CHOICE TASK

THERE(A)/WHERE(B) SENTENCES

1. (A) Is there an island in the Caribbean which has a free port?

(B) Where is the island in the Caribbean which has a free port?

2. (A) There is a doctor who makes housecalls on Sundays.

(B) He is the doctor who makes housecalls on Sundays.

3. (A) Is there a friend of Jane’s who lives in New York and always has room for guests?

(B) Who is the friend of Jane’s who lives in New York and always has room for guests?

4. (A) There are two men who were playing Chopin on the piano in the lobby.

(B) There are the two men who were playing Chopin on the piano in the lobby.
5. (A) Was there a man who whistled when the voluptuous blonde entered?
(B) Who was the man who whistled when the voluptuous blonde entered?

6. (A) There were some students who said the exam was too easy.
(B) There are the students who said the exam was too easy.

7. (A) Is there a marina on the Charles that has a gas pump?
(B) Where is the marina on the Charles that has a gas pump?

8. (A) Is there a critic who says that Vonnegut is worth reading?
(B) Who is the critic who says that Vonnegut is worth reading?

9. (A) Is there an inventor who designed a new burglar alarm?
(B) Who is the inventor who designed a new burglar alarm?

10. (A) There was an old woman who lived in a shoe.
(B) Who was the old woman who lived in a shoe?

11. (A) The tourists think that there is a place in Florida where Blackbeard buried his treasure.
(B) The tourists think that this is the place in Florida where Blackbeard buried his treasure.

12. (A) "There is a most amazing statue in Washington," the tour director said enthusiastically.
(B) "Here is the most amazing statue in Washington," the tour director said enthusiastically.

13. (A) According to the angry tenants, there are some rats that live behind the kitchen walls.
13. (B) "Look," said the angry tenants, "there are the rats that live behind the
kitchen walls."

14. (A) According to Scientific American, there is a proof that you never need more
than four colors to draw a map.

(B) Waving at the blackboard, the mathematician shouted, "There is the proof
that you never need more than four colors to draw a map."

15. (A) You may find it hard to believe, but there is a professor who is trying to col-

clect solar energy with mushrooms.

(B) If you want to meet someone interesting, over there is a professor who is trying
to collect solar energy with mushrooms.

16. (A) The secretary believes there is a copy of the letter you thought was missing
from the file.

(B) The secretary said, "There is the copy of the letter you thought was missing
from the file."

17. (A) Looking worried, the professor said, "I doubt that there is a good book on

relativity theory for laymen."

(B) Pointing to the shelf, the professor said, "There is a good book on relativity
theory for laymen."

18. (A) According to the cook, there is a kind of pie that all children like.

(B) Pointing to the pantry, the cook remarked, "There is the kind of pie that all
children like."

19. (A) It smells like there is a rotten egg in the refrigerator.
19. (B) There is the rotten egg which has been smelling up the refrigerator.

20. (A) My tennis coach says there is a new kind of racquet which is especially designed for beginners.
(B) There is the new racquet which is especially designed for beginners.

COMPARISON SET 5: FORCED CHOICE TASK
NEGATIVE (A) / POSITIVE (B) QUANTIFIERS

1. (B) Everyone owns a copy of the book that is required for the Calculus course.
(A) No one owns a copy of the book that is required for the Calculus course.

2. (B) Mary discovered that both of the settings on the blender were good for making frappes.
(A) Mary discovered that neither of the settings on the blender were good for making frappes.

3. (B) I know that either of the pinch hitters will win this game.
(A) I know that neither of the pinch hitters will win this game.

4. (B) There is some meat in the soup on the stove.
(A) There is no meat in the soup on the stove.

5. (B) It is obvious that the boy has measles.
(A) It is doubtful that the boy has measles.

6. (B) Either of these colors would look nice in this room.
(A) Neither of these colors would look nice in this room.

7. (B) In the department store, I found everyone helpful.
(A) In the department store, I found no one helpful.

8. (B) The reporter admitted that all of his sources had been paid for the information that they provided.
(A) The reporter admitted that none of his sources had been paid for the information that they provided.

9. (B) The gourmet noticed that none of the snails were cooked to perfection.
(A) The gourmet noticed that all of the snails were cooked to perfection.

10. (B) Both of these hints could be helpful in solving the problem.
(A) Neither of these hints could be helpful in solving the problem.
11. (B) The foreman discovered that all of the work was done by the time the lunch whistle blew.
   (A) The foreman discovered that none of the work was done by the time the lunch whistle blew.

12. (B) Both of these spices would taste good in this stew.
   (A) None of these spices would taste good in this stew.

13. (B) There is always some money in Bertha's checking account.
   (A) There is never any money in Bertha's checking account.

COMPARISON SET 6: FORCED CHOICE TASK
INTENSIONAL(A)/TRANSITIVE(B) SENTENCES

1. (B) After the storm the Red Cross found snowmobiles to carry food to the elderly.
   (A) After the storm the Red Cross sought snowmobiles to carry food to the elderly.

2. (B) Because there was plenty of wind all of the sailors made the trip without having to use their engines.
   (A) Although there wasn't much wind all of the sailors attempted the trip without using their engines.

3. (B) Since gasoline has become so expensive the commuters use a train to get to the city.
   (A) Since gasoline has become so expensive the commuters need a train to get to the city.

4. (B) For several weeks after her skiing accident Jane used a cane to help her walk.
   (A) For several weeks after her skiing accident Jane needed a cane to help her walk.

5. (B) The amateur naturalist suggested a new method of catching moths.
   (A) The amateur naturalist discovered a new method of catching moths.

6. (B) Everyone on the nominating committee asked one of their friends to be a candidate for president.
6. (A) Everyone on the nominating committee wanted one of their friends to be a candidate for president.

7. (B) After the heavy rains the town council repeated the news that the dam was safe.
(A) After the heavy rains the town council hoped for the news that the dam was safe.

8. (B) The board of law review students attended a conference on labor-management relations.
(A) The board of law review students suggested a conference on labor-management relations.

9. (B) The mechanic assembled the parts to fix the car.
(A) The mechanic ordered the parts to fix the car.

10. (B) In the last seconds of the game the quarterback fumbled the ball on the one-yard line.
(A) In the last seconds of the game the quarterback expected the ball on the one-yard line.

11. (B) In cooking class each chef tested the sauce for the roast duck.
(A) In cooking class each chef planned a sauce for the roast duck.

12. (B) The engineers found oil near the ridge where the road was to be laid.
(A) The engineers predicted oil near the ridge where the road was to be laid.

13. (B) The anxious housewife had a lucky streak at Wednesday night bingo.
(A) The anxious housewife needs a lucky streak at Wednesday night bingo.

14. (B) The tow truck pulled the car out of the snowdrift several days after the blizzard.
(A) The tow truck looked for the car in the snowdrift several days after the blizzard.
15. (B) The workman used a chain saw to cut the logs for the fireplace.
   (A) The workman wanted a chain saw to cut the logs for the fireplace.

16. (B) The weary world traveller visited Paris in the spring time.
   (A) The weary traveller imagined Paris in the spring time.

17. (B) After thirty years of service the postman enjoyed retirement with a special bonus.
   (A) After thirty years of service the postman requested retirement with a special bonus.

18. (B) The seniors attended a graduation party to celebrate the end of high school.
   (A) The seniors demanded a graduation party to celebrate the end of high school.

19. (B) The engineers at MIT have built a solar heating system that is more efficient than earlier models.
   (A) The engineers at MIT would like a solar heating system that is more efficient than earlier models.

20. (B) In the story of Uncle Whiskers, the cat ate rabbits with obvious enjoyment.
   (A) In the story of Uncle Whiskers, the cat hunted rabbits with obvious enjoyment.

COMPARISON SET 7: FORCED CHOICE TASK
CAUSATIVE(A)/TRANSITIVE(B) SENTENCES

1. (B) While cleaning up the old house the workers found some paint in the basement.
   (A) While cleaning up the old house the workers spilled some paint in the basement.

2. (B) When the police reached the student demonstration, they told the bystanders to go home.
2. (A) When the police stopped the student demonstration, they told the bystanders to go home.

3. (B) Nobody noticed that during the poker game the gambler used a card from his sleeve.
   (A) Nobody noticed that during the poker game the gambler dropped a card from his sleeve.

4. (B) The cautious hunters noticed the cougar that was hiding in the tree.
   (A) The cautious hunters killed the cougar that was hiding in the tree.

5. (B) In the middle of the quiet afternoon the students discovered a fire in the chemistry laboratory.
   (A) In the middle of a quiet afternoon the students started a fire in the chemistry laboratory.

6. (B) Against the recommendation of his advisors the mayor supported the project for urban redevelopment.
   (A) Against the recommendation of his advisors the mayor ended the project for urban redevelopment.

7. (B) The Sunday paper repeated the story that the senator was about to resign.
   (A) The Sunday paper spread the story that the senator was about to resign.

8. (B) The retiring chairman attended the meeting of the Board of Trustees for the last time.
   (A) The retiring chairman convened the meeting of the Board of Trustees for the last time.

9. (B) Before going on camera, the chef assembled most of the ingredients needed for the dish.
   (A) Before going on camera, the chef combined most of the ingredients needed for the dish.
10. (B) With only fifteen seconds left, the fullback fumbled the football on the one-yard line.
(A) With only fifteen seconds left, the fullback put the football on the one-yard line.

11. (B) After the meat was sliced the chef tried the sauce.
(A) After the meat was sliced the chef warmed the sauce.

12. (B) The contractors blasted the channel for the Panama Canal with dynamite.
(A) The contractors made the channel for the Panama Canal with dynamite.

13. (B) While working in the shop the carpenter hit the nails with a hammer.
(A) While working in the shop the carpenter bent the nails with a hammer.

14. (B) In setting up the tent the scouts pulled the lines on the center pole.
(A) In setting up the tent the scouts raised the lines on the center pole.

15. (B) Even in early colonial settlements they often used glass to make windows.
(A) Even in early Colonial settlements they melted glass to make windows.

16. (B) The maid left the room so the guests could use it.
(A) The maid cleaned the room so the guests could use it.

17. (B) The TV repairmen checked the color of the picture tube.
(A) The TV repairmen changed the color of the picture tube.

18. (B) Before ironing them the housewife examined the clothes that were in the basket.
(A) Before ironing them the housewife folded the clothes that were in the basket.
Procedures and Analysis

In this task, unlike the ratings task, a subject is presented with both versions of a test sentence, and then required to choose which of the two indicates a closer relation between the members of a specified word pair. Each subject saw a given sentence pair only once and made a single judgment involving one word pair. Subjects were also required to indicate their confidence in their judgment by marking a 5 point confidence scale printed on the same form as the stimulus sentences. The presentation order of the sentences was randomly varied, with each subject receiving a new randomization.

In the ratings experiments, the item based analyses were somewhat fragile because we did not have large numbers of sentence pairs representing each of the sentence types. For the forced-choice experiments, we improved that circumstance by increasing the number of sentence pairs in each structural type. However, because each subject saw any given sentence pair only once for a given word pair, the number of observations on each word pair condition from any given subject is small and confounded with sentence pair. Thus, while we were able to contrast experimental and control word pairs within subjects for a given test sentence pair in the ratings task, that same comparison is between subjects for the forced-choice task.

We have reported subject based and item based analyses for the forced choice experiments. The scores used are, for items, the differences in the frequency with which the A and B versions of a given sentence pair were chosen, and their associated confidence levels. For subjects, the scores used are the differences in the frequency with which A and B versions were chosen, summing across the different sentences for which a given structural choice was presented to a subject, and associated confidence levels.

Results

There were two experiments run. One, however, is only preliminary; it used only three sentence types and did not require confidence judgments. All the results reported below, save one, are from the principal experiment, which
included Sentence Sets 1, 2, 3, 4, 6, and 7. The results for Sentence Set 5 are from the preliminary experiment.

The outcomes for Sentence Sets 1, 2, and 3 are reported in Tables 10, 11 and 12; (these Sets are of the same structural types as Sets 1, 2, and 3 in the ratings experiments.) There are two quite consistent patterns. First, the frequency of B choices significantly exceeds the frequency of A choices for all

Table 10. *Sentence Set 1, Forced choice and confidence ratings results. Tests for complement constructions, common clause membership (B versions, VP complements) versus disjoint membership (A versions, NP complements).*

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**Example sentence pair with target words in italics:**

<table>
<thead>
<tr>
<th></th>
<th>control</th>
<th>control</th>
<th>subject</th>
<th>object</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Even though a bad <em>storm</em> was <em>predicted</em>, the <em>captain</em> expected the <em>passengers</em> to remain calm.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>Even though a bad <em>storm</em> was <em>predicted</em>, the <em>captain</em> persuaded the <em>passengers</em> to remain calm.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Analysis Type**

<table>
<thead>
<tr>
<th>Items (n = 20)</th>
<th>Subjects (n = 80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>forced choice mean B-A differences for primary word pairs (subject-object)</td>
<td>6.650</td>
</tr>
<tr>
<td>t = 3.754 (df = 19)</td>
<td>t = 6.496 (df = 79)</td>
</tr>
<tr>
<td>p &lt; 0.001</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>min F' = 15.274</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>forced choice mean B-A differences for primary control pairs (control-control)</td>
<td>4.100</td>
</tr>
<tr>
<td>t = 2.127 (df = 19)</td>
<td>t = 4.054 (df = 79)</td>
</tr>
<tr>
<td>p &lt; 0.023</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>min F' = 4.126</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>primary pairs versus controls</td>
<td>2.191 (df = 19)</td>
</tr>
<tr>
<td>p &lt; 0.023</td>
<td>p &lt; 0.015</td>
</tr>
<tr>
<td>min F' = 1.025</td>
<td>ns</td>
</tr>
<tr>
<td>mean difference between confidence ratings for primary pairs and control pairs when B versions were selected (SO_B - CC_B)</td>
<td>0.796</td>
</tr>
<tr>
<td>t = 7.623 (df = 19)</td>
<td>t = 2.635 (df = 79)</td>
</tr>
<tr>
<td>p &lt; 0.001</td>
<td>p &lt; 0.005</td>
</tr>
<tr>
<td>min F' = 6.202</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>mean difference between confidence ratings for B choices of primary pairs and ratings for A and B choices combined on control pairs</td>
<td>0.643</td>
</tr>
<tr>
<td>t = 5.794 (df = 19)</td>
<td>t = 5.294 (df = 79)</td>
</tr>
<tr>
<td>p &lt; 0.001</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>min F' = 15.274</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>
Table 11. *Sentence Set 2, Forced choice and confidence ratings. Tests for predicate adjective constructions, common clause membership (B versions) versus disjoint membership (A versions)*

Example sentence pair with target words in italics:

A. Especially after *losing* his *ship*, a *captain* is easy to retire on a pension.
B. Especially after *losing* his *ship*, a *captain* is *content* to retire on a pension.

<table>
<thead>
<tr>
<th>Analysis Type</th>
<th>Items (n = 20)</th>
<th>Subjects (n = 80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>forced choice mean B-A differences for primary word pairs (subject-adjective)</td>
<td>6.000</td>
<td>1.500</td>
</tr>
<tr>
<td>t = 2.739 (df = 19)</td>
<td>t = 5.764 (df = 79)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.006</td>
<td>p &lt; 0.001</td>
<td>min F' = 6.12</td>
</tr>
<tr>
<td>p &lt; 0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>forced choice mean B-A differences for primary control pairs (control-control)</td>
<td>4.250</td>
<td>1.063</td>
</tr>
<tr>
<td>t = 2.103 (df = 19)</td>
<td>t = 4.937 (df = 79)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.025</td>
<td>p &lt; 0.001</td>
<td>min F' ns</td>
</tr>
<tr>
<td>primary pairs versus controls</td>
<td>t = 1.984 (df = 19)</td>
<td>t = 1.324 (df = 79)</td>
</tr>
<tr>
<td>p &lt; 0.041</td>
<td>p &lt; 0.094</td>
<td>min F' ns</td>
</tr>
<tr>
<td>mean difference between confidence ratings for primary pairs and control pairs when B versions were selected (SAB = CCB)</td>
<td>0.710</td>
<td>0.154</td>
</tr>
<tr>
<td>t = 4.076 (df = 19)</td>
<td>t = 1.223 (df = 79)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.001</td>
<td>p &lt; 0.112</td>
<td>min F' ns</td>
</tr>
<tr>
<td>mean difference between confidence ratings for B choices of primary pairs and ratings for A and B choices combined on control pairs</td>
<td>0.757</td>
<td>0.367</td>
</tr>
<tr>
<td>t = 6.493 (df = 19)</td>
<td>t = 3.504 (df = 79)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.001</td>
<td>p &lt; 0.001</td>
<td>min F' = 9.509</td>
</tr>
<tr>
<td>p &lt; 0.01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

three structural types when the primary (subject, object) word pairs are considered; this is true for both the subject and the item based analyses. In Sentence Sets 1 and 2, though not in Sentence Set 3, these comparisons are also significant by min F' test.

Rather surprisingly and problematically, however, the same comparisons are, for the most part, also significant for tests based on the control pairs. The differences here are not as large as those of the experimental pairs, and they are not significant by min F', but with one exception, they are signifi-
Example sentence pair with target words in italics:

A. According to the gossip columns the heiress married someone, but none of the reporters knew who.

B. According to the gossip columns the heiress married someone, but none of the reporters know him.

<table>
<thead>
<tr>
<th>Analysis Type</th>
<th>Items (n = 20)</th>
<th>Subjects (n = 80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>forced choice mean B-A differences for primary word pairs (subject-object)</td>
<td>3.400 t = 1.919 (df = 19) p &lt; 0.035</td>
<td>0.850 t = 3.653 (df = 79) p &lt; 0.001</td>
</tr>
<tr>
<td>forced choice mean B-A differences for primary control pairs (control-control)</td>
<td>3.200 t = 1.637 (df = 19) p &lt; 0.059</td>
<td>0.800 t = 3.043 (df = 79) p &lt; 0.001</td>
</tr>
<tr>
<td>primary pairs versus controls</td>
<td>0.352 t = 0.138 (df = 19) p &lt; 0.486</td>
<td>-0.158 t = -1.143 (df = 79) p &lt; 0.139</td>
</tr>
<tr>
<td>mean difference between confidence ratings for primary pairs and control pairs when B versions were selected (SOB - CCB)</td>
<td>0.467 t = 3.966 (df = 19) p &lt; 0.001</td>
<td>0.235 t = 2.075 (df = 79) p &lt; 0.020</td>
</tr>
<tr>
<td>min F' ns</td>
<td>0.352 t = 3.001 (df = 19) p &lt; 0.003</td>
<td>-0.158 t = -1.143 (df = 79) p &lt; 0.139</td>
</tr>
<tr>
<td>mean difference between confidence ratings for B choices of primary pairs and ratings for A and B choices combined on control pairs</td>
<td>0.467 t = 3.966 (df = 19) p &lt; 0.001</td>
<td>0.235 t = 2.075 (df = 79) p &lt; 0.020</td>
</tr>
<tr>
<td>min F' ns</td>
<td>0.352 t = 3.001 (df = 19) p &lt; 0.003</td>
<td>-0.158 t = -1.143 (df = 79) p &lt; 0.139</td>
</tr>
</tbody>
</table>

Significant on both subject and item analyses. Given this effect in the control pairs, it would not be surprising if the direct comparisons of experimental and control pairs failed. However, for Sets 1 and 2, the primary test pair differences significantly exceed those of control pairs on item and subject analyses. If one collapses across the three sentence types and makes the
There seem to be two possible accounts of these circumstances: either subjects are using as a decision base some feature of structural contrast other than the one we have focussed on, or, the results in the control pairs reflect a halo effect from the manipulated contrast induced by the forced choice task. The latter conclusion seems more likely on several grounds.

First, and most obvious, there is the demonstrated specific effect of the clausal variable on these same sentence types in the ratings task. Second, there is the indication of a significantly stronger effect for the experimental pairs than for the control pairs; that is, the words directly involved in the putatively effective structural relations show larger effects than those not directly involved. If some alternate basis of choice were, in fact, operative, that difference would be unexplained. Further, and most persuasive, is the evidence that the experimental and control pairs show different effects for the confidence ratings.

We report two confidence results in the tables for the forced choice task. Both are tests of differences between confidence levels associated with experimental pairs and those associated with control pairs. The forced choices are, by hypothesis, motivated by direct involvement of the test words in the structural contrast between sentence versions, the latter, at best, indirectly so. The first test is for only B choices of both experimentals and controls; the second pools A and B choices for controls. This pooling reflects the fact that A/B choices in controls are arbitrary. In either case, however, focus on B choices tests differences for the preferred responses. Note: though we do not include the results in the tables, direct contrasts of A and B choices for experimentals were made. As one might expect, the less frequent A choices were also made with lower confidence for experimentals, though controls did not differ so consistently.

Tables 10, 11 and 12 include results for the confidence ratings for Comparison Sets 1–3. The differences are uniformly higher for experimental pair decisions, and significantly so, than are the comparable decisions involving control pairs. Again, if some alternate basis of decision is postulated this is a puzzle. On the grounds that the same basis of decision is being used by subjects in both cases, the outcome is as one might expect, however. The words directly involved in the relevant structural contrast are judged with greater confidence than those not directly involved.

To these results we may add those for Sentence Set 4, the contrast of transformationally introduced “there” with locative “there” or other pronouns present in the underlying structure. Again we see the pattern of Sets 1–3. Subject and item based analysis for the experimental pairs show signifi-
Table 13. Sentence Set 4, Forced choice and confidence ratings. Tests for existential 'there' constructions, common clause membership (B versions, pronoun subject) versus disjoint membership (A versions, existential 'there' subject)

Example sentence pair with target words in italics:

A. Is there an island in the Caribbean which has a free port?

B. Where is the island in the Caribbean which has a free port?

Analysis Type

<table>
<thead>
<tr>
<th>Analysis Type</th>
<th>Subjects (n = 80)</th>
<th>Items (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>forced choice mean B-A differences for primary word pairs (subject-object)</td>
<td>1.700</td>
<td>6.800</td>
</tr>
<tr>
<td>( t = 5.748 \ (df = 79) )</td>
<td>( p &lt; 0.001 )</td>
<td>( p &lt; 0.001 )</td>
</tr>
<tr>
<td>min ( F' ) = 9.90</td>
<td>( p &lt; 0.01 )</td>
<td>( p &lt; 0.01 )</td>
</tr>
<tr>
<td>forced choice mean B-A differences for primary control pairs (control-control)</td>
<td>0.950</td>
<td>3.800</td>
</tr>
<tr>
<td>( t = 3.338 \ (df = 79) )</td>
<td>( p &lt; 0.001 )</td>
<td>( p &lt; 0.01 )</td>
</tr>
<tr>
<td>min ( F' ) ns</td>
<td></td>
<td>( p &lt; 0.037 )</td>
</tr>
<tr>
<td>primary pairs versus controls</td>
<td>( p &lt; 0.004 )</td>
<td>( t = 1.812 \ (df = 79) )</td>
</tr>
<tr>
<td>mean difference between confidence ratings for primary pairs and control pairs when B versions were selected (SO_B − CC_B)</td>
<td>0.153</td>
<td>0.674</td>
</tr>
<tr>
<td>( t = 1.038 \ (df = 79) )</td>
<td>( p &lt; 0.151 )</td>
<td>( p &lt; 0.001 )</td>
</tr>
<tr>
<td>min ( F' ) ns</td>
<td></td>
<td>( p &lt; 0.01 )</td>
</tr>
<tr>
<td>mean difference between confidence ratings for B choices of primary pairs and ratings for A and B choices combined on control pairs</td>
<td>0.416</td>
<td>0.739</td>
</tr>
<tr>
<td>( t = 3.625 \ (df = 19) )</td>
<td>( p &lt; 0.001 )</td>
<td>( p &lt; 0.001 )</td>
</tr>
<tr>
<td>min ( F' ) = 10.412</td>
<td>( p &lt; 0.01 )</td>
<td>( p &lt; 0.01 )</td>
</tr>
<tr>
<td>min ( F' ) ns</td>
<td></td>
<td>( p &lt; 0.01 )</td>
</tr>
<tr>
<td>min ( F' ) ns</td>
<td></td>
<td>( p &lt; 0.01 )</td>
</tr>
</tbody>
</table>

Significant A-B differences for both forced choice and confidence ratings; so too do the control pairs, though again they are smaller differences. Direct comparison shows significant item and subject based differences between experimental and control pairs; min \( F' \) is not significant for forced choice judgments, but is so for confidence ratings.

These results all involve sentence types which were also tested in the ratings procedures, and essentially the same pattern of results has emerged: word pairs which share underlying clause membership are judged to be more
closely related than comparably surface-located words which do not co-
occur in an underlying clause. The forced-choice results for contrast of
experimental with control word pairs are in some measure less clear than for
the ratings case since there are significant effects observed for the control
pairs. Nonetheless, as we observed above, the effects for the words involved
in the structural manipulation are both larger and associated with higher
confidence levels. Thus, taken together, the results for the ratings and the
forced choice procedures seem to indicate an effect dependent upon clausal
membership of words in a sentence.

Before turning to the results for the causative sentences in the forced-
choice procedure, we will consider the sentences of Sets 5 and 6. These were
intended to test for effects of semantic relatedness in cases where such
relations are not directly represented by differences of syntactic structure.
The results for Sentence Set 5, it should be recalled, are preliminary; tests
were for the primary pairs only and did not include confidence ratings. The
negative quantifier versions of the sentences did yield a lower judgment of
relatedness for the test pairs than did the positive quantifier versions. We
have no basis for evaluating the specificity of this effect to the test pair
itself, however. (This sentence type is the subject of further investigation
now in progress.)

The results for the intensional verb sentences of Set 6 are reported in
Table 14. Again we find significant effects for the test of differences
between A and B versions. This holds for both the subject and the item
based analyses. And, again as with many of the tests of Sets 1–4, there are
significant differences for the control pair, albeit of lesser magnitude than
for the primary pair. The direct comparison of experimental and control
pairs is not significant. The item based tests for the confidence ratings are
significant, however, though the subject based tests are not. We thus have
some indication, though not a particularly strong one, that the procedures
are sensitive to semantic relations as well as to syntactic relations like clausal
membership. It seems entirely reasonable to expect that if the causative
sentences differ from their transitive counterparts in the test sets, then our
procedures would be able to detect that difference whether it be construed
in semantic or syntactic terms.

The results for the causative sentences of Set 7 are reported in Table 14;
they are simple to describe for their bearing on the causative hypothesis:
there is no indication of a difference in the A and B versions on the primary
test pairs. The control pairs show larger differences than the primary pairs,
and this seems to account for the significant values which do appear in the
table. Note that there are twenty test sentence pairs, and recall that the
forced choice procedures seem to be even more sensitive to differences in
Table 14. *Sentence Set 6, Forced choice and confidence ratings. Tests for intensional verbs, common clause membership (B versions, transitive verb) versus disjoint membership (A versions, intensional verb)*

Example sentence pair with target words in italics:

<table>
<thead>
<tr>
<th></th>
<th>control</th>
<th>control</th>
<th>subject</th>
<th>object</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Since gasoline has become so expensive, the <em>commuters</em> need a <em>train</em> to get to the city.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>Since gasoline has become so expensive, the <em>commuters</em> use a <em>train</em> to get to the city.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analysis Type</th>
<th>Items (n = 20)</th>
<th>Subjects (n = 80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>forced choice mean B-A differences for primary word pairs (subject-object)</td>
<td>5.300</td>
<td>1.325</td>
</tr>
<tr>
<td>t = 2.230 (df = 19)</td>
<td>t = 5.296 (df = 79)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.014</td>
<td>p &lt; 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>min F' = 4.22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.05</td>
<td></td>
</tr>
<tr>
<td>forced choice mean B-A differences for primary control pairs (control-control)</td>
<td>3.700</td>
<td>0.925</td>
</tr>
<tr>
<td>t = 1.637 (df = 19)</td>
<td>t = 3.043 (df = 79)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.045</td>
<td>p &lt; 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
<tr>
<td>primary pairs versus controls</td>
<td>t = 0.782 (df = 19)</td>
<td>t = 1.210 (df = 79)</td>
</tr>
<tr>
<td>p &lt; 0.240</td>
<td>p &lt; 0.115</td>
<td></td>
</tr>
<tr>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
<tr>
<td>mean difference between confidence ratings for primary pairs and control pairs when B versions were selected (SO_R – CC_R)</td>
<td>0.335</td>
<td>-0.077</td>
</tr>
<tr>
<td>t = 2.338 (df = 19)</td>
<td>t = -0.569 (df = 79)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.015</td>
<td>p &lt; 0.266</td>
<td></td>
</tr>
<tr>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
<tr>
<td>mean difference between confidence ratings for B choices of primary pairs and ratings for A and B choices combined on control pairs</td>
<td>0.284</td>
<td>0.039</td>
</tr>
<tr>
<td>t = 2.151 (df = 19)</td>
<td>t = 0.358 (df = 79)</td>
<td></td>
</tr>
<tr>
<td>p &lt; 0.022</td>
<td>p &lt; 0.361</td>
<td></td>
</tr>
<tr>
<td></td>
<td>min F' ns</td>
<td></td>
</tr>
</tbody>
</table>

the sentences from the validating sets than were the ratings procedures. Thus, it seems fair to conclude that if there were any difference of the sort which the decompositional analysis of the causatives claims, it could have been detected in the forced choice tests.

**Conclusion**

Any number of methodological issues remain unsettled. Principal among these are perhaps the issue of the specificity of the subjects’ response to the
Table 15. *Sentence Set 7, Forced choice and confidence ratings results. Tests for causatives, common clause membership (B versions, transitive verb) versus disjoint membership (A versions, causative verbs).*

Example sentence pair with target words in italics:

<table>
<thead>
<tr>
<th>Analysis Type</th>
<th>Items (n = 20)</th>
<th>Subjects (n = 80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>forced choice mean B-A differences for primary</td>
<td>0.100</td>
<td>0.025</td>
</tr>
<tr>
<td>word pairs (subject-object)</td>
<td>t = 0.052 (df = 19)</td>
<td>t = 0.087 (df = 79)</td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.479</td>
<td>p &lt; 0.465</td>
</tr>
<tr>
<td>forced choice mean B-A differences for primary</td>
<td>1.850</td>
<td>0.467</td>
</tr>
<tr>
<td>control pairs (control-control)</td>
<td>t = 0.818 (df = 19)</td>
<td>t = 1.765 (df = 79)</td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.212</td>
<td>p &lt; 0.045</td>
</tr>
<tr>
<td>primary pairs versus controls</td>
<td>t = -1.412 (df = 19)</td>
<td>t = -1.092 (df = 79)</td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.076</td>
<td>p &lt; 0.139</td>
</tr>
<tr>
<td>mean difference between confidence ratings for</td>
<td>-0.073</td>
<td>0.112</td>
</tr>
<tr>
<td>primary pairs and control pairs when B versions</td>
<td>t = -0.263 (df = 19)</td>
<td>t = 0.711 (df = 79)</td>
</tr>
<tr>
<td>were selected (SO_B – CC_B)</td>
<td>p &lt; 0.397</td>
<td>p &lt; 0.235</td>
</tr>
<tr>
<td></td>
<td>min F' ns</td>
<td>min F' ns</td>
</tr>
<tr>
<td>mean difference between confidence ratings for</td>
<td>0.080</td>
<td>0.318</td>
</tr>
<tr>
<td>B choices of primary pairs and ratings for A and</td>
<td>t = 0.512 (df = 19)</td>
<td>t = 2.443 (df = 79)</td>
</tr>
<tr>
<td>B choices combined on control pairs</td>
<td>p &lt; 0.307</td>
<td>p &lt; 0.009</td>
</tr>
<tr>
<td></td>
<td>min F' ns</td>
<td>min F' ns</td>
</tr>
</tbody>
</table>

We can say of the first point that there are some good indications that the manipulations of clausal structure are the focus of subjects' judgments for the sentences of Sets 1-4. But what mechanism yields the 'halo' effects for control pairs observed in the forced choice procedure is not apparent. It is not strange that, faced with the necessity of choice, a subject casts about for a basis of choice and actually finds one; it is surprising, however,
that they so often seem to settle upon the quite abstract differences of clausal structure which are not in any way directly implicated in the relations of the particular word pair they must judge. The results for control word pairs thus seem to suggest that this structural variable is more salient than might have been supposed.

Of the second issue, there is no doubt that the facts of clausal structure that we discussed in syntactic terms might be recast as claims about semantic relations. Whether they should be or not, we haven’t a clue.

Finally, we may reiterate the principal point of our exercise: If lexical decomposition is a fact, and a psychological one at that, it is a fact which should yield structural consequences of the sort we have explored, with some success, in several types of sentences. That our examination of causative sentences was the sole consistent occasion for null results strongly indicates that, for causatives at least, lexical decomposition is not a psychological fact.