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Discussion

A case for the lemma/lexeme distinction in models of speaking: comment on Caramazza and Miozzo (1997)

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**Abstract**

In a recent series of papers, Caramazza and Miozzo [Caramazza, A., 1997. How many levels of processing are there in lexical access? *Cognitive Neuropsychology* 14, 177–208; Caramazza, A., Miozzo, M., 1997. The relation between syntactic and phonological knowledge in lexical access: evidence from the ‘tip-of-the-tongue’ phenomenon. *Cognition* 64, 309–343; Miozzo, M., Caramazza, A., 1997. On knowing the auxiliary of a verb that cannot be named: evidence for the independence of grammatical and phonological aspects of lexical knowledge. *Journal of Cognitive Neuropsychology* 9, 160–166] argued against the lemma/lexeme distinction made in many models of lexical access in speaking, including our network model [Roelofs, A., 1992. A spreading-activation theory of lemma retrieval in speaking. *Cognition* 42, 107–142; Levelt, W.J.M., Roelofs, A., Meyer, A.S., 1998. A theory of lexical access in speech production. *Behavioral and Brain Sciences*, (in press)]. Their case was based on the observations that grammatical class deficits of brain-damaged patients and semantic errors may be restricted to either spoken or written forms and that the grammatical gender of a word and information about its form can be independently available in tip-of-the-tongue states (TOTs). In this paper, we argue that though our model is about speaking, not taking position on writing, extensions to writing are possible that are compatible with the evidence from aphasia and speech errors. Furthermore, our model does not predict a dependency between gender and form retrieval in TOTs. Finally, we argue that Caramazza and Miozzo have not accounted for important parts of the evidence motivating the lemma/lexeme distinction, such as word frequency effects in homophone production, the strict ordering of gender and phoneme access in LRP data, and the chronometric and speech error evidence for the production of complex morphology. © 1998 Elsevier Science B.V. All rights reserved

*Keywords:* Lemma; Lexeme; Speech production

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## 1. Introduction

A widely accepted view holds that speech planning proceeds through conceptualization and formulation, followed by articulation (see Levelt, 1989 for a review). Conceptualization processes map a communicative intention onto a message, which indicates the conceptual information to be verbally expressed in order to reach a speaker's communicative goal. Formulation processes activate and select words for the message concepts, which is called lexical access, and plan syntactic and morphophonological structures. The result is an articulatory program for the utterance, which, when executed, yields overt speech.

In lexical access, speakers draw on stored knowledge about words. This stored information comprises the meanings of words, their syntactic properties (such as the word class, subcategorization features for verbs, and grammatical gender for nouns), and information about their morphological structure and phonological form. The received view holds that lexical access consists of two major steps, corresponding to the formulation stages of syntactic encoding and morphophonological encoding, respectively. During the first step, often called lemma retrieval, a word's syntactic properties and, on some views, its meaning are retrieved from memory. During the second step, information about the word's morphophonological form, often called its lexeme, is recovered (e.g. Kempen and Huijbers, 1983; Levelt, 1989; Roelofs, 1992, 1993, 1997).

The distinction between a syntactic and a morphophonological level of formulation was first proposed by Garrett (1975) to account for certain properties of speech errors. Garrett's theory did not yet include the lemma/lexeme distinction, which was introduced by Kempen and colleagues (Kempen and Huijbers, 1983; Kempen and Hoenkamp, 1987). In their theory, a lexical entry's lemma specifies its semantic-syntactic properties, and the lexeme specifies its morphophonological properties. The lemma/lexeme distinction plays a prominent role in the theory of speaking of Levelt (1989). In our model of lexical access (Jescheniak and Levelt, 1994; Levelt et al., 1998; Roelofs, 1992, 1993; Roelofs et al., 1996), a lemma links up a word's meaning and syntactic properties, whereas a lexeme consists of a word's morphological and phonological properties. Importantly, lemmas are not phonologically specified, and lexemes are not syntactically or semantically specified (see Fig. 1a).

Our model holds that during lemma retrieval the task-relevant syntactic properties of a word are recovered from memory, and the abstract morphosyntactic parameters that are required for grammatical encoding are made available. For example, the lemma of the word *blackboard* specifies that the word is a noun. A noun lemma can be specified for the abstract morphosyntactic parameter of number. A verb lemma specifies, in addition to the word class, which types of arguments (e.g. a direct and an indirect object) the verb takes. It contains free parameters for the specification of tense (e.g. present or past), aspect (imperfective or perfective), number (singular or plural), and person (first, second, or third person). During the subsequent process of word-form encoding, the lemma and the abstract morphosyntactic specification are used to recover the appropriate morphemes and segments (together making up the lexeme) from the mental lexicon. For example, for the lemma of *blackboard* plus the

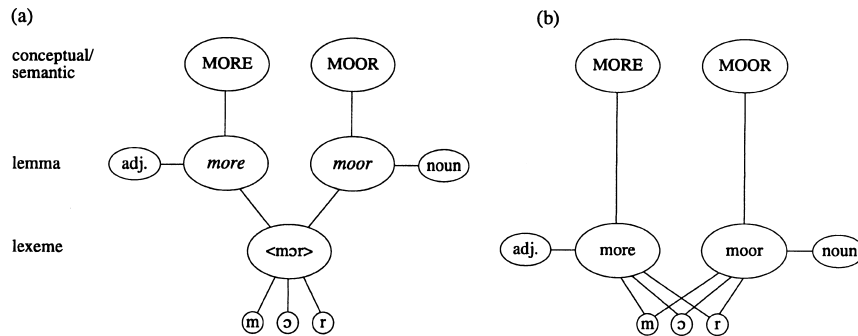


Fig. 1. Representation of homophones in our model (a) and in CM's model (b).

parameter singular, the morphemes <black> and <board> and their segments are recovered. The most important point for the further discussion is that we distinguish between lemmas (defined as syntactic word units) and morphemes (defined as word form units). A word's morpheme and segmental structure together form its lexeme.

## 2. The case against the lemma/lexeme distinction

In a recent series of papers, Caramazza and Miozzo (Caramazza, 1997; Caramazza and Miozzo, 1997 - henceforth CM; Miozzo and Caramazza, 1997) have argued against the lemma/lexeme distinction advanced by our model. They argued that there exists only one lexical level between the meaning and the segments of a word rather than the two levels, lemma and lexeme, that we postulate. In their independent network (IN) model a single lexical node is linked to the meaning and syntax as well as to the phonological properties of a word (as in Fig. 1b). Thus, CM's and our proposal agree that there are lexical representations specified with respect to meaning and syntactic properties. We call these representations lemmas, while CM call them lexemes. We also agree that there is a separate level of representation where words are represented in terms of their phonological segments. On CM's view, semantically and syntactically specified representations (lexemes) directly connect to these segments, whereas on our view, the mapping of concepts onto segments is mediated by a second lexical level, namely that of lemmas. Thus, the disagreement is whether words are represented as semantically and syntactically specified entities independently of their forms.

CM put forward three main arguments for their view. First, grammatical class deficits in amonic patients may be restricted to the spoken or to the written modality. Second, semantic substitution errors made by patients and normal speakers may occur in only one modality of output, and different spoken and written semantic errors may be made in response to the same object. Based on these two classes of observations CM suggest that modality-specific lexical representations are accessed in speaking and writing, which pleads against the existence of modality-neutral lemmas. Third, in tip-of-the-tongue states (TOTs), grammatical and phonological

form information appear to be available independently of each other. This, at first sight at least, argues against a model proposing that speakers first access a lemma and only after successful lemma access embark on the retrieval of the corresponding lexeme.

Below, we argue, first, that though our model concerns speaking and has never taken position on writing, extensions to writing are possible that are compatible with the evidence from aphasia and speech errors. Second, we demonstrate that our model does *not* predict a dependency of gender and form retrieval in TOTs. Our final point is that, on our view, Caramazza and Miozzo's proposal fails to account for important parts of the evidence motivating the lemma/lexeme distinction.

### 3. Modality-specific grammatical class deficits

CM observed that aphasic patients may have a grammatical class deficit restricted to either the spoken or written output modality (e.g. Caramazza and Hillis, 1991; Hillis and Caramazza, 1995; Rapp and Caramazza, 1997). For example, they may be able to say, but not to write, verbs, or vice versa. The comprehension of these words, when spoken or written, is unimpaired. According to CM, such dissociations show that the representations of words as syntactic entities are modality-specific. Hence, these findings are viewed as problematic for models postulating one set of lemmas that is accessed in both speaking and writing.

Our model was exclusively designed to explain speaking, not writing. We never proposed a joint architecture. To account for the evidence CM discuss, we could follow them in their proposal that the semantic and syntactic representations of words are modality-specific. A simpler solution, which we will adopt for the purpose of the further discussion, is that a grammatical class deficit has its locus in the connections between lemmas and written or spoken forms, rather than being located in the lemmas themselves. Brain damage specifically affecting neural structures that mediate one grammatical class must either concern neural structures that represent the functional links between syntactic and form units (which is our proposal), or the set of forms of the affected grammatical class itself (which is CM's proposal). Both options are open.

### 4. Handling homophones

Among the 'most compelling' evidence against the lemma/lexeme distinction, CM mention the processing of homophones. More in particular, they mention the case of patients who are impaired in accessing one homophone (for instance the verb *watch*) but not the other (the noun *watch*). And this happens in one modality only, for example the spoken, but not the written modality. Because these patients display convincing circumstantial evidence for having access to the semantics of the impaired word and clearly also have access to its phonology (namely the accessible twin word form), the damage must be located somewhere between the semantic and

the phonological levels of representation. That, obviously, is precisely our lemma level. But, CM argue, it cannot be the case that the impaired homophone's lemma is damaged because that would affect performance in *both* modalities. In the previous section we already argued that this does not follow. If there is damage in the linkage between the lemma and its spoken form node (lexeme), but not in the linkage between the lemma and its written form node, one would expect the modality-specific homophone damage.

In fact, homophone processing provides some of the most compelling evidence for the lemma/lexeme distinction. The evidence concerns the homophone frequency effects demonstrated by Jescheniak and Levelt (1994). In our theory, homophones are organized as diagrammed in Fig. 1a.

The homophones *more* and *moor* differ at the lemma level (*more* is an adjective, *moor* is a noun), but share their lexeme (mɔr), at least for some dialects of English. This is the structure correctly depicted in CM's Figure 8A. In the example, the adjective *more* is a high-frequency word, whereas the noun *moor* is low-frequency. How does word frequency affect production latencies in such a case? Jescheniak and Levelt found that low-frequency homophones such as *moor* behave as high-frequency controls, not as low-frequency ones. In other words, the low-frequency homophone *inherits* the high frequency of its homophone twin. The word frequency effect arises at the word form (lexeme) level. In the example, mɔr is a high-frequency lexeme, which is easily accessed from either lemma. This crucial finding cannot be handled by CM's homophone representation format, depicted (for the spoken modality only) in Fig. 1b. In that representation the word frequency effect must either arise in accessing the lexeme nodes or in accessing the phonological segments. If it arises in accessing the lexeme nodes, the prediction is that a low-frequency homophone (such as *moor*) should have a longer mean naming latency than its high-frequent twin (*more*), contrary to the empirical evidence. If the word frequency effect arises in accessing the shared segments, then it is in fact a segment frequency effect, which is obviously false. (For instance, the word frequency effect reported in Levelt and Wheeldon (1994) was obtained for word sets that were matched for both segment and syllable frequency.)

## 5. Semantic substitution errors in one output modality

CM observed that semantic substitution errors, such as erroneously saying *dog* instead of *cat*, may exhibit double dissociations between modalities. Some patients made substitution errors in spoken but not in written naming, while the reverse was true for other patients (Caramazza and Hillis, 1990). Furthermore, different spoken and written semantic errors were observed in response to the same objects in sequential naming tasks (Miceli et al., 1997; Rapp et al., 1997). For example, on one trial a speaker may erroneously say *dog* in response to a picture of a cat, while on another trial the same speaker may write *horse* in response to the same picture. CM argued that if semantic substitutions were failures of lemma selection, identical errors should be made in speaking and writing.

In our view, however, substitution errors need not result from failures in lemma selection but may also result from failures of mapping lemmas onto modality-specific morphemic representations. Occasionally, access to the spoken form of a word from a lemma may be impossible while access to its written form is intact, or vice versa, access to the spoken form may be intact, while access to the written form is impossible. If form access fails, the speaker's wish to communicate verbally may lead to a random selection of an alternative lemma from the semantic cohort established by the message concept and to subsequent access of the corresponding form (Levelt et al., 1991; Roelofs, 1992). Thus, substitution errors may differ between modalities and between trials, as empirically observed.

## 6. Independence of gender and form retrieval?

A speaker in a tip-of-the-tongue state has the feeling of knowing a particular word, but can only access part of the information about the word form. CM observed that in tip-of-the-tongue states, knowing the grammatical gender and gaining access to form information are not correlated. They conclude that access to syntactic information is apparently not a condition for access to the word form, which rules out models postulating such a dependence. CM maintain that our network model falls into that class of models.

In fact, however, our model does *not* assume that selection of form information depends on the selection of gender. Rather, the selection of a lemma node is a prerequisite for the selection of gender as well as form information (Roelofs, 1992; Jescheniak and Levelt, 1994). In the model's lexical network, a lemma node is connected to nodes for the syntactic properties and to morpheme nodes. We distinguish between activation and selection of nodes. Activated information is selected only when needed (Roelofs, 1992, 1993). For example, the gender node of a Dutch noun is selected when needed to choose the correct definite determiner or to compute noun-pronoun agreement. By contrast, to produce a bare noun, the lemma must be activated and selected, but gender information will only be activated but not selected.

The distinction between activation and selection of gender information is supported by results from picture-word interference experiments. Schriefers (1993) asked Dutch participants to name colored objects using noun phrases such as 'de groene tafel' ('the green table') or 'het groene huis' ('the green house'), where the grammatical gender of the noun determines the determiner (*de* or *het*). Written distractor words were superimposed on the pictures which either had the same gender as the object names or the opposite gender. The production latencies were shorter when target and distractor had the same gender than when they differed in gender (for similar results see van Berkum, 1997). However, no such congruency effect was found when the speakers produced bare nouns, such as *tafel* or *huis* (Jescheniak, 1994). In our model, lemma nodes point to grammatical gender nodes, but there are no backward pointers. Thus, boosting the level of activation of the gender node by a gender-congruent distractor will not affect the level of

activation of the target lemma node and therefore will not influence the selection of the target lemma node itself. Priming a gender node will only affect lexical access when the gender node itself must be selected. Thus, the gender congruency effect should only be obtained in producing gender-marked utterances, but not in producing bare nouns, as was empirically observed.

Hence, we fully agree with Caramazza (1997) that speakers can access the form of a word without accessing its grammatical gender. This is precisely what we *predict* to happen whenever grammatical gender information is not necessary to produce the intended utterance.

As just explained, on our model a word's grammatical gender need not be retrieved before its form. But we do predict that a word's lemma must be selected before its form: word form retrieval will only begin after the lemma has been selected. We have shown experimentally that a word's lemma begins to be activated before its phonological form (e.g. Levelt et al., 1991; Schriefers et al., 1990). However, as CM have correctly pointed out, these results do not uniquely support our position. It can be argued that the observed form effects can be assigned to the level of segmental retrieval and that the data merely show that it takes longer to retrieve information about a word's segments than about its meaning, which is perfectly compatible with CM's view. On that view, there is just a single lexical node, which is directly connected to both syntactic and segmental nodes (as in Fig. 1b). That architecture provides a natural account for the temporal priority of semantic versus phonological activation. But it does not restrict the ordering of syntactic and phonological access. In fact, CM's TOT experiments seem to suggest that either type of information may come first or even alone during lexical access. But clearly, there is no good reason to assume that the off-line metalinguistic processing of subjects in a TOT state reflect the ultra-fast on-line processing in tasks such as picture naming. What should be tested is whether in an on-line task, which runs within the normal time frame, retrieving syntax *precedes* retrieving phonology, even if the task requirements would make the reverse order more efficient. If that can be shown, we would have support for a 'hard-wired' ordering in accordance with our theory. In a CM-type theory, however, there is no such hard-wired ordering restriction; it can only be implemented by postulation.

The evidence for a strict syntax-to-phonology accessing order in an on-line task has recently been obtained by van Turennout et al. (1998). On each trial, the participants had to name a picture, but on 50% of the trials (the critical trials), they first performed a classification task and then named the picture. Throughout the experiment lateralized readiness potentials (LRPs) were recorded. LRPs are brain potentials which are directly related to movement preparation with the left or right hand (e.g. Coles, 1989; Coles et al., 1988). The classification task was a conjunction of a push-button response with the left or right hand and a go/no-go decision. In one experimental condition, the grammatical gender of the picture determined which button was to be pressed (e.g. left for neuter and right for non-neuter gender), and the first segment of the picture name determined whether or not to carry out the response (e.g. 'go' for /b/ and 'no-go' otherwise). Thus, when a ball was shown (Dutch *bal*, with non-neuter gender), the participants would press the right button; when a wheel

was shown (Dutch *wiel*, with neuter gender), they would not react at all. The LRPs showed response preparation on both ‘go-’ and ‘no-go’ trials. However, when the conditions were reversed and the first segment of the picture name determined the response hand, and the grammatical gender determined whether to respond or not, the LRP showed preparation for the response hand on ‘go’-trials only. Previous LRP studies have shown that when two types of information are simultaneously available, participants use one type of information to preliminarily activate a response hand (e.g. Smid et al., 1992). Moreover, in choice-reaction go/no-go tasks, participants give priority to the extraction of stimulus information that can be used to select a response hand (e.g. Coles et al., 1995). Thus, the results obtained by van Turennout et al. (1998) show that the participants could retrieve grammatical information about the target words before accessing form information and select a response hand on the basis of the grammatical information, while they could not select a response hand on the basis of phonological information before accessing grammatical information. These findings support our view that a word’s lemma and phonological form are distinct representations that can be accessed in this temporal order only. There is nothing in CM’s theory that would predict these findings.

## 7. Handling morphologically complex words

Totally lacking in CM’s IN model is an explicit account of morphological representation and morphological access. Still, any model of lexical access in production will have to deal with both speech error and chronometric evidence relating to complex morphology. Levels of representation are individuated by their vocabulary, among other things. In our view, there are at least two lexical levels at which a word like *afterthought* is available, namely at the lemma level as a node that links up the word’s meaning and its syntactic properties (i.e. that *afterthought* is a noun, not a preposition), and at the lexeme level as two nodes that specify the word’s morphemes (<after> and <thought>). CM propose one lexical level mediating between meaning and syntactic information on the one hand and phonological information on the other hand. As we will argue below, the lemma/lexeme distinction gives a principled account of the generation of morphologically complex words, whereas such an account is lacking in CM’s proposal. Furthermore, the lemma/lexeme account explains the classical observations concerning morphemic errors, as well as recent chronometric evidence on the production of complex words. The morphemic errors have always been an important argument for the lemma/lexeme distinction, but, somewhat surprisingly, are not referred to at all by CM.

In our model, a lemma and its diacritics (e.g. *walk* + PAST; *eat* + PAST) correspond to a stem and its affixes (either decomposed <walk> + <ed> or irregular, non-decomposed <ate>) at the lexeme level. For every word class there is a paradigm, i.e. a set of inflectional forms (regular or irregular) that encode the fixed set of grammatical functions specified by the diacritics. Some diacritics obtain their value directly from the message concept (e.g. tense), whereas other diacritics are set by agreement (e.g., person, number; *walks* versus *walk*) during the process of



grammatical encoding. The stems at the lexeme level may be simple or complex. Complex stems may be created by derivation (base morphemes plus one or more affixes, e.g. *exhale*) or compounding (existing words added together, e.g. *after-thought*). Thus, we propose to represent words at a syntactic level as lemmas plus diacritics, crucial for their use in sentences, and at a form level as concrete morphemes and segments.

The assumption of a syntactic level with lemma nodes as distinct from a form level with segment nodes explains the distributional properties of word and segment exchange errors. Word exchanges typically concern elements from different phrases and of the same word class, whereas segment exchanges typically concern elements from the same phrase and do not respect word class. Thus, the standard view is that word exchanges take place at a level of planning where a word's syntactic specification matters, whereas segment exchanges occur at a level where syntax plays no role, but adjacency in surface structure does. The wider error span for word than segment exchanges shows that the speaker's planning span tends to be larger at the lemma than at the segmental level. This conclusion is supported by experimental evidence (e.g. Meyer, 1996).

The important observation for our argument is that there are two types of morphemic errors adhering to the same types of constraints and spans as whole-word and segment exchanges, respectively. This supports the distinction between a lemma level with abstract morphosyntactic parameters on the one hand, and concrete morphemes at a lexeme level, on the other hand. For example, in 'how many pies does it take to make an apple?' (from Garrett, 1988), the interacting stems *pie* and *apple* belong to the same word class and come from different phrases. The distributional properties of these exchanges are similar to those of whole-word exchanges (Dell, 1986; Garrett, 1975, 1980, 1988), which suggests that these morphemic errors are due to lemma exchanges. The fact that the plural marker (*s*) was not exchanged but realized on *pie* suggests that an abstract number parameter was set. Similarly, errors such as '...that I'd hear one if I knew it' for '...that I'd know one if I heard it' (Garrett, 1980) suggest that syntactically specified lexical representations may trade places independently of their morphophonological specifications. But in CM's theory, there is only the lexeme to dislocate; hence its morphophonology and syntax should undergo the same fate. In their account, abstract tense markers cannot be stranded independently and the error should have been 'that I'd heard one if I know it'. By contrast, the exchanging morphemes in an error such as the swapping of *thin* and *slice* in 'slicely thinned' (from Stemberger, 1985) belong to different word classes and come from the same phrase, which suggests that these morpheme errors occur at the lexeme level, just like sound exchanges. It is difficult to explain both types of errors if only one lexical level mediates between meaning and segments.

Chronometric evidence for distinct memory representations of lemmas, morphemes, and segments in the production of morphologically complex lexical items comes from a series of studies by Roelofs (1996a,b, 1998). For example, Roelofs (1998) showed that the production latency of a verb-particle combination like 'give up' (the morphologically complex lexical item *opgeven* in Dutch) depended on the frequency of the verb (*geven*) in isolation, even though the syntactic

specification of the combination differed from that of the verb alone. The isolated verb *give* takes two internal arguments (a theme/direct object and a goal/indirect object), whereas *give up* takes only one argument (a theme/direct object). In experiments where Dutch participants produced verb-particle combinations, a frequency effect was observed for verbs such as *veeg* (low frequency) in ‘veeg op!’ (‘clean up!’) compared to *geef* (high frequency) in ‘geef op!’ (‘give up!’), even though the frequencies of the two verb-particle combinations were identical. This suggests that the verbs in isolation and in the combination have different lemmas but share a morpheme node (e.g. the morpheme node <give> is shared by *to give* and *to give up*). Frequency effects have also been found for the component morphemes of compounds (e.g. *black* in *blackboard*) when the frequencies of the compounds were kept constant (Roelofs, 1996a,b).

To conclude, the distinction between lemmas and morphemes allows us to account for the properties of morpheme errors and for morphemic effects in chronometric experiments. But more importantly, it provides us with a principled way of representing complex morphology in a model of lexical access. Such a principled account is lacking in CM’s proposal, and hence their model fails to account for the empirical evidence.

## 8. Summary and conclusion

In summary, Caramazza and Miozzo’s case against the distinction between lemmas and lexemes is based on the observations that grammatical class deficits of brain-damaged patients and semantic errors may be restricted to either spoken or written forms and that the grammatical gender of a word and its form can be independently available in TOT states. In our view, these findings do not challenge our model. As we have shown above, we can readily account for modality-specific deficits, either by postulating modality-specific lemmas or by assuming that modality-specific deficits arise when the links between amodal lemmas and modality-specific lexemes are affected. We further showed that, contrary to CM’s claims, the single lexical node solution does not provide a natural account of homophone production. In fact, on any rendering of that theory, it makes the wrong predictions for word frequency effects in homophones.

As we have also shown, independence of access to grammatical and form information in TOT states is perfectly compatible with our model. However, the implicit suggestion that there is no *intrinsic* ordering in accessing syntactic and phonological information during on-line word production, a suggestion that became materialized in CM’s IN-model, cannot be maintained given the recent LRP results of van Turennout et al. (1998). Our model, but not CM’s, provides a natural account for these findings.

Finally, we have pointed out that our model has never claimed to be an architecture for writing as well as speaking. Still, a natural extension of the model can deal adequately with the neuropsychological evidence that was levelled against it. In addition, it can deal with the representation and production of morphologically

complex forms, and we are not given any evidence that CM's model can do the same. It is one thing to provide an entirely new model for the explanation of a new empirical observation. It is quite another thing to have the new model also account for the myriad qualitative and quantitative experimental data that support the existing theory. That is still a far shot for the IN model. In conclusion, there is nothing in CM's data or arguments that requires us to reconsider our model.

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