The relation between syntactic and phonological knowledge in lexical access: evidence from the 'tip-of-the-tongue' phenomenon

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Abstract

The relation between access to the syntactic and to the phonological features of words in lexical access is investigated in two experiments. Italian speakers were asked to provide the gender and partial phonological information of known nouns they could not produce at that moment, words that they felt were at the tip-of-the-tongue (TOT). In both experiments, subjects were able to provide information about the word they could not produce with better-than-chance accuracy. This was true not only for phonological information such as the initial phoneme of the word but also for the word's gender – a purely syntactic feature of nouns. However, analyses of the correlation between correct retrieval of the gender and the initial phoneme failed to reveal a positive relationship. This result is inconsistent with theories of lexical access that interpose two lexical nodes, lemma and lexeme nodes, between a word's semantic and phonological content. A model of lexical access that does not postulate the lemma/lexeme distinction is briefly discussed. © 1997 Elsevier Science B.V.

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1. Introduction

Cognitive psychologists and neuropsychologists have obtained overwhelming

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evidence for the proposition that lexical access in language production occurs in two distinct moments: first the selection of a semantically and syntactically specified lexical representation, then the selection of its associated phonological (or orthographic) content (e.g., Fromkin, 1971; Garrett, 1976, 1980; Stemberger, 1985; Dell, 1986; MacKay, 1987; Butterworth, 1989; Levelt, 1989). The evidence most frequently cited in support of two-stage models of lexical access is the patterns of constraints that operate on word and sound exchanges in naturally occurring and experimentally induced 'slips-of-the-tongue'. It has been observed (e.g., Garrett, 1975) that word exchange errors involve words of the same grammatical class but different phonological structure, whereas the sounds that enter in an exchange error typically come from words of different grammatical classes but similar phonological environments. These contrasting patterns of constraints on speech errors have been interpreted to reflect the types of linguistic structures that are processed at different stages of speech production: semantic/syntactic information at one stage of processing; phonological information at a subsequent stage of processing. And by further inference it has been argued that lexical access is a multi-stage process involving first the selection of a semantically and syntactically specified lexical representation and then the selection of its phonological content.

Other types of evidence cited in support of two-stage models of lexical access include the momentary failures to retrieve the phonological form of known words (the 'tip-of-the-tongue' (TOT) phenomenon), the patterns of reaction times in naming and in lexical decision experiments, and the patterns of speech errors produced by brain-damaged subjects. Thus, for example, the analysis of the patterns of priming effects in speeded naming tasks has shown that the inhibitory effects of semantically related distractors and the facilitatory effects of phonologically related distractors occur, respectively, early and late in the naming process (e.g., Schriefers et al., 1990; Levelt et al., 1991). And investigations of the performance of aphasic patients have shown that naming failures can result from selective deficit in accessing the phonological (or orthographic) representations of words (e.g., Goodglass et al., 1976; Kay and Ellis, 1987; Henaff Gonon et al., 1989; Caramazza and Hillis, 1990). All these results have been interpreted as indicating that lexical access involves the sequential selection of a semantically and syntactically specified representation and then of its phonological content.

Although there is widespread agreement that lexical access occurs in two stages, there are alternative ways in which this notion can be implemented. Models of lexical access can differ in terms of their processing dynamics and/or the structure of representations at each stage of processing. For example, they can differ on whether they assume discrete (e.g., Garrett, 1976) or interactive (e.g., Stemberger, 1985) stages of processing, and on whether they assume componential (e.g., Bierwisch and Schreuder, 1992) or holistic (e.g., Roelofs, 1992) semantic representations. Despite such variation, the currently most influential models of lexical access (Dell, 1990; Roelofs, 1992; Jescheniak and Levelt, 1994) share a common assumption about the overall functional architecture of the process: access to a lexical-phonological representation (lexeme) is mediated by prior access to a modality-neutral lexical representation (lemma) that specifies the word's syntactic
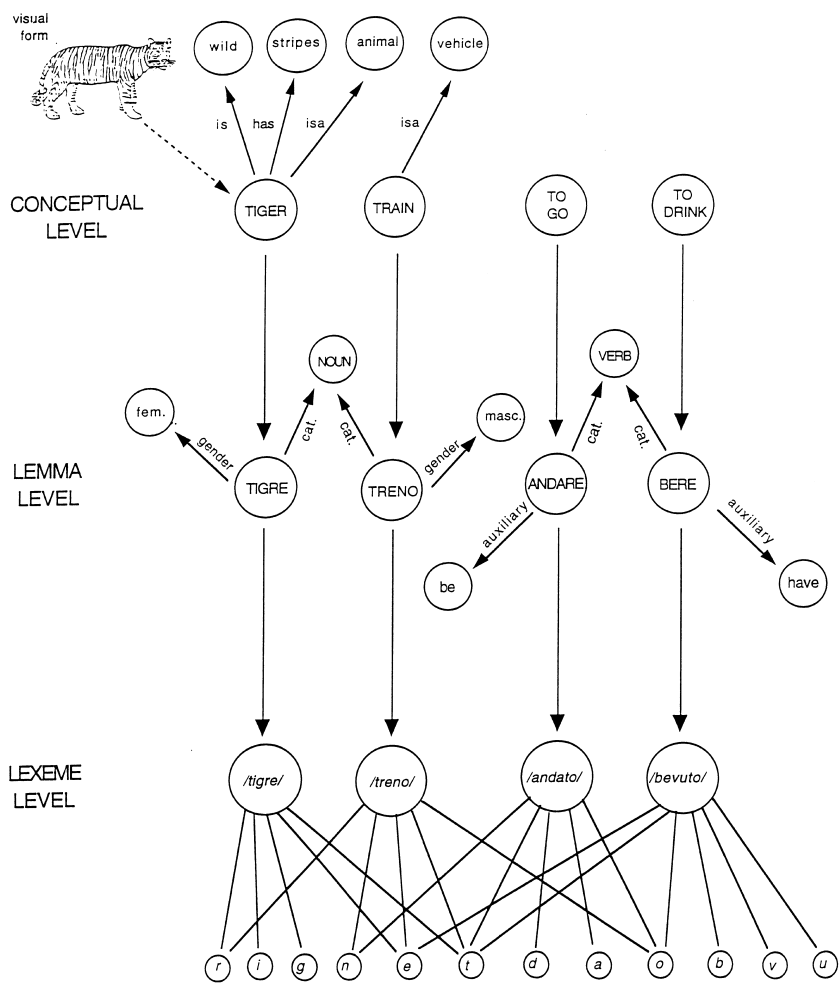
Fig. 1. Part of the lexical system showing the relation between lemma and other levels of lexical representation. The lemma and lexeme levels show the Italian words for the lexical concepts TIGER, TRAIN, TO GO, and TO DRINK. (Adapted from Bock and Levelt (1994), Jescheniak and Levelt (1994), and Roelofs (1992)).

properties. Fig. 1 is a schematic representation of the discrete-stage network model proposed by Roelofs (Roelofs, 1992; see also Bock and Levelt, 1994; Jescheniak and Levelt, 1994). The sequence of events in this model is as follows: first a semantic representation is selected; this is followed by the selection of its syntactically specified lexical representation (lemma), which is followed by the selection of the lexical form representation (lexeme) associated with the selected lemma, and finally the phonological content of the lexeme node is selected. That is, the activation of words as abstract 'syntactic entities' or lemmas precedes the activation of modality-specific lexical representations or lexemes. Dell (1990) adopts essentially the same functional architecture, but in an interactive network framework. Thus, a core prop-

erty shared by (most) current models of lexical access is the 'syntactic mediation' (SM) assumption (Caramazza, 1997), the hypothesis that abstract lexical-syntactic nodes (lemmas) mediate between semantic representations and lexical-phonological nodes (lexemes). This hypothesis assumes the existence of two types of lexical nodes: the lemma nodes that are connected to the syntactic features of words, and the lexeme nodes that are connected to the phonological content of words[1].

The evidence that has been adduced in support of dual stage models of lexical access does not necessarily also specifically support the SM assumption. In fact, there is very little evidence that directly speaks to the latter issue. Consider those experiments that have explored the time course of activation of lexical representations using the word-picture naming interference paradigm (e.g., Schriefers et al., 1990; Levelt et al., 1991). These experiments have shown that the phonology of the word distractor affects picture naming time at a later point than its semantics. The results of these experiments are consistent with any model that postulates that a semantically specified lexical representation is activated/selected before its phonological content is selected, but they are silent on the question of whether a lemma node, a syntactically specified representation, is activated/selected before a lexeme representation. A similar conclusion can be reached for the results of those studies that have investigated access of gender information in gender decision tasks (Jescheniak and Levelt, 1994) or the gender congruity effect in the picture-word interference paradigm (Schriefers, 1993). In both studies, clear gender effects are reported but they are indeterminate with respect to the level of lexical representation where gender information is represented. Or consider the case of the TOT phenomenon which is often cited as support of the lemma/lexeme distinction (Garrett, 1988; Levelt, 1989; Dell, 1990). Subjects in a TOT state have the 'feeling of knowing' a word despite their momentary inability to retrieve the word. When they are in this state, subjects can often retrieve partial phonological information about the word such as the initial sound or the number of syllables (Brown and McNeill, 1966; Koriat and Lieblich, 1974; Rubin, 1975; Jones and Langford, 1987; Kohn et al., 1987; Burke et al., 1991; Meyer and Bock, 1992; Perfect and Hanley, 1992; and see Brown, 1991 for review). These results, like the reaction time results in the picture-word naming interference paradigm, are consistent with any lexical access theory that postulates a distinction between semantically and phonologically specified representations, but they, too, are silent on the issue of whether an abstract syntactic node intervenes between semantic and lexeme representations.

More promising for the SM hypothesis are the observations concerning the contrasting constraints on the occurrence of word and sound exchange errors. The relevant observation here is the fact that word but not sound exchange errors involve words of the same grammatical class. This fact invites the inference that word exchange errors occur at a level of lexical access where grammatical but not phonological information is specified. This inference is eminently plausible but it does

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[1]Not all two-stage models of lexical access make the SM assumption. Butterworth (1989) and Fromkin (1971) only assumed a distinction between a level where a semantically specified representation is processed and one where a phonologically-specified representation is processed. Their formulation of the lexical access process was silent on the issue of how lexical-syntactic features are selected.
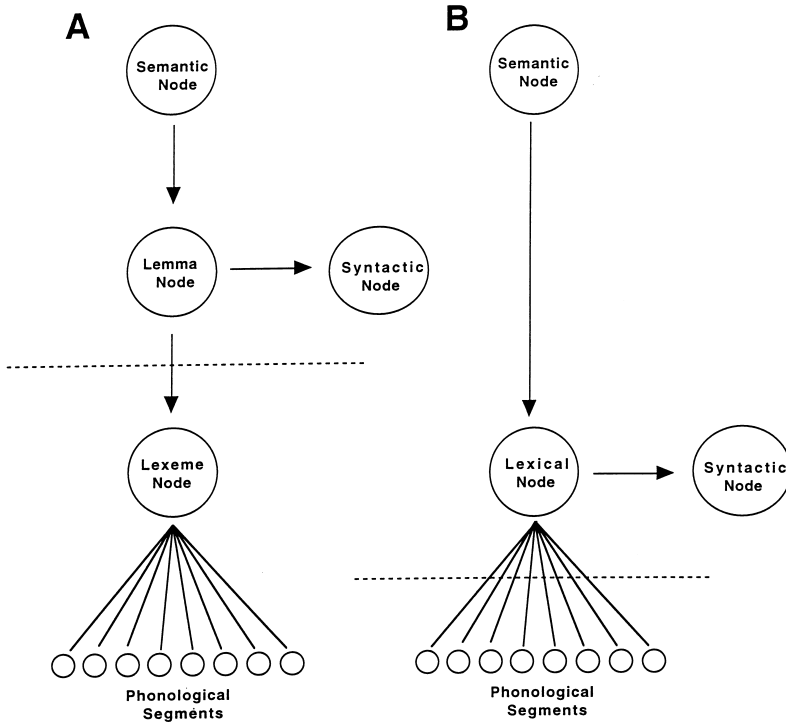
Fig. 2. (A) A generalized form of the SM hypothesis showing the hypothesized levels of representation without concern to the details of the various models cited that assume a lemma/lexeme distinction. (B) The contrasting hypothesis in which one less level of lexical representation is hypothesized. Dotted lines indicate the level of the damage responsible for the pattern of results shown in anomia and TOTs.

not require that we draw a distinction between lemma and lexeme representations. The observed constraints on word and sound exchange errors merely require that we assume a distinction between a semantically and syntactically specified representation and a level of representation where phonological segments are specified (the elements that enter in sound exchange errors). A model that captures the latter possibility and one that captures the standard SM hypothesis are schematically depicted for expository purposes in Fig. 2. The figure shows a generalized form of the SM hypothesis (i.e., all that is shown are the hypothesized levels of representation without concern to the details of the various models cited above) and the contrasting hypothesis in which one fewer level of lexical representation is hypothesized (Fig. 2A,B, respectively)[2].

Also relevant to the relation among semantic, syntactic, and phonological infor-

[2]Note that although only phonological segments are shown in the diagram, other phonological structure (syllable and suprasegmental information) is also specified with each lexical node. Note also that although the model in Fig. 2B is 'visually' similar to Dell's (1990) depiction of his interactive network model, it should be stressed that the similarity is misleading since he postulates an additional level of representation corresponding to the lemma level in Roelofs' (1992) model.

mation in lexical access are those results that show a dissociation between the availability of grammatical and phonological information in lexical access. Especially compelling are the results from the study of anomic patients, that is, patients with a selective deficit in naming objects. Henaff Gonon et al. (1989) were the first to formally observe that brain-damaged subjects with anomia seemed to know the gender of nouns they could not produce. They reported the naming performance of a brain-damaged, anomic subject who clearly recognized the common objects he was unable to name. Of interest here is the observation that their French-speaking subject spontaneously produced the correct gender-marked article of nouns he was unable to produce. Gender is a purely syntactic feature of nouns that, with minor exceptions, is not deducible from their meanings. Thus, this result indicates that the retrieval of the grammatical features of a word, the gender feature in this case, can proceed independently of the retrieval of its phonological form.

A more systematic investigation of the dissociation between grammatical and phonological information has recently been reported by Miozzo and his collaborators (Badecker et al., 1995; Miozzo and Caramazza, 1997a). They reported the naming performance of a brain-damaged, anomic subject who clearly understood the pictures and descriptions he was unable to name. This Italian-speaking subject was invariably able to indicate the gender of nouns and the auxiliary form of verbs he was unable to name. The auxiliary form of verbs in Italian, like the gender of nouns, is a syntactic property that is not deducible from a word's semantics or its phonology (Burzio, 1986; but see Van Valin, 1990). In a series of forced-choice tasks, he chose the gender of nouns and the auxiliary form of verbs almost always correctly but was at chance in choosing the phonological features of known words he could not name. Thus, the performance of this brain-damaged subject represents an essentially complete dissociation between the ability to retrieve grammatical information and the ability to produce the phonological content of known words. And, together with the case reported by Henaff Gonon et al. (1989), these results provide some of the strongest evidence for the autonomy of grammatical information in lexical access. However, like the other results briefly reviewed here, the reported dissociations between grammatical and phonological information do not compel us to adopt a distinction between lemma and lexeme representations in lexical access. The observation that subjects in anomic states can retrieve a word's grammatical features but not its phonological content may merely indicate that the *segmental* content of the correctly activated/selected lexical representation cannot be retrieved. That is, the reported dissociations only require that we distinguish between a lexical level where syntactic information is specified and a level of processing where the phonological content is specified (phonological segments and other phonological properties). In Fig. 2B the latter hypothesis would correspond to damage to the connections between the lexical node and the segmental (and other) phonological information (as indicated by the dotted lines).

Similar conclusions can be reached from recent observations with neurologically intact subjects in TOT states, a form of experimentally induced anomia. Two recent studies (Miozzo and Caramazza, 1997b; Vigliocco et al., 1997) used the fact that Italian nouns are gender-marked to address the question of whether the syntactic

properties of words can be accessed in TOT states, that is, in those situations in which, by hypothesis, subjects have accessed the word's correct lexical node but not its phonology. Since the experiments we report in this article also rely on the gender properties of Italian, it is useful to review in a little more detail the nature of this grammatical feature.

The words in a noun phrase in Italian must agree in grammatical gender. The choice of the article and the form of adjectives is determined by a noun's gender, they must all be of the feminine or the masculine gender (e.g., '*La* matita giall-*a*' [The_fem. pencil_fem. yellow_fem.]; '*Il* tavolo giall-*o*' [The_masc. table_masc. yellow_masc.]). As already noted, grammatical gender is a syntactic feature of nouns that is not deducible from their meanings. This fact can be most readily appreciated by noting that different languages assign different genders to the same concept: for example, 'flower' is masculine in Italian but feminine in French, 'sun' is masculine in Italian and French but feminine in German and Arabic. Although gender is not determined by meaning, it may be highly correlated with a word's phonology. This is certainly true in Italian: masculine nouns mostly end in /o/; feminine nouns mostly end in /a/. Nonetheless, there are very many exceptions to this rule: masculine and feminine words can end in /a/, /e/, /i/, /o/ or /u/ (e.g., *mano*, fem. [hand]; *poeta*, masc. [poet]). A comparison of performance with regular and irregular gender forms can be used to ensure that in TOT experiments the correct retrieval of gender is not inferred from the prior retrieval of phonological features of a word.

Miozzo and Caramazza (1997b; Experiment 2) asked native Italian speakers to name uncommon masculine and feminine Italian nouns, such as *biga* [chariot], *curaro* [curare], *alibi* [alibi], and *cornamusa* [bagpipe]. Both regular (e.g., *biga*, fem.; *curaro*, masc.) and irregular (e.g., *amniocentesi*, fem. [amniocentesis]; *plasma*, masc. [plasma]) gender nouns were used. Subjects were shown a picture and/or a definition and instructed to produce the name. If unable to name an item within 15 s, they indicated whether they felt confident that they knew the target name (TOT state) or whether they did not know it ('don't know' (DK) state). For both TOT and DK responses, subjects were asked to make several forced choice decisions in the following order: grammatical gender, the final vowel, and the initial letter. Subjects were not able to retrieve the gender, the initial, or the final letters with better than chance accuracy (0.5) for the DK words. However, for TOT responses, subjects were significantly more accurate than chance in retrieving the gender (70.6%) and the initial letter (71.8%), but not the final letter (58.6%) of these words. The significant advantage in retrieving gender information in TOT states was not affected by gender regularity. That is, subjects were as likely to correctly retrieve the gender for TOT words with irregular gender endings as they were for words with regular gender endings. A similar pattern of results was reported by Vigliocco et al. (1997) who also found that subjects could report the gender of TOT words with better than chance accuracy.

These two sets of results confirm the observations with anomic subjects (Henaff Gonon et al., 1989; Badecker et al., 1995; Miozzo and Caramazza, 1997a) which show that the grammatical features of a word can be correctly accessed despite failure to retrieve its phonology. However, as in the case of the data with anomic

subjects, they too fail to distinguish between those models of lexical access that assume two versus those that assume one level of lexical representation mediating between the semantic and the phonological content of a word. The reason for this contention is simple: the observation that a word's gender can be retrieved despite failure to retrieve its full phonological form merely establishes that gender is represented independently of the word's phonology; it does not allow further conclusions regarding the number of lexical nodes that are involved in speech production. That is, the TOT results are consistent with any theory of lexical access that distinguishes between the phonological content and the grammatical features of words. But, as shown in Fig. 2, this property of the organization of the lexical system is shared by models that propose two and those that propose one lexical node mediating between the meaning and the phonological content of words.

To this point we have argued that despite the widespread acceptance of the lemma/lexeme distinction in lexical access none of the results usually cited in its favor actually supports this view over the single lexical node hypothesis. All the studies that have addressed the lemma/lexeme distinction issue have done so from one of two perspectives: Either they simply assumed the existence of the distinction and interpreted the results in that framework (e.g., Dell, 1990; Jescheniak and Levelt, 1994) or they attempted to demonstrate that syntactic information is available even when the word could not be produced (e.g., Badecker et al., 1995; Vigliocco et al., 1997). But, as we have argued, the latter demonstration is consistent with both the SM hypothesis and the single lexical node hypothesis. And, in fact, the evidence needed to distinguish between the two hypotheses does not involve an assessment of whether syntactic information can be retrieved when there has been a failure to retrieve phonological information, the type of evidence reported in Badecker et al. (1995), Henaff Gonon et al. (1989), Miozzo and Caramazza (1997a), and Vigliocco et al. (1997), but whether phonological information can be retrieved when there has been a failure to retrieve syntactic information. To better appreciate the contrast between these two types of evidence, consider the expectations derived from the SM and the single lexical node hypotheses concerning the relationship between the retrieval of syntactic and of partial phonological information in TOT states.

In models that make the SM assumption there is a strict dependence between the successful retrieval of a word's phonological information and the prior successful retrieval of its syntactic features. This translates into the expectation that in those TOT states in which the initial phoneme has been correctly retrieved gender should also be available, since retrieval of the former depends on the prior successful retrieval of the latter. By contrast, the single lexical node hypothesis does not require that the successful retrieval of partial phonological information in TOT states should also lead to the correct retrieval of a word's syntactic features (compare Fig. 2A and 2B). These contrasting predictions can be evaluated by considering the correlation between the correct retrieval of gender and the correct retrieval of partial phonological information. Specifically, since the SM hypothesis requires that the correct access to a word's partial phonological information depends on correct access to its syntactic features (lemma) there should be a positive correlation between correct

retrieval of gender and correct retrieval of partial phonological information. This prediction was tested in two TOT experiments with Italian subjects.

2. Experiment 1

We have all experienced the TOT phenomenon. Its phenomenology is quite clear: despite the momentary failure to retrieve a word, we are sure that we know it and that it is about to come to mind; we also have the feeling that we know aspects of the word we are momentarily unable to retrieve in full, such as, for example, the beginning sound or its length. This 'feeling of knowing' is not inaccurate. Brown and McNeill (1966) were the first to experimentally investigate the TOT phenomenon in detail. In a naming-to-definition experiment, they were able to show that subjects in TOT states could, in fact, provide considerable information about the word they could not fully recall. As already noted, many subsequent studies confirmed and extended these basic observations about the TOT phenomenon (see Brown, 1991 for review of this literature).

In order to investigate quantitatively the accuracy of a subject's ability to retrieve partial information about words in TOT states we must resolve two issues: (1) we must find a way of determining when a subject in a TOT state is, in fact, searching for the word intended by the experimenter, and (2) we must obtain some measure of baseline performance in guessing partial information about words (in general) against which to compare performance with TOT words. There is no agreed-upon set of procedures for dealing with these two issues. Nonetheless, there are rough guidelines that may be followed.

In their classic experiment, Brown and McNeill (1966) drew a distinction between 'positive' and 'negative' TOTs. The former are those cases where the word the subject is searching for in a TOT state corresponds to the target response prescribed by the experimenter; the latter are those cases where the subject is searching for a different word from the one designated by the experimenter. The two types of TOTs are distinguished by giving subjects the correct response and having them judge whether or not it is the word they were searching for. The incidence of negative TOTs can be quite high; in Brown and McNeill's experiment it was 35%. In the experiments that follow we have chosen to consider only positive TOTs in evaluating subjects' level of accuracy in retrieving partial information about TOT words[3].

Subjects' guessing rates of the gender and partial phonological information of a word are likely to reflect complex distributional properties of the words in the language. To estimate baseline guessing performance for partial information about words, Koriat and Lieblich (1974) proposed using guessing performance with DK words. DK states are those in which a subject reports not to know the target word. We have followed Koriat and Lieblich (1974) in using performance

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[3]A special case is presented by those trials where a subject has in mind a different word from the experimenter and is able to retrieve it after having responded to the various partial knowledge queries. The responses to the partial knowledge questions for these alternative targets were included with the positive TOTs.

with DK words as a baseline for assessing subjects' accuracy level in retrieving partial information in TOT states. We also used performance with negative TOTs as another indicator of baseline guessing performance for partial information. Since the estimates of baseline performance for these two methods were not found to differ, we combined them into a single measure. (Nonetheless, we will first report them separately.)

2.1. Design and materials

One hundred and fifty-two uncommon Italian nouns were used in this experiment. They were the same as those used in Miozzo and Caramazza (1997b; Experiment 2) with the exception of seven items which were replaced either because they did not induce a consistent name or because they did not induce a TOT state. The target words had the following characteristics: (a) they were singular nouns; (b) they ended with a vowel[4]; and, (c) they did not denote the male or female exemplars of a concept (e.g., *re* [king]; *regina* [queen]), nor did they have a suffix which correlates with natural gender (e.g., *dottoressa* [female doctor] vs. *dottore* [male doctor]). The nouns *eutanasia* [euthanasia], *biga* [chariot], and *geroglifico* [hieroglyphic] are examples of the type of items used. Gender and regularity of noun ending were both controlled. Half of the nouns were masculine, the other half feminine. For each gender, there were 41 regular and 35 irregular nouns. Regular nouns ended with the vowel most frequently associated with a particular gender, the vowel -o for masculine and the vowel -a for feminine words. Irregular nouns ended with other vowels: -e, -a, and -i for masculine words, and -e, -o, and -i for feminine words. Target nouns ranged in length from two to five syllables, and were distributed as follows: two syllables, 30%; three syllables, 40%; four syllables, 24%; and five syllables, 6%.

The inclusion of words with irregular endings provides a crucial control for the proper interpretation of performance in guessing a word's gender. Because of the high correlation between the gender of words and their endings, it could be argued that subjects might be able to use their knowledge of a word's ending to infer the gender of the word. That is, if it were to turn out that subjects could correctly retrieve the final phoneme of words in TOT states, then, they might also be able to use this information to infer the gender of those words. However, the use of this strategy would be of no help (and it might even hinder performance) in the case of words with irregular endings. Thus, the probability of correctly retrieving gender for words with irregular endings provides an unbiased estimate of the level of correct gender retrieval for TOT words.

For each item a picture and/or a definition was prepared. To minimize the production of erroneous names, some pictures were accompanied by short definitions. Thus, for instance, for *cornamusa* [bagpipe] the description 'It is typical of Scotland' was added to prevent the production of the related noun *zampogna* [reed pipe].

On each trial, subjects had 15 s to name the stimulus. In the case of a naming failure, they decided whether or not they knew the name of the stimulus. Subjects

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[4]Almost all nouns in Italian end in a vowel. Exceptions consist mostly of foreign words (e.g., *computer*) and they are typically of the masculine gender.

were instructed to report being in a TOT state if 'they felt that they knew the word' and that they 'had the feeling that the word was about to come'. In those cases where subjects failed to recognize the picture and/or definition or thought that they had never acquired the specific name of the concept, they were instructed to say 'don't know'. Immediately after reporting that they were in a TOT state, subjects were asked to indicate how confident they were 'to have the word at the tip of the tongue'. In the case of DK responses, they rated how sure they were of 'not knowing the target word'. After having provided the confidence rating about their state of knowledge of the target word they reported in order the following features of the target name: grammatical gender, the final phoneme, the number of syllables, and the initial phoneme. For each feature, subjects also indicated how confident they were of knowing the response. All confidence ratings were expressed on a 4-point scale, where 1 was equal to 'very unsure' and 4 was equal to 'very sure'. At the end of these queries, there was a recognition test: the target word was presented, and subjects decided whether or not it was the word they were seeking to produce. If subjects reported that they were thinking of a word different from the one designated by the experimenter, they were asked to provide it. Also, subjects were instructed to immediately report the target word if it came to mind during the partial retrieval test. These 'recovered' TOTs were scored as correct naming responses, and therefore excluded from the corpus of TOTs.

Fifty-three native Italian speakers (students and staff at the University of Padua) participated in the experiment. They were tested individually, and were told that the experiment was an investigation of the TOT phenomenon. The tester was not informed about the specific objectives of the study.

2.2. Results

Subjects successfully named 80.9% of the stimuli – these data include 83 (1%) 'recovered' TOTs (cases in which subjects initially signaled that they were in a TOT state but were then able to retrieve the target word). Name 'agreement' was particularly high: 99.5% of the names produced by subjects conformed to those designated by the experimenter. Of the alternative names produced by the subjects, 8/36 (22%) can be scored as plausible responses (e.g., *lapide* [tombstone] → 'sepolcro' [sepulchre]); the remaining cases (28/36) were frank incorrect responses (e.g., *alce* [elk] → 'renna' [reindeer]). The remaining responses consisted of 906 (11.2%) DK responses (mean/subject = 17.0; range 1–49) and 632 (7.8%) TOTs. TOT responses can be further divided into positive and negative TOTs. There were 462 positive and 170 negative TOTs. On 70 occasions, after answering all the queries, subjects were able to retrieve the alternative word they sought to retrieve (these responses were scored as positive TOTs). The mean number of positive and negative TOTs per subject were 8.7 (range 0–35) and 3.7 (range 0–13), respectively.

The distribution of correct identifications of partial knowledge – gender, initial and final phoneme, and number of syllables – for positive and negative TOTs and for DK responses is reported in Table 1. Inspection of Table 1 shows an almost identical pattern of performance for negative TOTs and DK responses. Because of

Table 1
Number (%) of correct responses in recalling different features of words in TOT and baseline conditions (Experiment 1)

Type of feature	Gender	Number of syllables	Initial phoneme	Final phoneme[a]
Type of response				
Positive TOTs	341/462 (73.8)	172/462 (37.2)	131/462 (28.3)	229/341 (67.1)
Negative TOTs	88/170 (51.8)	52/170 (30.5)	12/170 (7.0)	41/88 (46.6)
DK responses	464/906 (51.2)	309/906 (34.1)	95/906 (10.5)	228/464 (49.1)
Baseline (negative TOTs + DK responses)	552/1076 (51.3)	361/1076 (33.5)	107/1076 (9.9)	269/552 (48.7)

[a]The responses included for analysis in this condition are only those in which subjects responded correctly to the gender query. See text for explanation.

their similarity, these responses were analyzed together. For simplicity, we will refer to positive TOTs as simply TOTs, and to negative TOTs and DK responses as 'baseline responses'.

Unless otherwise specified, the following general procedures were adopted in analyzing the data. Analyses were performed on the proportion of subjects' correct responses. If in any of the reported comparisons a cell was empty, none of that subject's data was analyzed further. Whenever less than the full set of responses is analyzed, the proportion of responses retained in the analysis is reported. Finally, for the last phoneme, we analyzed only responses in which gender was successfully retrieved. This procedure was adopted because responses to the gender queries were expected to influence responses to queries about the final phoneme. Thus, for example, if a subject mistakenly responded 'feminine' to a masculine noun, he/she would most likely also mistakenly assume that the final phoneme was an /a/. By restricting the analysis of the final-phoneme data to those words to which subjects had responded correctly to the gender query, we should obtain a more accurate estimate of the availability of the final phoneme in TOT states[5].

2.2.1. Retrieval of word features

A two-way analysis of variance (ANOVA) was carried out on the proportion of correct responses in identifying the gender, the initial phoneme and the number of syllables for the TOT and the baseline responses. The main effect of response type was significant: the retrieval of partial information was greater for the TOT than the baseline responses ($F(1,51) = 60.5$, $MS_e = 394.3$, P < 0.0001; 99.9% of baseline responses analyzed). Also significant was the interaction of type of response by type of information queried: the advantage of the TOT responses was unequal across word features ($F(2,102) = 3.4$, $MS_e = 441.0$, $P < 0.05$). Planned comparisons showed that subjects were more accurate in retrieving gender in the TOT than the baseline condition, 73.8% and 51.3%, respectively (paired $t(51) = 4.91$, $P <$

[5]Note that this scoring procedure will inflate the level of correct performance for the final phoneme. This makes interpretation of the absolute level of performance for this phonological feature of words highly problematic.

0.0001), and they were also more accurate in retrieving the initial letter in the TOT than baseline condition, 28.3% and 9.9%, respectively (paired $t(51) = 5.35$, $P < 0.0001$). No difference was found for number of syllables in the TOT and baseline conditions, 37.2% and 33.5%, respectively (paired $t(52) < 1$). In a separate analysis it was found that retrieval of the final phoneme was better in the TOT than the baseline condition, 67.1% versus 48.7% ($F(1,48) = 12.3$, $MS_e = 477.7$, $P = 0.001$; 97% of DK responses analyzed).

To further compare the availability of a word's features in the TOT and the baseline conditions, an ANOVA with items as a random factor was carried out. For this analysis, only positive TOTs were examined (i.e., we excluded those items where subjects produced acceptable, alternative responses; in this way, target words were identical for the two types of responses). Only stimuli that induced both TOT and baseline responses were entered in the analysis. The main effect of type of response ($F(1,104) = 16.3$, $MS_e = 745.7$, $P = 0.0001$) and the interaction between type of response and word feature ($F(2,208) = 8.7$, $MS_e = 621.9$, $P = 0.0002$) were also significant in this analysis (comparisons based on 96% of TOTs and on 93% of baseline responses). Post-hoc tests revealed that gender (paired $t(104) = 3.82$, $P < 0.0001$) and the initial phoneme (paired $t(104) = 4.28$, $P < 0.0001$) were more accurately reported in the TOT than the baseline condition; no such effect was found for number of syllables (paired $t(104) < 1$). A separate ANOVA by items for the final phoneme data again found a significant difference in favor of the TOT over the baseline condition ($F(1,82) = 4.3$, $MS_e = 658.2$, $P < 0.05$; comparison based on 60% of TOTs and 84% of baseline responses). Thus, identical patterns of results emerged from the analyses by subjects and by items: gender and the initial and the final phonemes, but not information about a word's number of syllables, were retrieved with better than chance level of accuracy in TOT states.
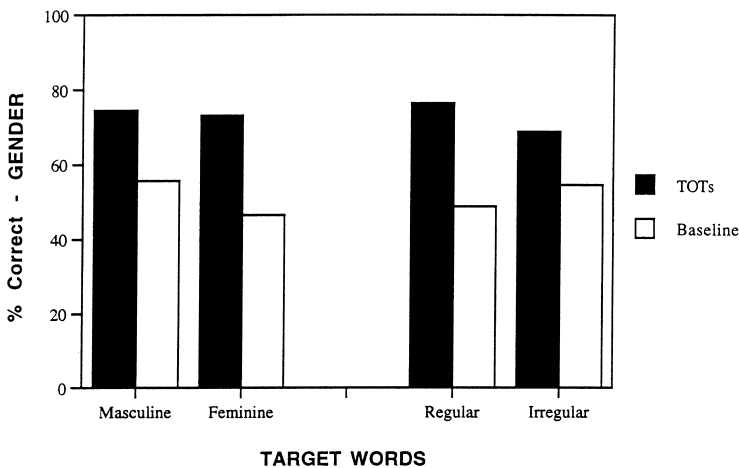

Fig. 3. Percent correct retrieval of gender in TOT and baseline conditions, for masculine and feminine nouns and for regular and irregular-ending nouns (Experiment 1).

Fig. 3 shows the distribution of correct retrieval of gender for masculine and feminine nouns, and for nouns with regular and irregular endings in the TOT and baseline conditions. Separate analyses were carried out to determine whether type of gender (masculine vs. feminine) and regularity (regular vs. irregular nouns) affected gender selection. Type of gender had no influence on the identification of gender in either TOT (paired $t(42) < 1$; 97% of responses analyzed) or baseline responses (paired $t(50) < 1$; 99% of responses analyzed); similarly, the regularity of a word's ending had no effect on the selection of gender in the TOT (paired $t(40) = 1.25$, n.s., based on 95% of responses) or in the baseline conditions (paired $t(50) < 1$, based on 99% of responses). This last result is crucial for interpreting gender retrieval performance: The fact that word-ending regularity had no effect on the level of accuracy of gender retrieval rules out the possibility that the observed performance in gender retrieval is merely a reflection of the correlation between gender and word-ending.

Further analyses investigated whether type of gender and ending regularity affected subjects' retrieval of the final phoneme of words (see Fig. 4). For the TOT responses, subjects were more accurate in retrieving the final phoneme of feminine (76.1%) than masculine nouns (59%; paired $t(41) = 2.56$, $P = 0.014$; 96% of the responses analyzed). No such difference was evident in the baseline condition (masculine, 46.3%; feminine, 51.8%; paired $t(46) < 1$; 96% of the responses considered). The basis for this pattern of results is not clear.

The analysis of the effect of regularity on the probability of correctly guessing the final phoneme also produced clear results: the regular endings were selected far more frequently than the irregular endings for both TOT and baseline states (TOTs: 85.3% vs. 32.5%; paired $t(37) = 6.94$, $P < 0.0001$, based on 92% of the responses; baseline condition: 74.2% vs. 18.6%; paired $t(46) = 10.21$, $P < 0.0001$, based on 97% of the responses). The asymmetry in favor of regular words was also found in
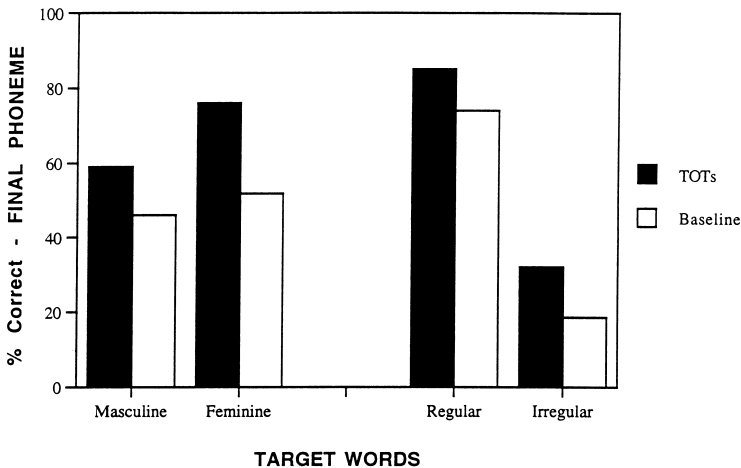

Fig. 4. Percent correct retrieval of final phoneme in TOT and baseline conditions, for masculine and feminine nouns and for regular and irregular-ending nouns (Experiment 1).

our previous study of the TOT phenomenon (Miozzo and Caramazza, 1997b), as well as in other investigations of gender processing in Italian (Bates et al., 1995; Bates et al., 1996; Burani, 1992). This result merely reveals a strong bias for producing responses consistent with the distribution of gender-marked word endings in Italian (see e.g., De Mauro et al., 1993).

Fig. 5 displays the distribution of subjects' responses in reporting the number of syllables as a function of the syllable length of the target words. An almost identical profile of responses appears for TOT and baseline responses, a fact that further confirms the conclusion that information about number of syllables was equally (un)available in the two conditions.

2.2.2. Confidence ratings

When subjects signaled to be in a TOT state, they rated how confident they were of 'having the word at the tip of the tongue'. Higher confidence ratings were obtained for trials in which subjects later recognized the word presented by the experimenter as their target (mean ratings, positive TOTs = 3.03, negative TOTs = 2.45; $F(1,43) = 45.7$, $MS_e = 0.132$, $P < 0.0001$). Similar differences were found for subjects' 'feeling of knowing' the queried features (see Table 2; $F(1,43) = 57.8$, $MS_e = 0.276$, $P < 0.0001$). These results indicate that subjects' 'feeling of knowing' the word were not inaccurate. However, this last conclusion must be tempered by the fact that the confidence ratings for negative TOTs were also higher than those for DK responses ($F(1,43) = 105.1$, $MS_e = 0.278$, $P < 0.0001$).

2.2.3. Gender versus initial letter

Further analyses were carried out for the TOT responses with the specific purpose of testing the hypothesis that the retrieval of partial phonological information about a word depends on the successful retrieval of its syntactic features, gender in this case. In order to evaluate whether there is a positive correlation between the retrieval
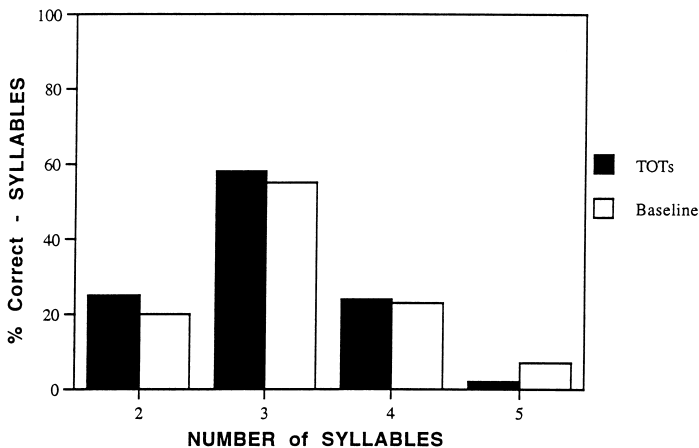

Fig. 5. Percent correct retrieval of number of syllables as a function of targets syllable length (Experiment 1).

Table 2
Mean confidence ratings of knowing various features of positive TOT, negative TOT and DK words (Experiment 1)

Type of feature Type of response	Gender	Number of syllables	Initial phoneme	Final phoneme
Positive TOTs	2.68	2.54	2.54	2.58
Negative TOTs	2.24	2.05	1.98	2.16
DK response	1.64	1.55	1.47	1.60

performance for gender and initial phoneme, ϕ coefficients were calculated for each subject. The mean ϕ value over subjects was −0.085 (38 observations, corresponding to 92% of the total corpus of TOTs). The corrected coefficient r (Fischer's z) was then calculated for each subject (mean $r = -0.101$, variance $= 0.113$) and confidence intervals were determined ($0.95 = -0.329 < \mu < 0.127$; and $0.5 = -0.178 < \mu < 0.069$). The mean r fell well within the boundaries of both the 0.95 and 0.5 confidence intervals. The strength of the correlation between correct retrieval of gender and the initial phoneme was also assessed by means of a t-test. We found no indication that the correlation between these two factors is different from zero (mean r vs. 0: $t(74) = -1.84$, $P = 0.069$). Thus, there is no evidence in the experiment reported here of a positive correlation between the retrieval of syntactic and of partial phonological information in TOT states.

2.3. Discussion

The results of this experiment confirm and extend previous research on the relation between the retrieval of grammatical and phonological information in TOT states (anomic patients: Henaff Gonon et al., 1989; Badecker et al., 1995; normal subjects: Miozzo and Caramazza, 1997a, 1997b; Vigliocco et al., 1997). They also once again confirm that subjects' 'feeling of knowing' in TOT states are accurate. Subjects were able to provide partial information about TOT words with greater-than-chance levels accuracy. Furthermore, subjects were more confident in those cases in which they turned out to be accurate than inaccurate in reporting partial information (e.g., Burke et al., 1991).

The partial information that subjects were able to retrieve in TOT states included the gender of the word and its initial phoneme. However, there was no indication in the data that the accuracy of retrieval of these two features of words were correlated. It would seem, then, that the successful retrieval of partial phonological information of a word in a TOT state does not depend on the prior correct retrieval of its syntactic features. This conclusion poses a serious challenge to the SM hypothesis of lexical access, and it undermines that class of models that would interpose two lexical nodes, lemma and lexeme nodes, between the semantic and the phonological content of words. Acceptance of the conclusion reached here would have far-reaching implications for theories of lexical access. It is important, therefore, to be sure

that the absence of a correlation between access to syntactic and partial phonological information obtained in this experiment is not the result of insufficient power or some other limitation of the experiment.

There are discrepancies between the results of this and of previously reported experiments which might be seen as cause for caution in interpreting the results reported here. In this experiment, subject were better able to retrieve the last phoneme in the TOT than in the baseline condition. This result contrasts with the results reported in Miozzo and Caramazza (1997b), for a very similar experiment and the same stimuli, where it was found that the last letter was not retrieved with betterthan-chance accuracy. This contrast in performance may simply reflect the fact that the last phoneme is not one of those features of words that is reliably retrieved in TOT states (see review in Brown, 1991). However, the fact that the last letter was retrieved with better-than-chance accuracy in this experiment can be used to undermine the interpretation of the results for gender retrieval. Since there is a strong correlation between gender and the last phoneme of words, it could be argued that subjects' better-than-chance accuracy with gender merely reflects their ability to retrieve the last phoneme of the word. That is, correct retrieval of the last phoneme could have been used to correctly guess the gender of the word. However, this interpretation is not supported by the results. If the good performance in the retrieval of gender were merely a consequence of having correctly retrieved a word's final phoneme, regularity of word ending should have affected performance in retrieving gender. No such effect was obtained (see Fig. 3). We must, therefore, interpret the accurate retrieval of gender as a true gender effect, and the failure to obtain a significant correlation between retrieval of gender and initial phoneme as an indication that the retrieval of partial phonological information about a word does not depend on the prior retrieval of its syntactic features.

The latter conclusion could be undermined by another aspect of the results reported here. In our experiment, subjects were not able to the report the number of syllables for TOT words any better than for words in the baseline condition, even though this feature of words is often easily retrieved in TOT states (e.g., Lovelace, 1987). Furthermore, although the initial letter was retrieved with greater-thanchance accuracy, the absolute level of performance was quite low (28.3%) by comparison to other studies which have reported accuracy levels around 50% (see Brown, 1991 for review). Thus, it could be argued that the relatively impoverished level of phonological retrieval in our experiment does not present the optimal conditions for testing the relation between access to syntactic and to phonological information. A second experiment was carried out in an attempt to create more favorable conditions for a fair assessment of the SM hypothesis.

3. Experiment 2

Experiment 1 was rather complex. It involved having subjects attempt to retrieve four types of information and make five confidence ratings for each word in the TOT and baseline conditions. It is not inconceivable that the complexity of the task may

have interfered with retrieval of information that, by its very nature, is elusive at best. The phenomenology of TOTs suggests that the 'feeling of knowing' the word that cannot be retrieved is highly ephemeral – we feel we know partial features of the word but we can't quite grasp them; they are there and yet beyond reach. Perhaps the low level of accuracy in retrieving the initial phoneme may have reflected the interference from the many other judgments that preceded it. To avoid the potential difficulties introduced by having subjects make many complex judgments that could interfere with each other, we carried out a second experiment in which subjects were required to report only the gender and the initial phoneme of TOT and baseline words. In this way, it was hoped that subjects' performance in retrieving the first letter of TOT words would be comparable to that in other studies of the TOT phenomenon.

3.1. Design and material

The materials used in this experiment were the same as those of Experiment 1. The experimental procedure differed from the last experiment in two major respects: (a) subjects were tested in small groups of 7–8 participants to facilitate data collection, and (b) the query part of the experiment was considerably simplified. When subjects failed to produce the target word, they were required to report only two features of the target nouns: first the grammatical gender and then the initial phoneme. The experiment took place in a classroom at the University of Padua. Stimuli (pictures and/or written definitions), were projected on a white wall by means of a slide projector. The experimenter read aloud the definitions. Subjects had 15 s from the end of the definition to write the name of the stimulus in a booklet. At this point, the experimenter invited subjects who experienced a naming failure but felt sure that they knew the word and that 'it was about to come' to guess the target's grammatical gender and its initial phoneme. Finally, the name designated by the experimenter was presented, and subjects decided whether or not that was the word they had been attempting to retrieve. Subjects were instructed to write down the name of the target if, up to the point of the noun presentation by the experimenter, it came to mind (these 'recovered' TOTs were included in the count of successful naming responses).

Forty-two volunteer subjects (students at the University of Padua) participated in the experiment.

3.2. Results

Responses were coded and analyzed as in Experiment 1. Subjects responded with a name they considered adequate for the concepts on 73.7% of the trials (of which 4.2% were 'recovered' TOTs). On 355 occasions (equal to 7.5% of successful naming responses), subjects produced a name inconsistent with the designated response. Fifty (14%) of these alternative names could be classified as plausible responses (e.g., *dinamite* [dynamite] → 'polvere da sparo' [gunpowder]), the remaining being frank errors (*rublo* [rouble] → 'dracma' [drachma]). Subjects

reported being in a TOT state on 818 (12.8%) occasions, divided as follows between positive and negative TOTs: 8.7% were positive TOTs ($n = 554$; mean/subject = 13.1, range = 2–32) and 4.1% were negative TOTs ($n = 264$; mean/subject = 6.3, range = 1–16). On 55 occasions, subjects were able to retrieve the alternative word they sought to produce. These responses, along with positive TOTs, will constitute the corpus of TOTs, which thus amounted to a total of 609 responses (mean/subject = 14.5, range = 2–32). Subjects declared to 'don't know' the name on 802 occasions (12.5% of trials; mean/subject = 19.1, range = 4–50).

3.2.1. Retrieval of word features

The distribution of successful retrievals of the gender and the initial phoneme for positive, negative, and DK responses is shown in Table 3. As in Experiment 1, a word's gender and partial phonological information were equally (un)available in the negative TOT (51.5% and 5.7% for gender and initial phoneme, respectively) and DK states (49.6% and 10.1% for gender and initial phoneme, respectively), and therefore responses in these two conditions will be considered together (baseline responses; $n = 1066$). Gender was correctly retrieved 67.8% and 50.1% for TOTs and baseline conditions, respectively; and the initial phoneme was correctly retrieved 57.5% and 9.0% for TOTs and baseline conditions, respectively. A two-way ANOVA was carried out in order to determine whether gender and initial phoneme were identified with different probabilities in the TOT and baseline conditions. This comparison proved to be statistically reliable ($F(1,41) = 206.4$, $MS_e = 267.7$, $P < 0.0001$). Paired *t*-tests revealed that both gender ($t(41) = 6.38$, $P < 0.0001$) and the initial phoneme ($t(41) = 13.55$, $P < 0.0001$) were more frequently identified in TOT than baseline states. The same pattern of results emerged in the analyses by items. For the latter analyses, only positive TOTs were examined (i.e., we excluded those items were subjects produced acceptable, alternative responses; in this way, target words were identical for the two types of responses). An ANOVA contrasting the retrieval of gender and the initial phoneme in positive TOTs and baseline responses revealed a significant difference between the two conditions ($F(1,118) = 121.2$, $MS_e = 703.2$, $P < 0.0001$; based on 91% and 98% of TOTs and baseline responses, respectively). The difference between response types was obtained both for the retrieval of gender (paired $t(118) = 2.99$,

Table 3
Number (%) of correct responses in recalling different features of words in TOT and baseline conditions (Experiment 2)

Type of feature Type of response	Gender	Initial phoneme
Positive TOTs	413/609 (67.8)	350/609 (57.5)
Negative TOTs	136/264 (51.5)	15/264 (5.7)
DK responses	398/802 (49.6)	81/802 (10.1)
Baseline (negative TOTs + DK responses)	534/1066 (50.1)	96/1066 (9.0)

$P = 0.003$) and for the retrieval of the initial phoneme (paired $t(118) = 13.15$, $P < 0.0001$).

The proportion of correct selections of gender for masculine and feminine nouns, and for nouns with regular and irregular endings in TOT and baseline conditions is displayed in Fig. 6. For TOTs, neither type of gender (paired $t(39) < 1$; 99% of responses analyzed), nor type of ending (paired $t(39) < 1$; 99% of responses analyzed) affected gender identification. In the baseline condition, however, the masculine gender was more frequently selected than the feminine gender (61.1% vs. 38.6%; paired $t(41) = 4.18$, $P < 0.0001$). This bias in responding 'masculine' is consistent with the distribution of gender assignment in Italian (see e.g., De Mauro et al., 1993), and has been observed in a previous investigation of the TOT phenomenon (Miozzo and Caramazza, 1997b). Finally, regularity of word ending did not influence gender selection (paired $t(41) = 1.11$, $P > 0.05$; 99% of responses analyzed).

3.2.2. Gender vs. initial letter

Analyses were carried out to test the hypothesis that the retrieval of partial phonological information about a word depends on the prior retrieval of its syntactic features. For this purpose we carried out the same type of analysis as in Experiment 1. That is, we considered the correlation between correct retrieval of gender and initial phoneme. For each subject the ϕ coefficient for the relation between correct retrieval of gender and initial phoneme was calculated. The mean ϕ value over subjects was very close to zero ($\phi = 0.034$; 39 observations, corresponding to 98% of the total corpus of TOTs). To assess the strength of the correlation, the corrected coefficient r (Fischer's z) was calculated for each subject (mean $r = 0.066$, variance $= 0.130$) and confidence intervals were determined ($0.95 = -0.197 < \mu < 0.329$; and $0.5 = -0.022 < \mu < 0.154$). The mean r fell well within
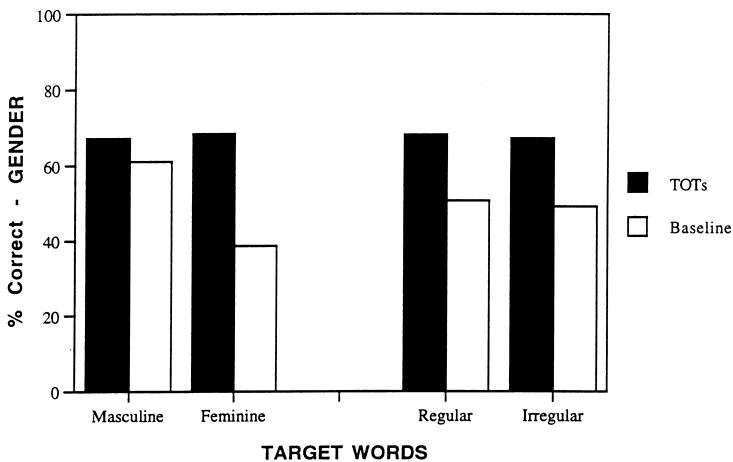

Fig. 6. Percent correct retrieval of gender in TOT and baseline conditions, for masculine and feminine nouns and for regular and irregular-ending nouns (Experiment 2).

the boundaries of both the 0.95 and 0.5 confidence intervals, indicating the clear absence of a correlation between the retrieval of gender and the initial phoneme.

The strength of the correlation between correct retrieval of gender and the initial phoneme was further evaluated by means of a *t*-test in which subject's *r* scores were compared against a zero correlation. This analysis, too, failed to provide any indication of a correlation greater than zero between correct retrieval of gender and initial phoneme (mean *r* vs. 0: $t(76) = 1.14$, $P = 0.254$). Thus, the results of this experiment replicate those of Experiment 1.

3.3. Discussion

The principal purpose of Experiment 2 was to replicate the major results of Experiment 1 in conditions that would provide a fairer assessment of the degree of association between the retrieval of syntactic and phonological features of words in TOT states. The results of the experiment clearly indicate that the desired objective was achieved. By reducing to two (gender and initial phoneme) the number of features subjects were required to retrieve for each word in a TOT or baseline condition, we were able to obtain a level of correct retrieval of the initial phoneme of TOT words (57.5%) that is comparable to the level of performance reported in previous studies (see review by Brown, 1991). This ensures that the evaluation of the strength of association between the retrieval of gender and initial phoneme is carried out in conditions comparable to those in the literature on the TOT phenomenon.

In this experiment we replicated an important result obtained in Experiment 1, and previously reported by Miozzo and Caramazza (1997b) and Vigliocco et al. (1997). Namely, the results confirm the observation that subjects in a TOT state are able to report not only partial phonological information about the target word but also its gender (i.e., its syntactic features). More important for present purposes, the correlation between retrieval of gender and the initial phoneme of words in TOT states was very close to zero ($\phi = 0.034$), thus replicating the results of Experiment 1. This result has grave implications for those theories of lexical access that would interpose two lexical nodes between the semantic and the phonological content of words.

4. General discussion

In Section 1 we argued that there are compelling arguments and empirical evidence in support of dual-stage models of lexical access, that is, for the thesis that in language production there is a moment at which a semantically and syntactically specified lexical representation has been accessed but not its phonological content. This claim about the nature of lexical access is as close to a universally shared position as anything is in cognitive science. It is accepted by theorists who subscribe to discrete- versus interactive-stage models of lexical access, by those who assume componential versus holistic views of word meaning, and by those who assume

morphological composition versus non-composition of lexical representations. Although there are multiple ways in which the notion of dual-stage lexical access can be implemented, the dominant view by far is to assume that two lexical nodes – a lemma and a lexeme node (Figs. 1 and 2A) – intervene between a word's semantic and phonological content. Because the principal role of the lemma node is to specify a word's syntactic features, Caramazza (1997) has labeled this view the 'syntactic mediation' (SM) hypothesis of lexical access. This assumption is shared by the two most clearly articulated models of lexical access – Levelt's discrete stage network model and Dell's interactive network model. These models make a clear prediction concerning the relative availability of syntactic and phonological features of a word in the course of lexical access. They both predict that phonological information about a word can only become available after its syntactic features have been successfully accessed[6].

As discussed in Section 1, there are aspects of the results with the TOT phenomenon and the naming performance of anomic subjects that appear to support the SM hypothesis (or, at least, this is the way the results have typically been interpreted; e.g., Dell, 1990; Jescheniak and Levelt, 1994; Vigliocco et al., 1997). The most striking evidence is the dissociation in anomic patients between the failure to name an object or action and the spared ability to provide, respectively, information about its gender (Henaff Gonon et al., 1989; Badecker et al., 1995) or auxiliary form (Miozzo and Caramazza, 1997a). However, as noted in Section 1, these results are also compatible with the view that the failure to retrieve the phonology of words despite the very good ability to retrieve their grammatical features may simply reflect a deficit in activating/selecting the phonological segments and other properties that define the phonological content of a word (see Fig. 2). In other words, these results do not mandate the postulation of two lexical nodes intervening between the semantic and phonological content of a word.

More pertinent in the present context are results involving the TOT phenomenon. It has now been documented in several TOT experiments with Italian subjects that although unable to momentarily retrieve a word's full phonology during a TOT episode they can quite accurately retrieval its gender (Experiments 1 and 2 above; Vigliocco et al., 1997; Miozzo and Caramazza, 1997b). This result is a powerful demonstration of the independence of grammatical and phonological information, and in its unadorned form it is certainly consistent with the SM hypothesis which predicts that the syntactic features of a word can be accessed even when its phonology is inaccessible. However, the SM hypothesis also predicts that a word's phonology should not be accessible unless its syntactic features (lemma) were previously

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[6]To be sure, because of the 'cascading' character (McClelland, 1979; Humphreys et al., 1988) of Dell's interactive network model it is possible to activate the phonological content of a word even before a specific lemma has been selected. The exact amount of such activation depends on the specific parameters of the model. Nonetheless, on the assumption that the TOT phenomenon represents the situation in which a word's lemma but not its lexeme representation has been selected (see Dell, 1990), this model, too, predicts (1) far superior performance in the retrieval of gender than partial phonological information and (2) that in the measure to which any phonological information is retrieved it should correlate with the retrieval of gender. As we will see below, neither prediction is supported by our results.

accessed. This translates into a prediction of a positive correlation between the retrieval of gender and partial phonological information of TOT words. That prediction was not confirmed in the two experiments reported here. Furthermore, a re-analysis of the results of Experiment 2 in Miozzo and Caramazza (1997b) also revealed a correlation very close to zero (the mean corrected coefficient r (Fischer's z) was 0.081, 0.5 intervals $= -0.014 < \mu < 0.148$).

Although we could not carry out the same type of re-analyses reported here for the results in Vigliocco et al. (1997), we can get to the same issue by considering the relative performance levels in the retrieval of gender and of partial phonological information for positive and negative TOT states. Positive TOT states are those cases in which the word the subject is searching for corresponds to the experimenter's target word; negative TOT states are those cases in which the word the subject is searching for is different from the experimenter's target word. The latter cases are functionally equivalent to the DK states in our experiments. The SM hypothesis, which assumes that access to the phonological content of a word depends strictly on the prior correct selection of its syntactic features (lemma), makes the following prediction. The probability of correctly retrieving partial phonological information given incorrect gender retrieval (and presumably failure to access the correct lemma) for positive and negative TOT states should be the same, since in both cases the incorrect lemma has been accessed. However, if access to the phonological content of a word is not mediated by a syntactic lexical node, as proposed by the single lexical node hypothesis, then, the probability of correctly retrieving partial phonological information given incorrect gender retrieval for positive TOT states should be greater than that for negative TOT states. The results from the Vigliocco et al.'s (1997) study are quite clear: subjects were nearly twice as likely to correctly report partial phonological information, given *incorrect* retrieval of the gender feature, in the positive versus negative TOT states (60% vs. 34%). Thus, contrary to the interpretation proposed by Vigliocco et al. (1997) for their results, this re-analysis of their data shows them to be highly problematic for the SM assumption of lexical access.

There is another aspect of the results reported in these experiments that is problematic for those models of lexical access that make the SM assumption. The SM hypothesis predicts better retrieval of gender than of partial phonological information. This prediction by the SM hypothesis is clearly illustrated by Bock and Levelt's (1994) discussion of the TOT phenomenon: 'The most dramatic reflection of the rift between the lemma and the lexeme levels is the so-called tip-of-the-tongue (TOT) phenomenon… In terms of the network model, the TOT phenomenon is a failure to access the lexeme from the lemma. The speaker *knows* the meaning to be expressed (i.e., the concept) and the word's syntax (that it is a plural noun, a transitive verb or whatever; i.e., the lemma). Only the word form is blocked…' (p. 953; emphasis added). In the four experiments we have carried out on the retrieval of gender during TOT episodes (the two experiments reported here and the two reported in Miozzo and Caramazza, 1997b), the level of correct performance in retrieving gender has hovered around 70%. This level of performance is not greater than correct performance in choosing the init-

ial phoneme in a two forced-choice task (also around 70%; Miozzo and Caramazza, 1997b). Furthermore, in our Experiment 2 the probability of correctly retrieving the initial phoneme was arguably far better than the probability of retrieving gender. Subjects correctly retrieved the initial phoneme 57.5% of the time (with 'chance level' estimated on the basis of performance with the baseline condition at around 10%); and they correctly retrieved the gender only 67.8% of the time (with chance level estimated on the basis of performance with the baseline condition at around 50%). Here too, then, the results on the relative levels of accuracy in retrieving gender and partial phonological information fail to support predictions derived from the SM hypothesis[7]. Thus, the results from the TOT experiments provide a powerful challenge to those models of the lexical system that assume a distinction between two lexical nodes (lemma and lexeme) in addition to semantic representations and phonological segments (and other phonological properties).

The challenge posed by the research reported here to theories of lexical access is how to accommodate both the evidence that suggests a dual-stage process in lexical access and the evidence from the TOT experiments showing that access to a word's partial phonological information can take place without selection of its syntactic features. One solution to this problem is to dispense with one of the two lexical nodes, either the lemma or the lexeme node, as in Fig. 2B. In this model, the first stage of access involves the selection of a lexical node that is connected to its syntactic and phonological features. In a subsequent stage of processing, the phonological content of the lexical item is selected. As argued in Section 1, this model is consistent with the results typically cited in favor of dual-stage theories of lexical access. For example, the model can account for the most celebrated observation in this area of research: the slips-of-the-tongue data showing among other things that syntactic and semantic factors affect word but not sound exchange errors, and that phonological factors affect sound but not word exchange errors. The model's distinction between a stage of processing where a lexical node is selected and one where its phonological content is specified readily accounts for the pattern of constraints on word and sound exchange errors.

The TOT results are explained as follows. TOT states represent those cases where activation of the lexical node is very high but not sufficient to allow selection. Activation from the lexical node propagates outward to its syntactic features *and* its phonological segments (and other phonological properties such as syllable structure). Because the target lexical node has not been selected, the amount of activation it propagates to its syntactic and phonological features is insufficient for their selection, although they will be highly activated. The differential activation patterns of syntactic and phonological features that result from the activation propagated by the 'unselected but highly activated lexical node' forms the basis for

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[7]Converging evidence for the possibility that a word's phonology can be retrieved despite failure to retrieve its lexical-syntactic features is provided by the performance of brain-damaged subjects who make gender (Miceli and Caramazza, 1988) and mass/count errors (Semenza et al., 1997) in speech production despite normal access to the word's phonology.

subjects' 'guesses' about the syntactic and phonological properties of the TOT word[8]. One implication of this view is that performance in guessing the gender and the initial phoneme of TOT words are not dependent on each other, thus accounting for the lack of correlation reported in our experiments.

The argument from the TOT data in support of the claim that a single lexical node mediates between semantic and phonological representations is based on the assumption that these data directly reflect aspects of the lexical access process. However, one could challenge the relevance of the TOT data for constraining theories of lexical access on the grounds that conscious retrieval of gender and other syntactic information operates on a different data base from that used for phrase structure building in sentence production (and comprehension): the former relies on episodic memory representations of the syntactic properties of words (e.g., explicit knowledge that the Italian word *sedia* [chair] is feminine), and the latter relies on unconscious knowledge in the lexical system. This is an important objection. But it is too sweeping, since similar objections could be raised for (perhaps) all experimental tasks. Thus, we could object that the data from the picture-word interference paradigm (e.g., Schriefers et al., 1990) used to inform theories of the time course of lexical access does not allow inferences about normal lexical access since picture naming may also involve episodic memory representations of the names of pictures. Nonetheless, we would have a more compelling argument if we could provide evidence obtained with other experimental paradigms that converges against the lemma/lexeme distinction. Below we briefly review just this type of evidence – neuropsychological results that are problematic for theories that postulate the existence of two lexical nodes mediating between the semantic and the phonological content of words.

4.1. What is in a lemma?

There is a sense in which the distinctions between the two models presented in Fig. 2 may be seen as no more than terminological ones. It could be argued that the essence of the lemma/lexeme distinction is captured in Fig. 2B by the contrast between the lexical node and its phonological segments: the lexical node would correspond to the lemma representation and the phonological segments would correspond to the lexeme representation. This would not do, however: both Dell and Levelt and his collaborators are quite explicit in drawing a distinction among

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[8]In this respect, the account of the TOT phenomenon presented here differs from a very similar account, the transmission failure hypothesis, proposed by Burke et al. (1991). In their model the selection of a lexical node is followed by failure to transmit full activation to its phonological features. On our view, the latter account is better suited to explain the anomic performance of the patient described by Miozzo and his collaborators (Badecker et al., 1995; Miozzo and Caramazza, 1997a) who was able to systematically provide the gender of nouns and the auxiliary of verbs for which he was unable to give any phonological information. This pattern of performance contrasts with that of neurologically intact subjects in TOT states who seem able to provide only partial information about syntactic and phonological properties of TOT words.
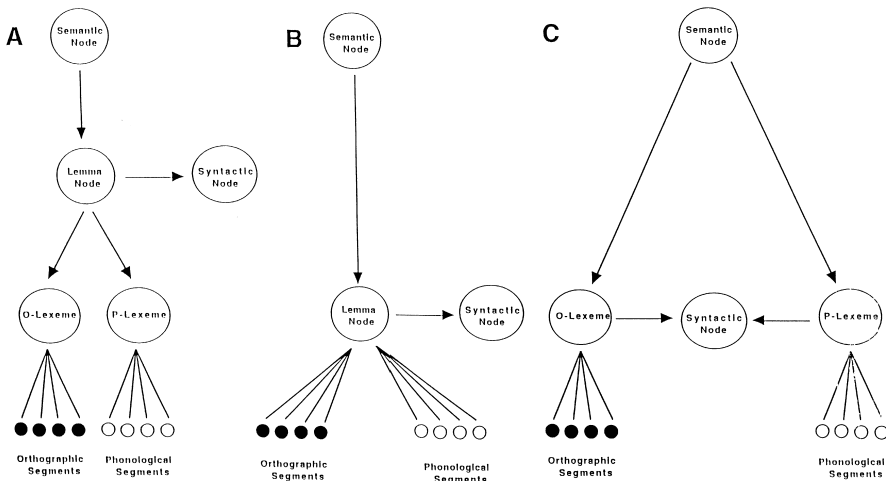
Fig. 7. (A) A generalized form of the SM hypothesis showing the relation among lemma and P- and O-lexeme representations; (B) shows a lexical access model in which lemma nodes connect directly to phonological and orthographic segments; (C) shows a model in which modality-specific lexical representation (P- and O-lexemes) are independently connected to semantic representations.

lemma, lexeme, and segmental representations[9]. Still, one could argue that the core assumption of these models is not the distinction between lexeme and segmental levels of representation but the distinction between lemma and phonological levels of representation. One could then dispense with the notion of a lexeme and postulate only lemma representations connected directly to their phonological segments. Viewed this way, the differences between the models in Fig. 2A,B are not nearly as important as their shared assumption that there is a level of representation, distinct from the semantic and phonological levels, where lexical nodes, lemmas, connect to their syntactic features. There are other considerations, however, that make this attempted conciliation of the two models less-than-satisfactory. The problem concerns the nature of the lexical node mediating among semantic, syntactic, and segmental information.

One of the core assumptions about the nature of lemma representations is that they are abstract lexical nodes that mediate between semantic representations and their associated phonological and orthographic representations. In Roelofs' and Levelt's (and presumably Dell's) model of lexical access we would capture this assumption

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[9]Thus, for example, Dell (1990) describes his model of lexical access as follows: 'The model's network contains nodes at three levels, lemma, lexemes, and phonological segments… The lemma node represents the lexical item as a syntactic/semantic entity. It corresponds to Dell's (1986) 'word node' and is assumed to connect directly to conceptual structure and to syntactic information. Below that, the lexeme node is a single unit representing the phonological form of the word. This corresponds roughly to the morpheme node and/or to the set of syllable nodes in Dell (1986) and MacKay (1987). The lexeme node connects to phonological segments…' (pp. 331–332). And, as may be seen from Fig. 1, which is adapted from various papers by Levelt and his collaborators (e.g., Roelofs, 1992; Bock and Levelt, 1994; Jescheniak and Levelt, 1994), their model of lexical access clearly distinguishes among lemma, lexeme, and segmental phonological information.

by distinguishing between a word's abstract lemma representation and its associated phonological (P-lexeme) and orthographic (O-lexeme) lexemes (see, e.g. Roelofs et al., 1996). In the formulation in which the lexeme representations are dispensed with (as above), the abstract lemma node would connect directly to phonological and orthographic segments (and other modality-specific properties). Fig. 7 depicts these two hypotheses of the relation between lexical, phonological and orthographic representations; Fig. 7A depicts the lemma/lexeme distinction as in Fig. 2A but with the addition of orthographic lexemes; Fig. 7B depicts the lemma only hypothesis. The latter hypothesis postulates the existence of a single, abstract lexical node mediating between the semantic and the phonological and orthographic content of each word. We have already argued that the model in Fig. 7A is undermined by our results on the relation between retrieval of the gender feature and the initial phoneme in TOT states. We now briefly review other neuropsychological evidence that is also problematic for the latter model of lexical access as well as for the model depicted in Fig. 7B. We will go on to propose that the functional architecture of the relation among semantic, phonological, and orthographic representations depicted in Fig. 7C is the one most compatible with the experimental evidence reviewed here and the evidence from neuropsychology.

One striking fact from cognitive neuropsychology is the existence of brain-damaged subjects who make semantic errors in only one modality of output, either only in speaking (R.G.B. and H.W.: Caramazza and Hillis, 1990) or only in writing (S.J.D.: Caramazza and Hillis, 1991). Thus, for example, in reading aloud R.G.B. made errors such as the following: *epistle* → 'disciple'; *winter* → 'summer'; *interest* → 'mortgage'; *banana* → 'pineapple, pumpkin, apple'; and in oral picture naming he made errors such as: *lemon* → 'sour'; *clam* → 'octopus'. However, he did not make even a single semantic error in writing to dictation or in written picture naming. Similarly, in reading aloud H.W. made semantic errors such as the following: *radio* → 'music'; *decide* → 'choose'; *lobster* → 'crab'; and in oral picture naming she made errors such as: *table* → 'chair'; *grapes* → 'wine'; *shelf* → 'book'. However, she, too, failed to make any semantic errors in any spelling task. And S.J.D. made the following semantic errors in writing: *faith* → 'belief'; *bring* → 'carried'; *visual* → 'seeing'; but she did not make semantic errors in oral production tasks.

Another important characteristic of these patients' performance is that they are clearly unimpaired in single-word comprehension tasks, and they fully understand the words they are unable to produce. For example, in a task in which the patients were required to read aloud and define words R.G.B. produced responses such as the following: *white* → 'yellow. Color of your skin… another color in our flag… The paper in books is usually that color… and clouds… I can get everything but the word'; *bowl* → 'dish… glass. In the morning meal, you'd eat your cereal out of it'. Similarly, H.W. produced responses such as the following: *encyclopedia* → 'book. Young people used to get you to buy them… beautiful books to hear (sic) everything'; *reflex* → 'knees. What your knee's supposed to do when the doctor… (gestures)'.

This pattern of impaired and spared performance indicates a deficit in accessing

word form representations despite normal semantic processing. The fact that the patients produced the correct definition of words to which they made semantic errors in reading aloud, and the fact that they produced the correct written name of pictures to which they made semantic errors in oral naming, clearly indicate that their ability to process the meaning of words is unimpaired. Consequently, damage must be restricted to a post-semantic level of processing. Since the errors produced in the damaged modality were lexical (semantic) substitutions, we can infer that the damage is restricted to a level of lexical selection, that is, to a level prior to the selection of phonological segments. An implication of this chain of reasoning is that semantic errors arise from the mis-selection of one of the lexical representations partially activated by the (normal) semantic representation. And since the mis-selection is restricted to one modality of output, the link between semantic and lexeme representations must be unmediated by modality-neutral representations (lemma). The reasoning leading to this conclusion may be made a little clearer by considering the alternative models in Fig. 7.

In models of the type depicted in Fig. 7A, the mis-selection of a word may involve either the lemma node or the lexeme node. We know that the problem cannot be in the mis-selection of the lemma node for otherwise the patients would have produced semantic errors (or correct responses) *both* in speaking and in writing. But, if the mis-selection were to occur at the level of lexeme nodes, it would be unclear how a *semantic* error could arise at this level of processing. Recall that the connectivity between lemmas and lexemes is one-to-one and that the selection of lemma nodes precedes the full activation of their lexemes. Thus, the functional architecture of the lexical system in Fig. 7A does not readily allow for the occurrence of semantic errors from a deficit in activating/selecting lexeme representations. The same argument can be made for the model depicted in Fig. 7B since the crucial factor in this argument is whether or not a single, abstract node mediates between semantic representations, on the one hand, and phonological and orthographic representations, on the other. Thus, the existence of semantic errors restricted to one modality of output is problematic for the models depicted in Fig. 7A,B, but is fully consistent with the model depicted in Fig. 7C. The latter model assumes that semantic activation propagates independently to distinct lexical nodes that are connected to their respective phonological and orthographic properties. Because these lexical nodes are modality-specific, in the sense that they are connected exclusively to one type of segmental information, either phonological or orthographic, we refer to them as P(honological)-lexeme and O(rthographic)-lexeme, respectively (but we could just as well have referred to them as P-lemma and O-lemma, respectively). Note, however, that the lexical nodes themselves are not phonological or orthographic representations; they are abstract, semantically- and syntactically-specified lexical nodes with direct connections only to their phonological or their orthographic content. Thus, the status of a lexeme as modality-specific (either phonological or orthographic) is determined by its connectivity and not its internal content.

Other neuropsychological evidence that raises difficulties for models that postulate abstract lexical representations mediating between modality-specific lexical nodes and semantic representations, is the existence of patients who make different

semantic errors in speaking and writing in dual-naming tasks (W.M.A.: Miceli et al., 1997; P.W.: Rapp et al., 1997). These are patients who when asked to speak and then write (or vice versa) the name of a picture produce two different semantic errors. For example, P.W. in response to a picture of a *knife* wrote 'spoon' and then said 'fork', and in response to a picture of *tweezers* said 'pliers' and then wrote 'needle'. This pattern of performance is difficult to explain by models that postulate a lexical node intervening between lexemes and semantic representations. In these models, semantic errors entail the mis-selection of lemma representations and, therefore, should result in the same lexical response in speaking and writing. However, the results obtained with patients P.W. and W.M.A. are consistent with models of lexical access that assume independent links between semantic representations and their P- and O-lexeme representations.

Perhaps the most compelling neuropsychological evidence against the lemma/lexeme distinction in lexical access is provided by the performance of patients with modality-specific, grammatical category deficits in processing homonyms (e.g., *the watch/to watch*). There are reports of patients who are impaired in accessing either only the verb or only the noun form of homonyms in the written modality, and others who are impaired in accessing either only the verb or only the noun form in the spoken modality (Caramazza and Hillis, 1991; Hillis and Caramazza, 1995; Rapp and Caramazza, 1997; Rapp and Caramazza, in press). Because these patients' impairment is restricted to only one modality we can rule out damage to the semantic component of the lexical system; because the errors they make in the impaired modality consist of semantically related lexical substitutions and because they can produce the word form in one grammatical class (e.g., they might be able to produce 'watch' in 'to watch' but not 'the watch') we can rule out a deficit at a peripheral level of processing. Thus, as reasoned earlier for the occurrence of modality-specific semantic errors, the locus of damage responsible for these patients' performance must be located at a level of processing mediating between an intact semantic component and intact post-lexical phonological and orthographic processes, that is, at a level of processing where semantically and syntactically specified lexical forms are represented. The crucial question is whether a theory of lexical access that assumes a lemma/lexeme distinction can account for these observations.

Theories that distinguish between lemma and lexeme levels of lexical representation assume that homonyms are distinguished at the lemma level, where their syntactic content is specified (e.g., Dell, 1990; Jescheniak and Levelt, 1994). This hypothesis is schematically represented in Fig. 8A and, for comparison purposes, the single lexical node hypothesis is shown in Fig. 8B. It is not at all obvious how the model in Fig. 8A could account for the results with homonyms. In this model, selective deficit in accessing words of one grammatical class presumably involves damage at the lemma level, the level where the lexical representation is specified syntactically. However, damage to a lemma node would necessarily result in impaired performance for both its P-lexeme and its O-lexeme (see Fig. 8A). But this is not what was observed in the patients with category- and modality-specific deficits; their impairment for words of one grammatical class was restricted to only the spoken or only the written modality. And since these models assume a single
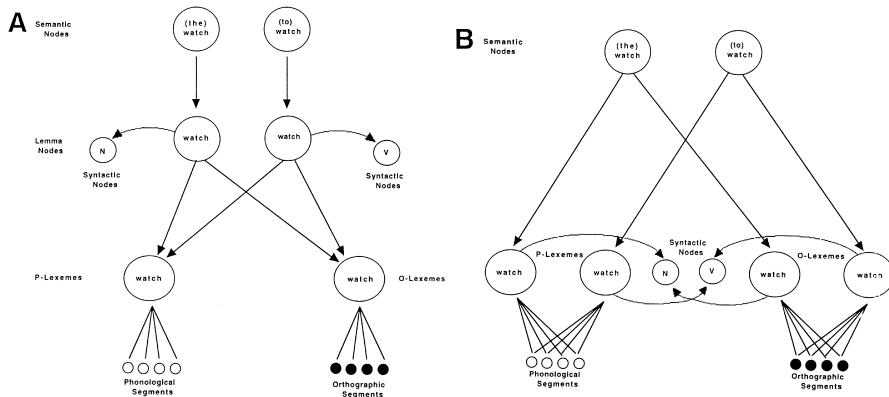
Fig. 8. (A) A schematic representation of a lexical model in which homonyms are distinguished at the lemma but not at the lexeme level as proposed by Dell (1990) and Jescheniak and Levelt (1994). (B) A model in which homonyms are distinguished at the lexeme level, consistent with the single lexical node hypothesis.

lexeme representation for homonyms, it is not possible to damage the lexeme level without affecting both the noun and the verb form of the homonym pair. Thus, the model depicted schematically in Fig. 8A fails to provide a natural account for the homonym results[10]. By contrast, damage to the lexeme nodes in the model depicted in Fig. 8B, naturally accounts for the occurrence of modality-specific grammatical class deficits. For example, in this model the selective difficulty in producing 'watch' in 'to watch' (but not 'the watch') is explained by assuming damage to the lexeme representation of the verb form of the word.

In this section, we have argued that the existence of patients who produce different lexical responses in speaking and writing (either a semantic error in one and a correct response in the other, or two different semantic errors) and patients who are selectively impaired in producing only one form of a homonym in only one modality (either only speaking or writing) provide some of the most difficult challenges for those models of lexical access that postulate a lemma node between semantic and lexeme representations (see Caramazza, 1997 for a more detailed discussion of this evidence).

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[10]Proponents of the lemma/lexeme distinction could attempt to save the theory by adopting a version of lexical organization that does not postulate a single lexeme node for homonyms. However, this solution is merely an enriched version of the model depicted in Fig. 8B. In other words, the new model would simply add an additional layer (the lemma nodes) to the model in Fig. 8B. Parsimony, if nothing else, should block this move.

Fig. 9. (A) A schematic representation of the independent network (IN) model showing the relation among semantic, syntactic, and lexical form representations. In (B) the representation of the Italian words *tavolo* [table], *sedia* [chair] and *tigre* [tiger] is shown. The O-lexeme network is not presented in this figure to avoid excessive crowding. The flow of information is from semantic to lexeme and syntactic networks and then on to segmental information. The abbreviations in the syntactic network should be read as follows: N, noun; V, verb; Adj, adjective; M, masculine; F, feminine; Cn, count noun; Ms, mass noun. Dotted lines indicate weak activation. Links within a network are inhibitory.

A

B
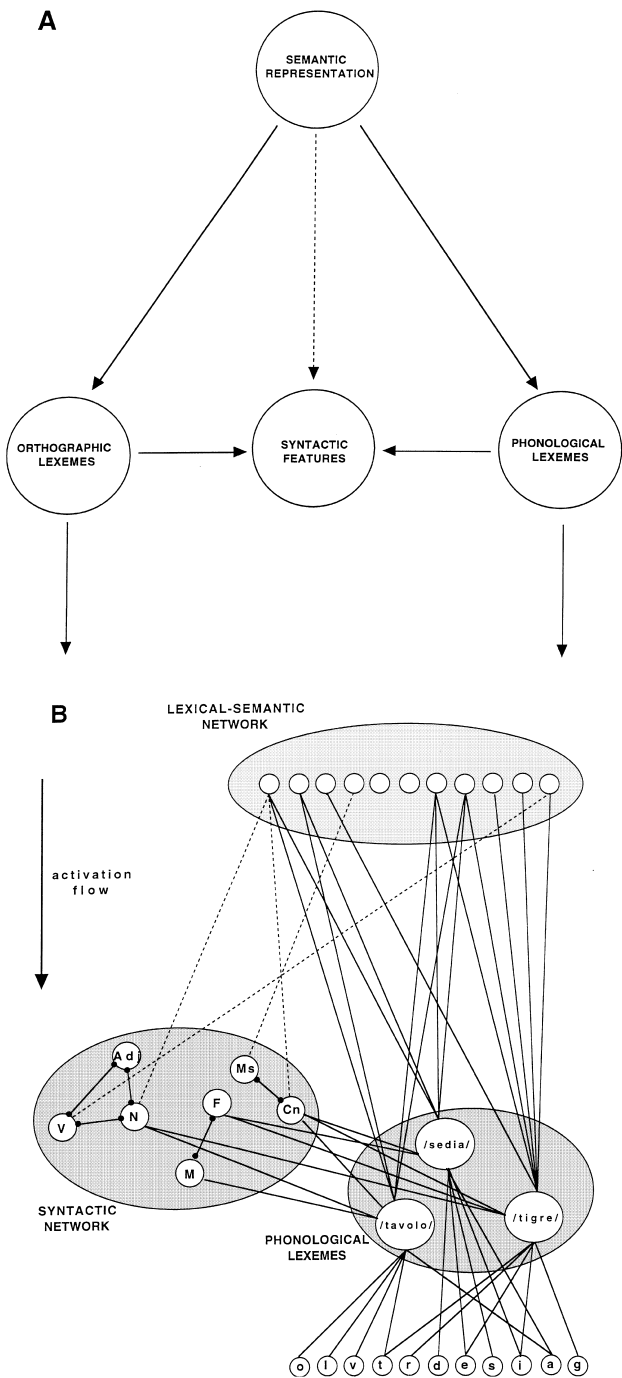
4.2. The independent network (IN) model

We have identified three sets of facts that must be accounted for by models of lexical access: (1) semantic and syntactic factors affect performance independently of phonological factors (e.g., the word and sound exchange errors; the performance of anomic subjects); (2) the retrieval of phonological information about a word does not (strictly) depend on the prior selection of its syntactic features (i.e., the results reported in this paper); and, (3) the relation between semantic representations and modality-specific lexical representations is not mediated by modality-neutral lexical representations (e.g., the results of brain-damaged subjects who make semantic errors in only one modality of output). The facts in (1) have been used to motivate the dual-stage models of lexical access. However, these facts are consistent both with models that assume a lemma/lexeme distinction and those that would dispense with one of these two levels. The facts in (2) and (3) are problematic for models that adopt the existence of an intervening (syntactic) lexical node between semantic and modality-specific lexical nodes. A model that can accommodate all three sets of facts is the independent network (IN) model (Caramazza, 1997). A schematic representation of this model is shown in Fig. 9. Fig. 9A shows the overall functional architecture of the lexical system, including P- and O-lexeme components; Fig. 9B shows a more detailed representation of the model, but only for P-lexemes.

The IN model shares many properties with other models of lexical processing, including the assumption of dual-stage access. Furthermore, the IN model has a network structure like other lexical access models (e.g., Dell, 1986; MacKay, 1987; Roelofs, 1992; Bock and Levelt, 1994). However, it differs from most of these other models in assuming that there is only one lexical node intervening between the semantic and the segmental content of words. For present purpose, the crucial assumptions of the model are the following: (1) semantic representations are componential; (2) semantic representations activate in parallel all lexemes that share semantic properties; (3) semantic representations *weakly* activate or 'prime' those syntactic features that have a semantic reflex (e.g., grammatical class, tense, number)[11]; (4) lexemes activate and allow selection of their associated syntactic features; (5) lexemes activate their associated segments and other form information (e.g., syllable structure); and, (6) activation is feedforward only, but cascading. With these assumptions, the model can account for the facts listed above. Because it assumes the existence of lexical nodes between semantic and phonological segments, it allows dual-stage access; because lexical nodes are connected directly to their syntactic and phonological content, it allows for the independent access to syntactic and partial phonological features in TOT states; and, because the connection between modality-specific lexical nodes and their semantic content is unmediated by modality-neutral lexical nodes (lemmas), it can account for the

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[11]Note that this activation merely primes syntactic features, but it is *not sufficient* to allow selection of those features. Selection of the bundle of syntactic features associated with a word only occurs upon selection of that word's lexical node.

existence of brain-damaged subjects who only make semantic errors in one modality of output.

In conclusion, the results of two experiments that investigated the relation between retrieval of gender and partial phonological information in TOT states failed to support predictions derived from current models of lexical access that assume a distinction between two lexical nodes mediating between the semantic and phonological content of words. In two experiments we obtained essentially zero correlations between the retrieval of gender and partial phonological information for TOT words. Consistent with the latter conclusion are the results of the re-analyses of two other TOT experiments that also addressed the relation between gender and partial phonological information (Vigliocco et al., 1997; Miozzo and Caramazza, 1997b). Furthermore, the existence of brain-damaged subjects who make semantic errors in only one modality of output and of those who make different semantic errors in speaking and writing in dual naming are also highly problematic for theories that propose a lemma/lexeme distinction in lexical access. Thus, given that models of lexical access that make the SM assumption encounter severe difficulties, and given that it is possible to develop models of lexical access that can account for the relevant empirical facts without having to make the SM assumption (e.g., Caramazza, 1997), we might want to dispense with this recalcitrant assumption. Doing so would inevitably lead to dispensing with the lemma/lexeme distinction as well.

Acknowledgements

References

Badecker, W., Miozzo, M., Zanuttini, R. 1995. The two-stage model of lexical retrieval: evidence from a case of anomia with selective preservation of grammatical gender. Cognition 57, 193–216.

Bates, E., Devescovi, A., Pizzamiglio, L., D'Amico, S., Hernandez, A. 1995. Gender and lexical access in Italian. Perception and Psychophysics 57, 847–862.

Bates, E., Devescovi, A., Hernandez, A., Pizzamiglio, L. 1996. Gender priming in Italian. Perception and Psychophysics 58, 992–1004.

Bierwisch, M., Schreuder, R. 1992. From concepts to lexical items. Cognition 42, 23–60.

Bock, K., Levelt, W. 1994. Language production: grammatical encoding. In: Gernsbacher, M.A. (Ed.), Handbook of Psycholinguistics. Academic Press, San Diego, CA.

Brown, A.S. 1991. A review of the tip-of-the-tongue experience. Psychological Bulletin 109, 204–223.

Brown, R., McNeill, D. 1966. The 'tip-of-the-tongue' phenomenon. Journal of Verbal Learning and Verbal Behavior 5, 325–337.

Burani, C. 1992. Patterns of inflectional errors with reference to the Italian adjectival system. Rivista di Linguistica 4, 255–272.

Burke, D., MacKay, D.G., Worthley, J.S., Wade, E. 1991. On the tip of the tongue: what causes word finding failures in young and older adults? Journal of Memory and Language 30, 542–579.

Burzio, L. 1986. Italian Syntax. D. Reidel, Dordrecht.

Butterworth, B. 1989. Lexical access in speech production. In: Marslen-Wilson, W. (Ed.), Lexical Representation and Process. MIT Press, Cambridge, MA.

Caramazza, A. 1997. How many levels of processing are there in lexical access? Cognitive Neuropsychology 14, 177–208.

Caramazza, A., Hillis, A.E. 1990. Where do semantic errors come from? Cortex 26, 95–122.

Caramazza, A., Hillis, A.E. 1991. Lexical organization of nouns and verbs in the brain. Nature 349, 788–790.

Dell, G.S. 1986. A spreading activation theory of retrieval in sentence production. Psychological Review 93, 283–321.

Dell, G.S. 1990. Effects of frequency and vocabulary type on phonological speech errors. Language and Cognitive Processes 4, 313–349.

De Mauro, T., Mancini, F., Vedovelli, M., Voghera, M. 1993. Lessico di Frequenza dell'Italiano Parlato. ETAS, Milano.

Fromkin, V.A. 1971. The non-anomalous of anomalous utterances. Language 47, 27–52.

Garrett, M.F. 1975. The analysis of sentence production. In: Bower, G. (Ed.), The Psychology of Learning and Motivation: Advances in Research and Theory, Vol. 9. Academic Press, New York.

Garrett, M.F. 1976. Syntactic processes in sentence production. In: Wales, R. and Walker, E. (Eds.), New Approaches to Language Mechanisms. North Holland, Amsterdam.

Garrett, M.F. 1980. Levels of processing in sentence production. In: Butterworth, B. (Ed.), Language Production, Vol. 1: Speech and Talk. Academic Press, London.

Garrett, M.F. 1988. Processes in language production. In: Newmeyer, F.J. (Ed.), The Cambridge Survey of Linguistics, Vol. 3: Biological and Psychological Aspects of Language. Harvard University Press, Cambridge, MA.

Goodglass, H., Kaplan, E., Weintraub, S., Ackerman, N. 1976. The 'tip-of-the-tongue' phenomenon in aphasia. Cortex 12, 145–153.

Henaff Gonon, M., Bruckert, R., Michel, F. 1989. Lexicalization in an anomic patient. Neuropsychologia 27, 391–407.

Hillis, A.E., Caramazza, A. 1995. Representation of grammatical categories of words in the brain. Journal of Cognitive Neuroscience 7, 396–407.

Humphreys, G.W., Riddoch, M.J., Quinlan, P.T. 1988. Cascade processes in picture identification. Cognitive Neuropsychology 5, 67–103.

Jescheniak, J.D., Levelt, W.J.M. 1994. Word frequency effects in speech production: retrieval of syntactic information and of phonological form. Journal of Experimental Psychology: Learning, Memory, and Cognition 20, 824–843.

Jones, G.V., Langford, S. 1987. Phonological blocking in the tip of the tongue state. Cognition 26, 115–122.

Kay, J., Ellis, A.W. 1987. A cognitive neuropsychological case study of anomia: implications for psychological models of word retrieval. Brain 110, 613–629.

Kohn, S.E., Wingfield, A., Menn, L., Goodglass, H., Berko Gleason, J., Hyde, M. 1987. Lexical retrieval: the tip-of-the-tongue phenomenon. Applied Psycholinguistics 8, 245–266.

Koriat, A., Lieblich, I. 1974. What does a person in a 'TOT' state know that a person in 'don't know' state doesn't know. Memory and Cognition 2, 647–655.

Levelt, W.J.M. 1989. Speaking: From Intention to Articulation. MIT Press, Cambridge, MA.

Levelt, W.J.M., Schriefers, H., Vorberg, D., Meyer, A. S., Pechmann, T., Havinga, J. 1991. The time course of lexical access in speech production: a study of picture naming. Psychological Review 98, 122–142.

Lovelace, E. 1987. Attributes that come to mind in the TOT state. Bulletin of the Psychonomic Society 25, 370–372.

MacKay, D.G. (1987). The Organization of Perception and Action: A Theory for Language and other Cognitive Skills. Springer, New York.

McClelland, J.L. 1979. On the time relations of mental processes: a framework for analyzing processes in cascade. Psychological Review 86, 287–330.

Meyer, A.S., Bock, K. 1992. The tip-of-the-tongue phenomenon: blocking or partial activation? Memory and Cognition 20, 715–726.

Miceli, G., Benvegnù, B., Capasso, R., Caramazza, A. 1997. The independence of phonological and orthographic lexical forms: evidence from aphasia. Cognitive Neuropsychology 14, 35–69.

Miceli, G., Caramazza, A. 1988. Dissociation of inflectional and derivational morphology. Brain and Language 35, 24–65.

Miozzo, M., Caramazza, A. 1997a. 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 Neuroscience 9, 160–166.

Miozzo, M., Caramazza, A. 1997b. The retrieval of lexical-syntactic features. Journal of Experimental Psychology: Learning, Memory, and Cognition. 23, 1–14.

Perfect, T.J., Hanley, J.R. 1992. The tip-of-the tongue phenomenon: do experimenter-presented interlopers have any effect? Cognition 45, 55–75.

Rapp, B., Benzing, L., Caramazza, A. 1997. The autonomy of lexical orthography. Cognitive Neuropsychology 14, 71–104.

Rapp, B., Caramazza, A. 1997. The modality-specific organization of grammatical categories: evidence from impaired spoken and written sentence production. Brain and Language 56, 248–286.

Rapp, B., Caramazza, A. in press. A case of selective difficulty in writing verbs. Neurocase.

Roelofs, A. 1992. A spreading-activation theory of lemma retrieval in speaking. Cognition 42, 107–142.

Roelofs, A., Meyer, A.S., Levelt, W.J.M. 1996. Interaction between semantic and orthographic factors in conceptually driven naming: comment on Starreveld and La Heij (1995). Journal of Experimental Psychology: Learning, Memory, and Cognition 22, 246–251.

Rubin, D.C. 1975. Within word structure in tip-of-the-tongue phenomenon. Journal of Verbal Learning and Verbal Behavior 14, 392–397.

Schriefers, H. 1993. Syntactic processes in the production of noun phrases. Journal of Experimental Psychology: Learning, Memory, and Cognition 19, 841–850.

Schriefers, H., Meyer, A.S., Levelt, W.J.M. 1990. Exploring the time course of lexical access in language production: picture-word interference studies. Journal of Memory and Language 29, 86–102.

Semenza, C., Mondini, S., Cappelletti, M. 1997. The grammatical properties of mass nouns: an aphasia case study. Neuropsychologia 35, 669–675.

Stemberger, J.P. 1985. An interactive activation model of language production. In: Ellis, A.W. (Ed.), Progress in the Psychology of Language, Vol. 1. Erlbaum, Hillsdale, NJ.

Van Valin, R.D. 1990. Semantic parameters of split intransitivity. Language 66, 221–260.

Vigliocco, G., Antonini, T., Garrett, M.F. 1997. Grammatical gender is on the tip of Italian tongues. Psychological Science 8, 314–317.