

CHAPTER 32

Cross-linguistic research on language production

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32.1 Introduction

There is consensus that many aspects of the language faculty are universal. Psychologists have tried to uncover the general cognitive mechanisms underlying this universal faculty. Such an approach has been extremely fruitful and has provided the backbone of psycholinguistic research. However, languages of the world differ in many important aspects. Thus, a complementary approach is to investigate how these language specific properties may modulate the cognitive mechanisms and representations involved in language processing. For example, research in the field of language perception (reading, auditory word processing, etc.) has shown how a number of critical cross-linguistic differences can affect language processing (Paulesu et al., 2000; Cutler et al., 1983). These effects indicate that some characteristics of the cognitive system are fine-tuned to language specific properties. The lesson to learn from these observations is that a full description of the language faculty requires uncovering both the universal characteristics of the language system *and* the modulations imposed by language specific properties. This second requirement can only be achieved by conducting cross-linguistic research.

The use of different languages to inform theories of language processing has taken three different forms.

First, researchers have asked general questions about the speech production system by investigating properties that are thought to be shared across all languages. This is an important enterprise; it helps to determine the extent to which derived theoretical implications can be considered independent of the specific languages

tested. In other words, this approach can help us decide which properties of the language production system are general and shared by all languages and which properties seem to have a more language-specific origin.

Secondly, researchers have asked general questions about the speech production system by making use of the specific linguistic properties that are present in certain languages. Languages which differ in some of their linguistic properties provide different contexts to explore general principles of speech production. For example, the general mechanism of agreement can be studied by investigating grammatical gender agreement (in those languages in which this feature is present, e.g. Romance languages). Alternatively, it can be studied by investigating number, person, or tense agreement in those languages where those features are present. Just as the first type of research, this approach seeks to describe general organizing principles of the language production system.

Finally, the third path refers to those studies that have assessed the extent to which contrastive linguistic properties across languages may affect the processes and representations used by the corresponding speakers.

Language production is a relatively young field of investigation. In fact, research on the processes and representations involved in language production has increased dramatically in the last decade. Between 1990 and 1994, 96 articles published in journals indexed by the database Psycinfo® included the term “language production” in their abstract. Between 2000 and 2004, this number more than doubled (214). Perhaps because of the contrastive effects observed

in language perception across languages, cross-linguistic studies have started to be conducted to investigate language production as well. The growth in the number of published articles has been accompanied by an increase in the number of languages in which research in language production has been conducted.

A brief outline of a language production model (see below for more details) would distinguish between:

- (a) the processes involved in establishing the message to be communicated;
- (b) the processes responsible for lexicalization (i.e. “putting the message into words”) and sentence construction;
- (c) the processes of surface form construction involving phonological, phonetic, orthographic, as well as other representations;
- (d) the processes of motor execution: via articulators in the case of speaking, via the hand in the case of writing, etc.

It is important to identify which of these levels could be tuned to language-specific properties, since it is likely that they are not all equally sensitive to cross-linguistic differences. For example, the message level, where the thoughts and message to be expressed are constructed, is generally thought to be largely language-independent (see Levelt, 1989:103; Slobin, 1996). Also, given the shared anatomy across humans, the motor execution stage will probably show little differences across languages. Thus the most likely candidates to show cross-linguistic differences are those processes involved in lexical access, sentence construction, and phonological encoding. As we will see below, differences such as the various rules of agreement or the phonological structure of the words in a given language may produce important cross-linguistic processing differences.

In this chapter we review some of the recent research conducted in the field of language production that bears on cross-linguistic issues, as defined above. Most of the research providing relevant data for models of speech production comes from two sources:

- (a) psycholinguistic experiments in which chronometric and/or accuracy performance is registered in normal speakers; and
- (b) analyses of the production performance of brain damaged individuals.

Here, we will focus on the first of these two kinds of evidence. Also, as it will become clear in this review, most of the studies that we discuss were conducted in a rather limited number of

languages belonging either to the Germanic family (English, Dutch, and German) or to the Romance family (Spanish, Catalan, Italian, and French). This is indicative of the fact that, although the number of languages in which research in speech production is conducted is increasing, we still lack experimental evidence from many language families.

The chapter is divided into six sections, organized according to the levels of processing postulated in language production models. In section 32.2, we review several studies that have addressed the processes involved in the retrieval from the lexicon of open-class words (i.e. lexical categories such as nouns, verbs, adjectives, certain adverbs, etc.) In section 32.3, we turn to the question of how closed-class words are retrieved from the lexicon (closed-class words are grammatical words such as determiners, prepositions, and conjunctions). The distinction between open- and closed-class words followed here was originally motivated by the contrastive effects found for open- and closed-class words in errors by aphasic and healthy speakers. Such distinction has been pervasive in language production models since the early work of Garrett (1988; 1984; 1975; see also Bock and Levelt, 1994; Levelt, 1989).

In section 32.4, we present some studies that have addressed how speakers compute agreement during speech production. Section 32.5 is devoted to the processes involved in the construction of syntactic structures during speech planning. Section 32.6 presents some research addressing the structure of the phonological and phonetic representations. Finally, in section 32.7 we review some of the research addressing the issue of phonological planning in speech production.

32.2 Retrieving open-class words from the lexicon

One of the central stages of language production is that of retrieving words from the lexicon. It is well accepted that lexical access proceeds in two major stages: the retrieval of words' semantic-syntactic information and the retrieval of words' phonological information (e.g. Caramazza, 1997; Dell, 1986; Garrett, 1975; Levelt et al., 1999). The processes involved in these two steps are referred to as grammatical encoding and phonological encoding, respectively. In this context, researchers have paid special attention to two main questions:

- (a) What are the processing principles governing access to these two kinds of information?

- (b) What is the time-course of these two processes?

A very influential framework regarding these two issues has been put forward by Levelt and collaborators (e.g. Levelt, 1989; Levelt et al., 1999). This framework has been primarily tested by exploring contextual effects in the picture–word interference paradigm. In this paradigm, participants are required to name a picture while ignoring the presentation of a distractor word. By manipulating the relationship between the target picture and the distractor, and also by manipulating the timing between the presentations of the two stimuli, different effects have been observed. For example, when the distractor word (e.g. *truck*) is semantically related to the target picture (CAR), naming latencies are slower than when both stimuli are unrelated. Conversely, when both stimuli are phonologically related (*cap*–CAR), naming latencies are faster in comparison to unrelated distractors. Although these two effects were known already in the seventies (Lupker, 1979; Rayner and Springer, 1986; Rosinski, 1977), they began to play a crucial role for theories of language production when they were interpreted as revealing different stages of word production. The first effect, the so-called “semantic interference effect,” is assumed to reveal the processes involved in the translation of semantic information into lexical items (Roelofs, 1992; for converging evidence see Damian and Bowers, 2003b; but see Costa et al., 2005; Miozzo and Caramazza, 2003 for different views). This is one of the crucial processes of grammatical encoding called “lexical selection.” The second effect, the so-called “phonological facilitation effect,” is thought to reveal the processes involved in retrieving the morphophonological composition of the lexical items. From a cross-linguistic perspective, it is relevant to assess whether these two effects and their corresponding time-courses are present across languages.

After a series of experiments conducted in Dutch (Schriefers et al., 1990), many studies tried to replicate the semantic interference and the phonological facilitation effects in several languages including English (e.g. Vitkovitch and Tyrrell, 1999; Damian and Martin, 1999), Dutch (Starreveld and La Heij, 1995), Spanish (Costa et al., 1999), French (Alario et al., 2000), Italian (Miozzo and Caramazza, 1999), and German (Glaser and Döngelhoff, 1984). The most reliable effects observed in these studies are the following:

- (a) Semantic interference effects are observed whenever the distractor word and the target

picture belong to the same semantic category and participants have to name the picture using a basic-level term.

- (b) Semantic facilitation effects are observed whenever the distractor-word and the target picture belong to the same semantic category and participants have to provide the category name of the target picture (e.g. animal).
- (c) Phonological facilitation effects are observed whenever the distractor word and the target picture share some segmental information.¹
- (d) Semantic effects tend to be present when the distractor is presented before the picture or at the same time, while phonological effects tend to be present when the distractor is presented at the same time or after the target picture (e.g. see review and discussion in Starreveld, 2000).

Interestingly, these results are quite consistent across languages, leaving little room to postulate cross-linguistic differences in the lexical selection and phonological encoding processes revealed by these two effects. Notice that this does not imply that there is consensus about the precise origin of the semantic interference (e.g. Caramazza and Costa, 2000; Caramazza and Costa, 2001; Costa, Mahon, et al., 2003; Costa et al., 2005; Roelofs, 2001; 1992) and of the phonological facilitation effects (e.g. Starreveld and La Heij, 1996; Roelofs et al., 1996; Starreveld, 2000; 2004), nor on the relationship (strictly serial or interactive) that these two processes entertain over the time course of lexical access.

The studies we have reviewed in this section focused on the processes involved in the production of open-class words (mostly nouns), which appear to be largely shared among the languages investigated up to now. As we will see, cross-linguistic differences emerge when the processes in charge of selecting closed-class words are investigated.

32.3 Retrieving closed-class words from the lexicon

Research on the selection of closed-class words, in particular determiners, has been marked by strong cross-linguistic differences. This is so, in part, because the information needed to select these words varies across languages. For example, in languages such as English, the retrieval of the

¹ There are some indications of potential cross-linguistic variability on the presence of phonological facilitation effects. This evidence is reviewed below in section 32.7.

definite article (*the*) depends entirely on semantic information (definiteness). However, in Germanic, Slavic, and Romance languages, the retrieval of the determiners (and other closed-class words, such as pronouns) also depends on a grammatical property of nouns called “grammatical gender.” For instance, in Dutch, nouns belong either to the so-called “neuter” gender or to the “common” gender. The definite determiners accompanying the nouns belonging to the two sets are respectively *het* (e.g. *het huis*, ‘the house’) and *de* (e.g. *de appel*, ‘the apple’). Thus, the processes involved in the production of the phrase *the house* or *het huis* are necessarily different in English and in Dutch, since only in the former case is access to the grammatical properties of the noun needed to retrieve the correct determiner form.

The first study which experimentally explored the processes in charge of retrieving determiners and more concretely, the process of gender selection was conducted in Dutch using the picture–word interference paradigm (Schriefers, 1993). In this study, participants were asked to produce noun phrases of the type gender-marked determiner + adjective + noun (e.g. *het groene huis*, ‘the green house’ or *de groene appel*, ‘the green apple’) while ignoring distractor words that could have the same gender or a different gender than the picture name. Naming latencies were faster when the distractor word had the same gender as the picture’s name. This so-called “gender congruency effect” has been replicated in several languages including Dutch (van Berkum, 1997; La Heij et al., 1998), German (Schriefers and Teruel, 2000; Schiller and Caramazza, 2002), and Croatian (Costa, Kovacic, et al., 2003). Furthermore, the gender congruency effect has been extended to the retrieval of other closed-class gender marked words such as pronouns (Costa, Kovacic, et al., 2003).

Additional studies on the origin of this gender congruency effect revealed an interesting cross-linguistic phenomenon. The gender congruency effect is absent in all Romance languages tested up to now: Italian (Miozzo and Caramazza, 1999), French (Alario and Caramazza, 2002), Catalan and Spanish (Costa et al., 1999; Miozzo et al., 2002). This cross-linguistic variability has been attributed to the different kinds of information needed to retrieve closed-class words in these two language families. While in Germanic languages the specific phonological context in which the determiner appears is irrelevant for its selection (e.g. in Dutch, neuter nouns take *het* and common nouns take *de*, irrespective of phonological context), this is not the case in

Romance languages. Consider the case of singular definite determiner forms in Italian. The singular definite determiner form for feminine nouns is *la*, while the singular definite determiner form for masculine nouns can be *il* or *lo*. The selection of one of these two determiners depends on the phonological properties of the following word in the noun phrase. If the following word begins with a vowel, a consonant cluster of the form *s* + consonant, *gn*, or an affricate, then the proper masculine determiner is *lo* (e.g. *lo sgabello*, ‘the stool’; *lo gnomo*, ‘the gnome’). In all other cases, the correct determiner is *il*. For example, the determiner accompanying the noun *treno* is *il* in the case of *il treno strano* (lit. ‘the train strange’) but *lo* in the case of *lo strano treno* (lit. ‘the strange train’). According to some researchers (Caramazza et al., 2001), this difference in the types of information needed to select the determiner form is at the basis of the presence or absence of the gender congruency effect. This interpretation leads to a clear cross-linguistic hypothesis: for those languages in which the determiner form can be selected on the basis of only semantic and grammatical information (so-called “early selection languages”), the gender congruency effect will be present, while for those languages in which the selection of the determiner form needs to wait until the contextual phonological information is retrieved (so-called “late selection languages”), the effect will be absent (Caramazza et al., 2001; Miozzo and Caramazza, 1999, see Figure 32.1). This hypothesis reflects how the specific properties of different languages may affect the processes involved in language production, and how a better understanding of the mechanisms involved in the selection of closed-class words requires a cross-linguistic approach. Notice, however, that these cross-linguistic differences do not imply that closed-class word retrieval is governed by completely different principles in Germanic and in Romance languages. Although the *selection criteria* appear to be different for these two groups of languages, the *activation* of determiner forms seems to follow similar principles in the two language families. This conclusion comes from studies exploring the processes by which individual features (e.g. grammatical gender, number, phonological value) activate determiner forms (Alario and Caramazza, 2002; Janssen and Caramazza, 2003).

The experiments in Alario and Caramazza (2002) took advantage of the fact that, just as in Italian (see examples above), gender agreement in French is sometimes modulated by the phonological context. For example, when the

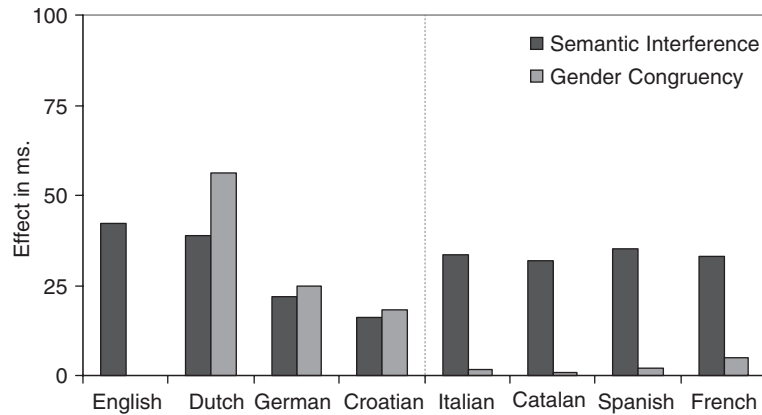


Figure 32.1 Semantic interference and gender congruency effects in various languages. Semantic interference is calculated by subtracting naming latencies in the related (e.g. desk–TABLE) and in the unrelated (e.g. fork–TABLE) conditions. Gender congruency is calculated by subtracting naming latencies in the gender incongruent (e.g. huis_{neuter}-TAFEL_{common}) and in the gender congruent (e.g. appel_{common}-TAFEL_{common}) conditions. The semantic interference effect is present in all languages. The gender congruency effect is observed in Germanic languages but not in Romance languages.

English: Damian and Martin (1999); Dutch: Schriefers (1993); German: Schriefers and Teruel (2000); Croatian: Costa, Kovacic et al. (2003); Italian: Miozzo and Caramazza (1999); Catalan and Spanish: Costa et al. (1999) and Costa and Caramazza (1999); French: Alario et al. (2000) and Alario and Caramazza (2002).

word following the noun begins with a consonant, the masculine form of the possessive ‘my’ is *mon* and its feminine form is *ma* (e.g. *mon bureau*_{masculine} ‘my desk’; *ma table*_{feminine} ‘my table’). By contrast, if the word following the possessive begins with a vowel, then the determiner is *mon* irrespective of gender (e.g. *mon arbre*_{masculine} ‘my tree’; *mon étoile*_{feminine} ‘my star’). This property of French allows testing the role of the features “gender” and “phonological onset” on the activation of determiner forms. To do so, Alario and Caramazza (2002) compared the production of noun phrases where the determiner form and the noun were gender-consistent (the so-called “standard condition,” e.g. *mon arbre*_{masculine} ‘my tree’) with the production of noun phrases where the determiner and the noun were not gender-congruent (the so-called “non-standard condition,” e.g. *mon étoile*_{feminine} ‘my star’).² The results showed that noun phrase production latencies were shorter in the standard than in the non-standard condition. This result was taken as evidence that grammatical gender activates determiner forms

² Notice that the non-standard condition is grammatical, and is indeed the only grammatical option for producing the possessive.

irrespective of the other features involved in the process (e.g. independently of the phonological onset value VOWEL). More specifically, during the production of non-standard responses, the feature gender is thought to activate the inappropriate feminine form (*ma*), which results in a delay in the activation/selection of the appropriate form (*mon*). Such activation/selection delay is not present in the standard condition, where the grammatical gender and the phonological value conspire for the selection of the same determiner form (see Alario and Caramazza, 2002).

In short, this type of experiment provides evidence for a process of determiner activation that is driven by the individual features which define the determiner form to be selected. Importantly for us, similar findings have been observed when other features with similar combinatorial properties have been used in Dutch (features gender, number and diminutive; see Janssen and Caramazza, 2003) and in German (features gender, and number; see Schriefers et al., 2002; 2005). The parallel observations and interpretations in Romance and Germanic languages suggest that the process of determiner *activation* could be shared across language families. This is despite the fact that, as discussed above, the

process of determiner *selection* seems to vary across languages.

In short, then, determiner retrieval, an interesting test case for closed-class word retrieval, appears to be governed by a combination of language-independent and language-specific principles. The language-specific principles are constrained by the phonological properties of the languages investigated.

32.4 Computing agreement

Another topic of research which has benefited from a cross-linguistic approach is the investigation of the properties that affect the syntactic agreement between different elements in an utterance. As discussed in the previous section, words in sentences hold intrinsic syntactic dependencies (e.g. determiners agree with the gender of the head noun). A central question in language production relates to how these dependencies (agreement) are computed, and the variables that affect this computation during sentence production.

One such dependency, present in most languages, is that between the number of the subject and the number of the verb in a sentence. The issue of how this agreement is computed has been experimentally explored by means of a paradigm in which participants have to complete sentence fragments. In the seminal study conducted by Bock and Miller (1991), participants were asked to complete fragments of the type (*the road to the lake*; see Figure 32.2) with a verb plus an argument. Importantly, the number of the local noun was manipulated. It could either be consistent or inconsistent with the number of

the head noun (e.g. *road*_{singular} combined with *lake*_{singular} or with *lakes*_{plural}). Participants made more agreement errors (they produced the wrong verb form) when the local noun and the head noun had a different number value than when they did not. This effect, referred to as “attraction,” has been replicated in several languages (Spanish: Vigliocco et al., 1996; French: Lardy et al., 1996; Italian: Vigliocco et al., 1995). Although the precise origin of the effect is still debated, the fact that it is present in many languages suggests that the syntactic mechanisms being revealed by the effect (e.g. grammatical feature migration, verb form selection) are similar across languages.

Following a similar experimental strategy, several studies have looked at whether the process of syntactic agreement (e.g. between subject and verb) is independent of conceptual and morphophonological factors. The issue is to determine whether the syntactic process of agreement is “blind” to the conceptual and morphophonological properties of the specific words included in the utterance.

Regarding the first issue, one of the best-studied phenomena is the effect of the so-called “distributed interpretation” of noun phrases in the agreement process. In the seminal study by Bock and Miller (1991), participants were asked to complete preambles of the sort *the picture on the postcards* or *the road to the lakes*. Crucially, in order to properly complete these two noun phrases the verb needs to be inflected in the singular, since the head of the noun phrase is a singular noun (*picture* and *road*, respectively). However, the preferred conceptual interpretation

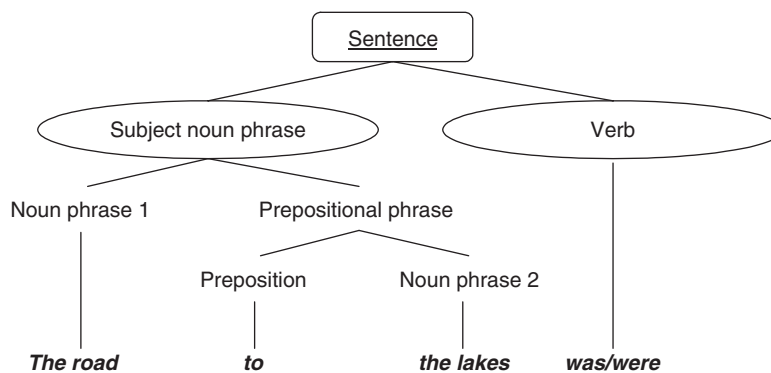


Figure 32.2 An example of the sentence preambles (without the verb) used to elicit agreement errors in speech language tasks. The properties (e.g. singular or plural number) of the head noun (*road*), of the “local” noun (*lakes*), and of the meaning of the subject noun phrase are manipulated and modulate error rates. Attraction is said to occur when the produced verb agrees with the local noun rather than with the head noun.

of the first noun phrase is that of several “tokens” (or a distributed interpretation: several pictures), while in the second noun phrase the interpretation is that of a single token (one road). The original results in English revealed an equal number of agreement errors for both preambles, suggesting that the processes of subject–verb agreement are not affected by this conceptual information (Bock and Miller, 1991). However, further studies in Italian, French, Spanish, and Dutch showed a different scenario (Vigliocco et al., 1995; Vigliocco, Butterworth, and Garrett, 1996; Vigliocco, Hartsuiker, et al., 1996; Vigliocco and Franck, 2001). In these languages, participants made more agreement errors when the preferred conceptual interpretation was that of several tokens (*the picture on the postcards*) than when such an interpretation was of a singular token (*the road to the lakes*). This cross-linguistic variation led researchers to hypothesize that languages may vary in the extent to which the selection of the verb and the corresponding agreement process is affected by conceptual properties (Vigliocco, Butterworth, and Garrett, 1996; Vigliocco, Hartsuiker, et al. 1996). Contrary to this hypothesis, however, more recent results have revealed that agreement in English seems also to be affected by the preferred conceptual interpretation of the noun phrase (Eberhard, 1999; see also Nicol and Greth, 2003 for a study with bilingual English-Spanish speakers showing the effect in the two languages). Convergent evidence for this claim comes also from a the study conducted by Thornton and MacDonald (2003) in English. By varying the conceptual property “animateness,” these authors manipulated the degree to which the head or local noun could be a plausible subject for the sentence. Attraction errors on number agreement were reduced whenever the local noun was not a plausible subject (e.g. because it was inanimate) as opposed to when the local noun was animate. In other words, the conceptual feature “inanimate” of the local noun reduces the likelihood that its plural feature is used (incorrectly) to compute subject–verb agreement.

Further evidence on the effects of conceptual information in syntactic agreement comes from a series of experiments which exploit the gender agreement process in Romance languages. As discussed in the previous section, in many Romance languages some words such as determiners and adjectives agree with the grammatical gender of the noun (e.g. in Italian *il ragazzo*, ‘the_{masculine} boy’; *la ragazza*, ‘the_{feminine} girl’). Furthermore, for some nouns there is a correlation between the grammatical gender and the so-called “conceptual gender”; male

entities (e.g. *ragazzo*, ‘boy’; *uomo*, ‘man’) usually correspond to nouns with masculine grammatical gender, and female entities (e.g. *ragazza*, ‘girl’; *donna*, ‘woman’) to nouns with feminine grammatical gender. However, irrespective of this regularity, gender agreement is determined by the grammatical feature of a noun and not by its semantic features. For example, the feminine noun *vittima* (‘victim’) calls for feminine agreement (*la vittima*) irrespective of whether the victim is a man or a woman.

This linguistic property provides the right conditions to assess the extent to which a noun’s semantic information affects gender agreement, a process that is supposed to be purely grammatical. This issue has been assessed experimentally by asking participants to complete preambles with a gender-marked adjective. Crucially, the noun with which the adjective had to agree could have a conceptual gender (sex) or not. For example, the head noun *ragazza* (‘girl’) in the preamble *la ragazza nel parco è rossa* (‘the girl in the park is red-haired’) has both grammatical gender (feminine) and a conceptual gender (female), while the head noun *panchina* (‘bench’) in *la panchina nel parco è rossa* (‘the bench in the park is red’) has only grammatical gender (feminine). If gender agreement is computed only by considering grammatical information, agreement errors when inflecting the adjective (*rosso*, ‘red’) should not differ between the two preambles. However, if conceptual information of the noun is used, to some extent, during gender agreement, then errors should be less common when the noun has both grammatical and conceptual genders. The results observed in French and Italian were consistent with the second hypothesis, suggesting that conceptual information is used during gender agreement (Vigliocco and Franck, 1999; 2001).

At present, there is consensus that syntactic agreement is, to some extent, affected by conceptual information. This effect seems to be found across languages. Note however that conceptual information might not affect homogeneously all types of agreement (see Bock et al., 2004, for experimental evidence and discussion of possible differences between verb and pronoun agreement). Importantly from a cross-linguistic point of view, the opportunities given by the different linguistic properties of different languages have allowed the extension of these conceptual effects on agreement to several contexts (subject–verb agreement, gender agreement, etc.)

Cross-linguistic research has also been useful when assessing the effects of morphophonological properties on syntactic agreement. The issue at stake here is similar to the one discussed just

above: to what extent do the morphophonological properties of words affect an agreement process that is supposed to be governed by purely grammatical features? Bock and Eberhard (1993) asked English native speakers to complete preambles of the sort *the ship for the crew* The crucial manipulation in this study involved the phonological properties of the local noun (*crew*). As in previous studies, the number of the local noun was congruent or incongruent with the number of the head noun. However, in one condition the local noun was a singular noun (*cruise*) that was a homophone of a plural word (*crews*). Despite the fact that in sentences such as *the ship for the cruise* the local noun was a “phonological pseudoplural” (ending in /z/ and, in this respect, inconsistent with the singular head noun *ship*), participants did not make more agreement errors than in sentences in which such an inconsistency was not present (*the ship of the crew*). This result suggests that the phonological properties of the local noun seem irrelevant for the process of attraction that is present when computing subject–verb agreement.

However, other studies have found positive evidence for the effects of morphophonological properties on agreement. This evidence comes mostly from manipulations of the properties of the *head* noun, rather than of the *local* noun of the preambles. For example, Vigliocco et al. (1995) took advantage of one particularity of Italian number system to assess this issue. In Italian most nouns are inflected for number (e.g. *la panchina* ^{singular}, ‘the ^{singular} bench’; *le panchine* ^{plural}, ‘the ^{plural} benches’). However, a subset of nouns does not carry any number inflection. These nouns are invariant with respect to number (e.g. *la città* ^{singular}, ‘the ^{singular} city’; *le città* ^{plural}, ‘the ^{plural} cities’). The authors compared whether agreement errors were present more often when completing preambles which contained a number-variant noun (*panchine* ^{singular} – *panchine* ^{plural}) than when completing those which contained a number-invariant noun (*città* ^{singular} – *città* ^{plural}). The results revealed that participants produced the wrong verb number more often when the subject (the head noun) of the sentence was ambiguous than when it was unambiguous, suggesting that the morphophonological properties of the head noun affect number agreement. Convergent evidence for such a claim comes from other languages (Dutch and German), other experimental contexts (pronoun retrieval), and other manipulations (e.g. case marking; Hartsuiker et al., 2003).

The results of these studies reveal that in various languages and contexts both semantic and

morphophonological information seem to influence agreement processes. Beyond the theoretical conclusions that can be drawn from the studies revised in this section, what is important for our purposes here is to see how the different properties offered by different languages can be used to assess general issues in speech production, such as how agreement is computed.

32.5 Accessing syntactic structures

Perhaps one of the most relevant observations for our understanding of how grammatical encoding proceeds is the phenomenon called “syntactic priming.” This phenomenon refers to the tendency of speakers to mimic syntactic structures that they have recently encountered. Interestingly, syntactic priming is present not only when the source of the repetition is the speaker’s own production but also when it is the speech of others (see Garrod and Pickering, 2004; Pickering and Garrod, 2004 for a discussion of how this phenomenon relates to dialogue).

This phenomenon was first reported in English by (Bock, 1986; see also Pickering and Branigan, 1999). Other studies, also conducted in English, revealed that the effect had a clear syntactic component, in the sense that it is not explainable in terms of the closed-class words that provide the syntactic structure (Bock, 1989; V. S. Ferreira, 2003), the open-class words that compose the sentence (Pickering and Branigan, 1998), or the thematic role of the components of the sentence (Bock and Loebell, 1990). Subsequent work conducted in other languages revealed other important aspects of syntactic priming. Experiments in Dutch established that syntactic priming occurs in the same structures as in English (Hartsuiker and Kolk, 1998) and that mere word-order variations also show priming (Hartsuiker and Westenberg, 2000; Hartsuiker et al., 1999). Experiments conducted in German established that different relative-clause attachments exhibit priming (Scheepers, 2003). Interestingly, recent research has shown that syntactic priming can also be observed across languages (Meijer and Fox Tree, 2003; Hartsuiker et al., 2004; Loebell and Bock, 2003). The main observation of these studies is that processing a structure in one of the bilingual’s languages can prime the analogous structures in their other language. As a first approximation, “analogous” refers to structures which are descriptively similar in syntactic terms across the two languages. This suggests that, when possible, bilingual speakers have a common

representational vocabulary for the syntactic structures of their languages. Furthermore, although the number of studies is somewhat limited, the presence of syntactic priming seems to be present regardless of the directionality of the prime target (L1–L2 or L2–L1) and the level of proficiency of the bilinguals tested.

This evidence consistently points to the existence of syntactic priming in several languages (Pickering and Branigan, 1999), which leaves little room for cross-linguistic differences. Furthermore, this priming can be observed from one language to another, suggesting a great degree of commonality between the processes of syntactic encoding for production in different languages. Notice, however, that the syntactic properties of the few languages tested share a great number of relevant properties. Whether syntactic priming can be found similarly for languages with rather different syntactic properties remains an open question. Clarifying this issue in the case of languages which have diverging syntactic properties will certainly require a fine-grained description of the similarities and differences between the relevant structures across languages.

32.6 The structure of phonological and phonetic representations

The models which describe how the forms of words are retrieved and encoded generally assume

a distinction between phonological and phonetic levels. During processing at the phonological level, the speaker has access to two types of information that need to be combined later on (see Figure 32.3):

- the specific segmental information corresponding to the word to be produced;
- an abstract phonological frame containing the slots to which the segmental content will be assigned during phonological encoding (e.g. Dell, 1986; 1988; Roelofs, 1997; Shattuck-Hufnagel, 1992; Levelt and Wheeldon, 1994).

Processing at the phonetic level involves the retrieval of representations that will drive the process of articulation. One prominent hypothesis in this context is that syllable programs are retrieved from a mental “syllabary” during phonetic encoding. Among the various questions which have been addressed in this context, three have generated some cross-linguistic research: the organization of segment retrieval, the role of the CV structure (the consonant-vowel sequences of words), and the role of syllabic information. We discuss these three issues in turn.

The first aspect of form encoding to have received considerable cross-linguistic attention concerns the role of syllabic representations during speech production. In section 32.2, we discussed the phonological facilitation effect observed across languages in the picture–word interference paradigm. The general finding is that when a distractor shares phonological

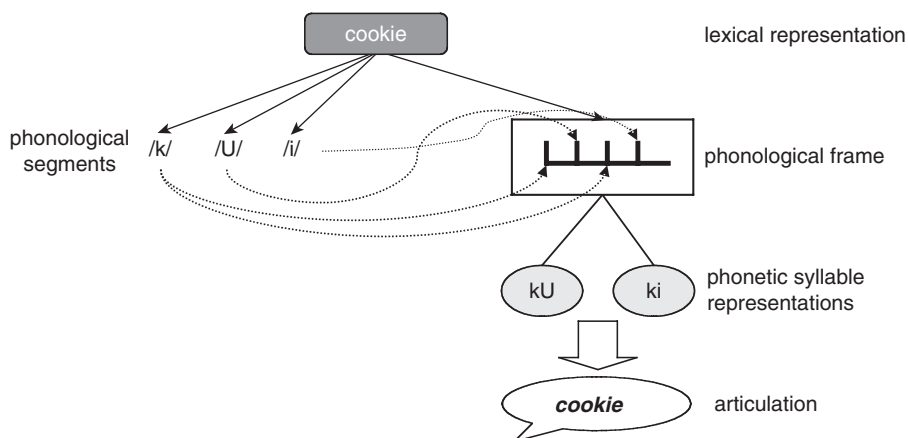


Figure 32.3 A schematic representation of the phonological encoding process. On the basis of the selected lexical item, phonological segments and a phonological frame are retrieved. Segments are then inserted in the frame in the appropriate order. The investigation of the frame has led to seemingly different conclusions across languages (see text). Not all authors agree with all the hypotheses that are implicit in the schema. Morphological units have not been represented.

information with a target word, performance is faster and more accurate than when the distractor is unrelated. Some studies have made use of this paradigm and its variants to explore issues related to the structure of the phonological representations used across languages. For example, Ferrand et al. (1996) used a variant of the picture–word interference paradigm in which distractor word fragments (instead of words) are presented very briefly and masked. In experiments conducted in French, they observed that the fragment primes facilitated responses more when they corresponded to the whole first syllable of the picture target name than when they did not. That is, the fragment PAL facilitated the naming of the target PAL.MIER more than the naming of the target PAL.LACE. A similar effect was reported in English for words with clear syllabic boundaries and no ambisyllabicity (Ferrand et al., 1997; in this study, the target pictures were replaced by target words to be read). However, these observations have been difficult to replicate in both languages (for French see Brand et al., 2003; for English see Schiller, 2000). The syllable priming effect was also absent in Spanish (Schiller et al., 2002). According to these latest studies, it would appear that, across languages, phonological priming is sensitive to the number of shared segments between prime and target rather than to the shared syllabic structure. This suggests that the segment-retrieval process is shared across languages.

The second (related) aspect of form encoding which has been investigated cross-linguistically is the nature of the phonological frame that is retrieved to encode the segments. This frame is supposed to be independent of the specific segmental content of the target word, and serves as a guide for the syllabification process during phonological encoding. In this context, the issue arises of what the structure of such a phonological frame is. An influential proposal is that this frame contains the sequence of consonant and vowels of a given word—the so-called CV structure (Clements and Keyser, 1983; Dell, 1986; Halle and Vergnaud, 1980; but see Levelt et al., 1999, for a different view).

One of the first chronometric studies to explore the role of the CV structure in speech production was conducted in English by Sevald et al. (1995). In their experiments, participants were asked to repeat two items as fast as possible during a given period of time. In some conditions, the CV structure of the first item and that of the first syllable of the second item was the same (KEM (CVC) – TIL.FER (CVC.CVC)) while in others it was different (KEM (CVC) – TIL.NER

(CVCC.CVC). The number of syllables produced per second was larger in the first than in the second condition. Furthermore, this effect was independent of whether or not the two items shared precisely the same segmental content. This result was interpreted as revealing priming in the retrieval of the word's CV structure.

Along the same lines, results reported in Spanish and French (Ferrand and Segui, 1998; Costa and Sebastián-Gallés, 1998) suggest that reusing the same CV structure of words accelerates naming latencies. In these two studies, participants were asked to read sequences of words which served as primes and, in the last trial of the sequence, to name a picture that served as target. Picture-naming latencies were faster when primes and pictures shared their CV structure (but not their segmental content) than when they did not. Convergent evidence, although somewhat less robust, for the existence of a CV structure in language production was also reported in Dutch by Meijer (1996).

However, contrasting results leading to contrasting conclusions are also present in the literature. Roelofs and Meyer (1998) ran a series of experiments in Dutch using the implicit priming paradigm (Meyer, 1990). In this paradigm, participants produce words in two different types of blocks. In the homogeneous blocks all target words share some phonological properties, while in the heterogeneous block they do not. The standard result in this paradigm is that when the words of a homogeneous set share their initial segments, naming latencies are faster than when they do not. Roelofs and Meyer (1998) found that this priming effect was only present when the words in the homogeneous block had also the same number of syllables and stress pattern. In contrast, whether or not the words in the homogeneous set had the same number of consonant and vowels (e.g. the same CV structure) was irrelevant for observing the priming effect. It was argued that the abstract phonological frame retrieved during phonological encoding specifies only the number of syllables and the stress pattern, but not the CV structure (for a discussion see Santiago et al., 2000).

Thus, the present cross-linguistic evidence suggests that the CV structure seems to be a relevant phonological structure in English, French, and Spanish. The results in Dutch are less clear, and more research needs to be conducted to assess whether this inconsistency actually reveals the different role of this structure in different languages, or whether it can be traced down to methodological differences across studies (see Hartsuiker, 2002 for a cross-linguistic hypothesis

about the role of CV structure in Spanish and Dutch).

Converging evidence for cross-linguistic variability in the role of syllabic structure during phonological encoding also comes from an investigation in Mandarin Chinese, which led to one of the most explicit cross-linguistic hypotheses in this context (Chen et al., 2002). In their study, these authors used the implicit priming paradigm (see above) to explore the processes involved in phonological encoding in Mandarin Chinese. Priming effects were observed when the words shared the whole first syllable. However, contrary to what has been observed in Dutch and in English, there was no priming effect when the words of a given block shared their first segment only. The specific orthographic properties of Mandarin Chinese cannot account for this pattern; in fact the contrasting effects of segmental priming in Mandarin Chinese and in Dutch and English (Roelofs, 1999; Damian and Bowers, 2003a; Chen et al., 2002) were interpreted as revealing differences in the properties of these languages. The proposal is that the syllable may be a more important unit during phonological encoding in Chinese than in the other two languages, leading Chinese speakers to use the syllable as a major unit guiding form retrieval. According to these authors, the relative importance of the syllable in these languages may depend, among other things, on the number of syllable types, their complexity, and their ambisyllabic status in these languages.

Finally, despite the controversial role of syllabic units in phonological encoding, and the potential cross-linguistic variations of this role, a third line of research shows that syllables play an important role in the subsequent level of processing referred to as “phonetic encoding.” Following the original idea of Crompton (1981), Levelt and Wheeldon (1994) hypothesized the existence of a syllabary which contains the syllabic motor programs of the most frequently used syllables. One way to test such a hypothesis is to explore the syllable frequency effect. The agreement across studies and languages here is large. Syllables which are more frequent are produced faster than syllables that are less frequent in Dutch (Levelt and Wheeldon, 1994; Cholin et al., forthcoming), Spanish (Carreiras and Perea, 2004), German (Hutzler et al., 2005), and French (Laganaro and Alario, submitted). The syllabary containing this syllable representations is hypothesized to be located at the level of phonetic encoding, and there is some direct evidence to corroborate this hypothesis (see Laganaro and Alario, submitted, for details). Thus it appears

that, at least at the level of phonetic encoding, syllables are an important unit regardless of the phonological properties of the language.

In summary, investigations on the structure of the phonological representations involved in language production provide evidence that such representations may vary cross-linguistically. However, much more research is needed, especially in unexplored languages with distinctive phonological properties, to determine which representations are universally shared and which are language-specific. Studies regarding the phonetic representations involved in speech production are more consistent across languages. This may reveal the constraints imposed by the articulatory system on the types of representations that can be produced.

32.7 Planning phonological information

There is wide agreement on the assumption that the language production system works in an incremental fashion. This means that, at some point in time, the speaker may be concurrently planning some parts of the utterance at the grammatical level and other parts at the phonological level. Accordingly, speakers do not need to finish computing an utterance at one level of processing before information starts to be processed at the next level of representation (Bock and Levelt, 1994). Although, the extent to which speakers produce language incrementally may be under strategic control (F. Ferreira and Swets, 2002), it is nevertheless relevant to explore the minimal unit of linguistic encoding that needs to be processed at one level of representation before its product can be passed on to the next level of processing.

Regarding phonological encoding, the issue of incrementality has been intensively investigated by assessing how much phonological material needs to be processed before articulation starts. In this context, it has been hypothesized that the minimal or preferred phonological unit that needs to be completed before articulation is released is the phonological word (Nespor and Vogel, 1986). The phonological word is assumed to involve a content word plus any clitic words that attach to it (e.g. the noun phrase *the red car* has two phonological words, *the red* and *car*).

Wheeldon and Lahiri (1997) provided clear evidence that the phonological word is indeed a fundamental unit of phonological encoding in a language like Dutch. These authors asked participants to perform a delayed naming task in

which participants had to prepare an utterance and start articulating it when a cue appeared about 4 sec. afterwards. Initiation times depended, among other things, on the number of phonological words composing the utterance irrespective of the number of lexical words, suggesting a critical role of the phonological word unit during phonological encoding.

Evidence suggesting that the first phonological word is enough for speakers to start their articulation comes from the study conducted in Dutch by Meyer (1996). She made use of the phonological facilitation effect in the picture–word interference paradigm to explore the scope of phonological planning. In this study, participants were presented with two target pictures and were asked to produce conjoined Noun Phrases (e.g. *de pijl en de tas*, ‘the arrow and the bag’) while ignoring distractor words which were phonologically related to the first noun (e.g. *pijp*, ‘pipe’) or to the second noun (e.g. *tand*, ‘tooth’) of the NP. Crucially, the first noun of the NP was located in the first phonological word and the second in the second phonological word. A phonological facilitation effect (faster naming latencies for the related distractor in comparison to an unrelated distractor word) was observed for the first noun of the NP but not for the second. These results suggest that:

- (a) the first phonological word needs to be computed before articulation starts; and
- (b) the retrieval of the phonological properties of the second phonological word does not need to be completed before articulation proceeds.

However, subsequent research (also in Dutch) revealed a more complex scenario. Roelofs (1998) ran a series of experiments in Dutch using the implicit priming paradigm (see above). Interestingly, he observed a preparation effect when the segmental content shared by the target words was placed in the second phonological word, suggesting that the scope of phonological planning extends to the second phonological word before articulation starts. Similar results using a different paradigm and a different language (English) have been observed by Smith and Wheeldon (1999); (see also van der Meulen et al., 2001, for evidence with the eye-movement technique).

Perhaps the clearest example of using a cross-linguistic approach to the issue of the scope of phonological planning was the study of Costa and Caramazza (2002). In this study Spanish and English native speakers were asked to produce noun phrases of the type “determiner + noun + color adjective” in Spanish (e.g. *el coche*

rojo, lit. ‘the car red’) and of the type “determiner + color adjective + noun” in English (e.g. *the red car*), while ignoring distractor words that were phonologically related to the noun or the adjective of the NP. Crucially, word order in these noun phrases varies in the two languages (post-nominal adjective in Spanish, pre-nominal adjective in English). Thus, the words located in the first phonological word are different in the two languages, including the head of the NP in Spanish (determiner + noun) but not in English (determiner + adjective). This different word order offers the opportunity to assess whether the syntactic status of the element located in the first phonological word (head or complement of the NP) affects the amount of phonological material computed before articulation starts. In this study, distractor words phonologically related to the first content word of the NP facilitated naming latencies in both languages. That is, the phonological facilitation effect was present for the words located in the first phonological word (the noun in Spanish and the adjective in English). More importantly, phonologically related distractors to the second content word also speeded naming latencies in both languages. That is, the phonological facilitation effect was also present for words located in the second phonological word (the adjective in Spanish and the noun in English) regardless of their syntactic role in the NP (see also Alario et al., 2002, for converging evidence using simple picture naming). This latter observation reveals that the scope of phonological planning extends to at least two phonological words. Furthermore, this cross-linguistic comparison allows the conclusion that (at least in the specific context used in these experiments) the syntactic role of the words located in the phonological frame does not affect the scope of phonological planning.

Research in Italian with a different paradigm has led to similar conclusions. Miozzo and Caramazza (1999) took advantage of one property of determiner production in Italian: determiners depend, among other things, on the phonological properties of the following word (see discussion of this issue in section 32.3). Thus, these authors could create a context in which the phonological properties of the word following the determiner required a given determiner form, while the phonological properties of the head of the noun phrase required another determiner form (e.g. *il grande scoiattolo*, ‘the big squirrel’, where *grande* requires the determiner *il* and *scoiattolo* calls for the determiner *lo*). Naming latencies were affected negatively by this mismatch: if the pre-nominal adjective and the noun required different determiner forms,

naming latencies were longer than if they required the same determiner form. This suggests that the phonological properties of the second phonological word (*scoiattolo*) are activated when the determiner form is being retrieved, and hence before articulation. This result was replicated in French by Alario and Caramazza (2002), indicating similarly that in this other Romance language, the phonological properties of the second phonological word affect the onset of articulation.

The results observed in several languages (Dutch, German, Italian, French, and English) suggest that usually the scope of phonological encoding encompasses more than one phonological word, irrespective of the specific type of utterance produced by the speaker.³ This is an interesting observation, given that the prosodic properties of the languages being tested are somewhat different. The extent to which this general observation can be extrapolated to more complex utterance types, and to other languages with more distant prosodic properties, is an open question.

32.8 Conclusions

In this chapter we have reviewed those topics in language production which have generated more cross-linguistic research. Some of the studies presented here have led to results that are quite homogeneous across languages (see e.g. section 32.2), while others have revealed cross-linguistic differences which potentially shape the processes involved in language production (see e.g. section 32.3). On yet other occasions, the specific linguistic properties of different languages have provided researchers with the appropriated conditions to test hypotheses about language production (see e.g. section 32.4).

Cross-linguistic research is critical for teasing apart which processes and representations are shared across languages (universal properties of the language faculty) and which ones are language-specific. In the last decade we have advanced in our knowledge of the general cognitive mechanisms and representations involved in speech production. However, this advance has largely neglected the potential influence of

³ This evidence is consistent with the observation that phonological contextual errors (e.g. sound exchanges) quite often involve phonological elements corresponding to words located in different phonological words (Garrett, 1975). However, the contribution of strategic factors to the size of the phonological units used in speech production is still an open question.

language differences. As a consequence, the cross-linguistic approach to language production has been rather limited, in terms both of the languages investigated and of the language-specific properties that have been considered. Moreover, the relatively great similarity between the languages tested may have prevented the appearance of cross-linguistic differences.

We think that it is time for us to assess more deeply how cross-linguistic differences (e.g. vowel harmony, ergative constructions, agglutinative morphology) may shape current models of language production. Hopefully, when the time comes for the next *Handbook of Psycholinguistics* to be written, our understanding of the language production system will be based on a larger number of languages.

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