LANGUAGE PROCESSING in SPANISH

Edited by

Manuel Carreiras
José E. García-Albea
Núria Sebastián-Gallés

LANGUAGE PROCESSING IN SPANISH

LANGUAGE PROCESSING IN SPANISH

Edited by

Manuel Carreiras
Universidad de La Laguna, Spain

José E. García-Albea
Universitat Rovira i Virgili, Spain

Núria Sebastián-Gallés
Universitat de Barcelona, Spain

LAWRENCE ERLBAUM ASSOCIATES, PUBLISHERS
1996 Mahwah, New Jersey

Lawrence Erlbaum Associates, Inc., Publishers
10 Industrial Avenue
Mahwah, New Jersey 07430

cover design by Cheryl Minden

Library of Congress Cataloging-in-Publication Data

Language processing in Spanish / edited by Manuel Carreiras, José E. García-Albea, Núria Sebastián-Gallés.
p. cm.
Includes bibliographical references (p.) and index.
ISBN 0–8058–1721–2 (alk. paper).
1. Psycholinguistics. 2. Spanish language—Psychological aspects. I. Carreiras, Manuel. II. García-Albea, José E. III. Sebastián-Gallés, Núria.
P37.L368 1995
401'.9'0946—dc20 95-37986
CIP

Books published by Lawrence Erlbaum Associates are printed on acid-free paper and their bindings are chosen for strength and durability.

Printed in the United States of America
10 9 8 7 6 5 4 3 2 1

CONTENTS

PREFACE

Since the early 1980s, there have been a number of important changes in Spain that bear, among other things, on scientific and academic policies: the number of universities has doubled; research funding has multiplied tenfold, with the creation of graduate scholarships, exchange programs, travel grants, and financial support for laboratory equipment; and the organization of scientific meetings has increased dramatically. Psychology has particularly benefited, as an emerging field that has developed in new university departments and curricula throughout the country. This development has coincided with a general trend within psychology toward the study of the functioning of the cognitive mind. The important role played by psycholinguistics in this enterprise has been reflected in the orientation of a considerable number of Spanish scholars and research groups. A sample of their main contributions to the field is offered in this book. In these introductory remarks, however, we offer a brief account of the process that has made it possible.

The concern about language is not entirely new among Spanish psychologists. On a smaller scale, and from quite different perspectives, the work of Mariano Yela in Madrid—on the factorial dimensions of verbal intelligence—and by Miquel Siguan in Barcelona—on developmental stages in language acquisition and bilingualism—prepared the ground during the late 1960s and the 1970s for the new generation. The changes experienced during the 1980s and 1990s provided opportunities for graduate and postdoctoral training in foreign universities; for establishing contacts and cooperative projects with some of the leading groups in psycholinguistic research all over the world; for attending international conferences; and, at home, for setting up laboratories and starting new projects with an even newer generation of graduate students.

Over these years, we were perhaps overengaged in keeping track of what was happening abroad, trying to absorb new ideas and techniques and test them in our language. Until very recently, we were blind to what was happening within our borders, ignoring the work of our closest fellows. We were trapped in an almost paradoxical situation. It was usually in other countries that we started to meet each other (while visiting foreign research centers or attending international conferences) and to discuss our work on Spanish (sometimes, obligated to speak in a foreign language); at the same time, we also began to meet our compatriots through publications in some of the leading journals in the field. We eventually discovered that exchange and collaboration in psycholinguistics might also be pursued with our next-door neighbors.

An initiative was needed to facilitate communication at home. A

Simposium de Psicolingüística, organized by Manuel Carreiras in Tenerife (April 1993), was an important step in this direction. It is illustrative of the situation just described that the first announcement of the event was made from the University of Oregon, where Carreiras was spending a short sabbatical. Further contacts with José García-Albea and Núria Sebastián-Gallés, at that time visiting at Rutgers University and the University of Pennsylvania respectively, served to consolidate the idea and ensure a certain level of continuity in the collaborative efforts.

The Tenerife Symposium attracted about 30 Spanish-speaking researchers who presented and discussed their work in a friendly and pleasant atmosphere. Everyone was convinced of the necessity of pursuing this kind of meeting periodically, so we planned to hold a symposium every 2 years, progressively opening them to the international community of psycholinguists. The second meeting took place in Tarragona, in April 1995, and was organized by García-Albea. We envisage a third one to be held in Oviedo in 1997, to be organized by Francisco Valle-Arroyo and Fernando Cuetos.

In addition to paving the way for continued interaction, the first symposium was a starting point for collaborative projects between participants, such as the creation of a lexical database for psycholinguistic research in Spanish—a project currently underway, promoted by Sebastián-Gallés, Cuetos, Carreiras and Martí—and the exploitation of a Spanish corpus of speech errors compiled by Del Viso, Igoa, and García-Albea (this corpus is already available). At the first symposium, a decision was also made to compile a set of contributions covering a wide range of topics in psycholinguistics, which was the origin of this book. From the beginning, it was clear to us that this book had to be written in English, to reach the international community and, to a certain extent, to acknowledge our debt to it for what we received during our training years. At the same time, we thought that it was important to incorporate research made on Spanish by Spanish authors, with new, challenging data, into the flow of present concerns about language processing in different languages.

The topics covered by this book range from one end of the spectrum of language-related behavior to the other: speech perception, lexical access in word recognition, relations between phonological and orthographic/visual representations, sentence processing, discourse comprehension, and language production. It goes without saying that the treatment of these topics is far from exhaustive. Nevertheless, each chapter focuses on questions of general interest within its areas, and in most cases they appeal to one or another particular feature of the Spanish language that is relevant to a given question.

Spanish, the third most widely used language in the world, belongs to the family of Romance languages and differs from English in a number of respects. Because English has predominated in psycholinguistic research, contrasting properties of Spanish may help to test the generality of language

processing mechanisms and refine their description. The set of contrasting features considered in this book includes the following: acoustical and syllabic transparency (fewer vowels, no ambisyllabicity, no vowel reduction), shallow orthography, a much richer morphology, flexibility in constituent order within the sentence, less variability in intonational contours, and the existence of null pronominal subjects for inflected verbs. There are also interesting contrasts in the frequency of different types of units (syllables, words, phrases) whose impact on language processing are also considered. All in all, one of the main lines of argument throughout this book deals with the tension between universality and variation as a way of characterizing the functioning of our language capacities and processes.

We have organized the book to follow the processing steps from speech perception to language production. The first chapter, by Núria Sebastián-Gallés, focuses on the role played by syllabic and metrical structure in the segmentation of the speech signal that is required for accessing the mental lexicon. She compares results in Spanish and Catalan with the ones obtained by other authors in English and French, establishing a scale of influence for both kinds of variable (syllabic and metrical) that is sensitive to the phonological characteristics of each language.

The second and third chapters move on to visual word recognition and explore different aspects of lexical access through various priming techniques. Rosa Sánchez-Casas (chap. 2) examines the notion of access code in light of search-based and activation models. She questions the validity of structurally defined units (in terms of either phonological or orthographic syllables) and presents evidence, in Spanish and English, showing that access from partial inputs is mainly driven by a restrictivity principle operating on each word according to the statistical distribution of grapheme sequences in the language. José Cañas and María Teresa Bajo (chap. 3) concentrate on studying priming effects on lexical decision under different temporal constraints. They show how these effects can be attributed to either automatic activation processes or expectancy attentional strategies. They also suggest distinguishing these two types of prelexical factors from the kinds of postlexical strategies that are mainly associated with checking and decision routines (once lexical information has been made available).

In chapter 4, Francisco Valle-Arroyo tests dual-route models of reading in Spanish. This is a language with a shallow (transparent) orthography, where grapheme-to-phoneme conversion rules apply unequivocally, contrasting with languages, such as English, that have deep (opaque) orthographies. In spite of the potential advantage of nonlexical routines in Spanish, Valle-Arroyo provides convergent evidence, from children at different reading levels and from adult patients with different types of acquired dyslexia, that supports the availability

and efficient use of lexically mediated routines in Spanish readers. The incidence of these routines increases with reading expertise and is particularly manifest in the dissociation pattern between phonological and surface dyslexics.

Reading behavior in a more constrained set of circumstances is also explored by Jesús Alegría in chapter 5. He considers the case of deaf children who receive early training in lip-reading, with the aid of a complementary system of manual gestures known as Cued Speech. Their performance in a variety of experimental tasks shows that these children closely resemble their normally hearing peers, as far as the role played by phonological information is concerned. Alegría advocates generality over differences in input modality, in much the same way as Valle-Arroyo argues for the generality of a dual-route model of reading over orthographic differences between languages. Alegria's is the only chapter that does not make explicit reference to the Spanish language, but the phonological closeness between French and Spanish provides some support for the hypothesis that similar processing mechanisms should be expected for deaf Spanish speakers.

The next two chapters deal with the issue of universality in sentence processing. They are representative of an intense dispute over parsing theories that has been provoked, in large part, by Spanish results. On the one hand, Fernando Cuetos, Don Mitchell, and Martin Corley (chap. 6) present evidence—from corpus studies, questionnaires, and on-line processing—that is difficult to reconcile with classical accounts of parsing based on structural principles. They propose, instead, a tuning model that is sensitive to the statistical prevalence of interpretative analyses, best suited to explain not only crosslanguage differences, but also other kinds of idiosyncratic variation (e.g., developmental and individual differences). On the other hand, Elizabeth Gilboy and Josep Sopena (chap. 7) criticize Cuetos et al.'s conclusions, appealing to the distinction between primary and nonprimary relations among constituents. They propose that the former are processed by universal mechanisms that honor grammatical constraints, whereas the latter are managed by the principles derived by the *construal hypothesis*. Under this hypothesis, preferences among alternative analyses are exposed to structural and nonstructural influences.

Apart from parsing operations (to recover phrase structure), sentence processing also includes mechanisms for establishing coreference relations between meaning-dependent elements (roughly termed *anaphoric expressions*) and their antecedents. In chapter 8, José García-Albea and Sheila Meltzer make use of the contrast between two types of null subject pronominals in Spanish—little pro and big PRO—in order to test the graded influences of linguistic and nonlinguistic factors on antecedent assignment. Through a slightly revised version of the crossmodal priming paradigm, they show that the role of contextual (nonlinguistic) information is constrained by the previous presentation

of grammatical information, in agreement with a modular view of syntactic operation. From a different perspective, Manuel Carreiras, Alan Garnham, and Jane Oakhill (chap. 9) also examine the influence of linguistic and nonlinguistic variables on the interpretation of definite pronouns. They are more concerned with discourse comprehension in the light of the *mental models* theoretical approach, mostly using self-paced reading times as the performance measure. Through a long series of experiments, they disentangle a number of factors that clearly influence anaphoric resolution and that can be grouped into two classes, superficial and conceptual, which seem to operate in parallel.

In a further application of the mental models approach, Manuel de Vega (chap. 10) explores different kinds of inference that operate in the comprehension of narratives. He reports a wide range of experimental data that contribute to clarifying the mechanisms underlying the construction of a discourse-specific model to gain coherence from the text, to process spatial information, and to represent interpersonal relations (characters, emotions, goals, and beliefs). At the same time, de Vega analyzes the specific nature of this format of representation by distinguishing it from other kinds of representation, such as propositions, mental images, and schemas.

Finally, in chapter 11, José Manuel Igoa looks at the field of language production, addressing central topics concerning the architecture and functional properties of the corresponding system. He adopts the framework of a staged-level model to scrutinize the relations that may hold between message-level and sentence-level components, on the one hand, and among subcomponents of the latter, on the other. Evidence from spontaneous speech errors and self-repairs in Spanish shows a very limited top–down influence of conceptual processes on sentence formulation, whereas interaction is only allowed within the formulation processes themselves. Igoa also reports evidence from an experimental study in Spanish assessing the effects of lexical activation (semantic vs. phonological priming) on syntactic planning in a picture description task. His results suggest a functional separation of processes driven by meaning and thematic relations from those that are sensitive to word form and positional relations.

As already noted, the chapters included in this book are no more than a sampling of the contributions to psycholinguistic research from a Spanish perspective. Other topics and other highly active researchers have been neglected with no better justification than lack of space. It is worth recognizing here the existence of important lines of research—on, for example, language acquisition, language breakdown, bilingualism, and pragmatics—that have not been fairly represented. We hope that this initiative will serve as an incentive for better and more complete accounts of the progress achieved by Spanish psycholinguistics.

There is a long list of people and institutions that deserve our sincere gratitude. Thanks, first, to all the contributors to this volume, for their willingness

to collaborate in the editorial process. We are most grateful to Jacques Mehler and Juan Seguí, who contributed greatly to the Tenerife Symposium and joined us in the early discussions that led to the plan for this book. We also thank some experienced friends who advised and supported us in the early stages: Chuck Clifton, Anne Cutler, Janet Fodor, and Morti Gernsbacher. In addition, we acknowledge a debt to our colleagues at the Universities of La Laguna, Barcelona, and Rovira i Virgili, who helped us to read the chapters, conveyed insightful comments to the authors, and provided support during the production of the book. Our thanks, also, to the staff of Lawrence Erlbaum Associates, in particular to Judith Amsel, Kathleen Dolan, and Chava Reyna Casper for their generous support, patience and understanding. A very special acknowledgement to Patricia Duarte who has taken care of the editing of this book. The Spanish Ministry of Education, the Research Council of the Canary Islands and the Research Council of the Generalitat of Catalunya provided financial support for most of the research and for organizing the symposia that form the basis of this book, we are pleased to acknowledge this support.

Finally, we thank many friends and colleagues, from home and abroad, who have influenced our training and interest in language research over the years. We especially thank our families for their understanding and silent collaboration during the time that we were so deeply engaged in this project. We dedicate this book to all of them.

Manuel Carreiras
Universidad de La Laguna
José E. García-Albea
Universitat Rovira i Virgili
Núria Sebastián-Gallés
Universitat de Barcelona

LIST OF CONTRIBUTORS

Jesús Alegría
Laboratoire Psychologie Experimentale
117 Av. Adolphe Buyl
1050 Bruxelles, Belgium
e-mail: alegria@ulb.ac.be

María Teresa Bajo
Departamento de Psicología
Universidad de Granada
Granada, Spain
e-mail: delagado@ugr.es

José Cañas
Departamento de Psicología
Universidad de Granada
Granada, Spain
e-mail: delagado@ugr.es

Manuel Carreiras
Departamento de Psicología Cognitiva
Universidad de La Laguna
38205 Tenerife, Spain
e-mail: mcarreiras@ull.es

Martin M.B. Corley
Department of Psychology
University of Edinburgh
7 George Square
Edinburgh EN8 9JZ
United Kingdom
e-mail: Martin.Corley@ed.ac.uk

Fernando Cuetos
Departamento de Psicología
Universidad de Oviedo
C/ Aniceto Sela s/n
33005 Oviedo, Spain
e-mail: cmssi2@vmesa.cpd.uniovi.es

Manuel de Vega
Departamento de Psicología Cognitiva
Universidad de La Laguna
38205 Tenerife, Spain
email: mvega@ull.es

José E. García-Albea
Universitat Rovira i Virgili
Departamento de Psicología
Carretera de Valls, s/n
Aptdo 576
43007 Tarragona, Spain
email: jegar@astor.urv.es

Alan Garnham
Experimental Psychology, BIOLS
University of Sussex
Brighton BN1 9QG
United Kingdom
e-mail: alang@epunix.susx.ac.uk

Elizabeth Gilboy
Departament de Psicologia Bàsica
Universitat de Barcelona
Passeig de la Vall d'Hebron, 171
08035 Barcelona, Spain
e-mail: egilboy@psi.ub.es

José Manuel Igoa
Departamento de Psicología
Universidad Autónoma de Madrid
Campus de Cotoblanco
Madrid, Spain
e-mail: jigoa@ccuam3.sdi.uam.es

Sheila Meltzer
Graduate Center of CUNY
33 W. 42 Street
New York, NY 10036
e-mail: sgm@cunyvm.cuny.edu

Don C. Mitchell
Department of Psychology
University of Exeter
Exeter
Devon EX 4QG
United Kingdom
e-mail: D.C.Mitchell@exeter.ac.uk

Jane Oakhill
Experimental Psychology, BIOLS
University of Sussex
Brighton BN1 9QG
United Kingdom
e-mail: janeo@epunix.susx.ac.uk

Rosa M. Sánchez-Casas
Universitat Rovira i Virgili
Departamento de Psicología
Carretera de Valls, s/n
43007 Tarragona, Spain
email: rscp@astor.urv.es

Núria Sebastián-Gallés
Departament de Psicologia Bàsica
Universitat de Barcelona
Passeig de la Vall d'Hebron, 171
08035 Barcelona, Spain
e-mail: nsebastian@psi.ub.es

Josep M. Sopena
Departament de Psicologia Bàsica
Universitat de Barcelona
Passeig de la Vall d'Hebron, 171
08035 Barcelona, Spain
e-mail: jsopena@psi.ub.es

Francisco Valle-Arroyo
Departamento de Psicología
Universidad de Oviedo
c/Aniceto Sela, s/n
33005 Oviedo, Spain

1

Speech Perception in Catalan and Spanish

Núria Sebastián-Gallés
Departament de Psicologia Bàsica
Universitat de Barcelona
Barcelona, Spain

All human beings share the capacity to use language. Therefore, there must be some fundamental functions common to all language users; the basic functioning of both understanding and producing language must be the same for all human beings.

Accordingly, most models of speech perception and acoustic lexical access assume that the primary underlying mechanisms are identical, regardless of the languages speakers and listeners are using. It is obvious that, to a certain extent, this must be the case, but it may also be that, beyond this basic commonality in language processing, there are language-specific routines that impose certain restrictions on the way languages are used. One of the fields where these differences seem to be most important is speech perception. If this were not the case, it would be nonsensical to write a chapter on speech processing in such-and-such a language.

In this chapter, we first present an overview of the state of the art in cross-linguistic studies of speech perception, and then proceed to detail studies in

Spanish and Catalan.

LANGUAGE SPECIFICITY

Language is a biological function. One of the basic concepts of biology is the adaptation of organisms to their environment. Therefore, given a certain genetic endowment, which will determine the limits and landmarks of development of a certain function, the precise form a function (organ) will adopt will depend (partially) on its interactions with the environment. All human beings are born with a genetic endowment that allows them to develop a linguistic capacity. This genetic endowment imposes some limits and restrictions on what can and what cannot be a natural language, the initial capacities of newborns to acquire a language, the sequence and pace of neurological maturation, and other fundamental cornerstones of language development and use.

Until very recently, the general assumption was that these constraints were extremely rigid, and therefore it was not useful to study language-specific properties to understand language processing. However, research conducted in different languages has shown that these differences are quite important, at least in the field of speech perception, for both theoretical and practical reasons.

From a theoretical point of view, two issues are crucial: First, it is important to know to what extent the mechanisms underlying speech perception are different (i.e., language-specific), and to what extent they are common. The second consideration is a developmental one. On the one hand, all human beings can learn any language at birth, and on the other, the only determining factors in developing a certain language and not another are environmental. Thus, knowing how adults process speech (in the stable state) can shed light on the way babies solve the problem of learning a language.

The study of crosslinguistic differences in speech perception is an important domain for many practical reasons, too. Consider the extreme difficulty we have when learning a new language as adults. A superficial analysis of the problems that adult learners suffer as second-language learners shows that strong biological (adaptational) processes took place during the first years of our lives (as, e.g., the work of Werker and colleagues has shown: Werker, Gilbert, Humphreys, & Tees, 1981; Werker & Tees, 1983, 1984). Very young children do not seem to make any effort in learning a new language; this is not only true of the acquisition of new words and syntactic structures, but also of basic mechanisms involved in speech perception. As adults, however, even when we know the words pronounced in a foreign language, we still may not be able to split the continuous

sound stream into appropriate words. Being a native speaker of two Romance languages, I have found that my colleagues who are also native speakers of other Romance languages pronounce English very clearly, even clearer than native English speakers. Speakers of other languages, such as German, Russian or Japanese have a very poor pronunciation of English to my Romance ears! This tells us that there must be some specificity in the way languages are pronounced and/or perceived by speakers of different languages.

THE PROCESS OF SPEECH PERCEPTION

Speech perception is a process by which information contained in an acoustic stream is transformed into meaningful words and sentences. We do not discuss here either the complexity of this acoustic stream, or how the very first processes of transforming it into a suitable format for the nervous system are performed. Although no direct evidence is available, we can assume that these processes are universal and, therefore, no language-dependent.

Most classical models of speech perception (though not all; see further on) assume that this acoustic information is organized into sublexical units before the lexicon is accessed. These units are used to contact the lexicon to select the appropriate entry. Two important remarks must be made here. First, although no one model has made this assumption explicitly, this sublexical unit is presumed to be a universal, and therefore all speakers of all languages should make use of the same one. Second, there has been more or less general agreement that this sublexical unit is equivalent to something close to what linguists describe as a *phoneme*. Research performed crosslinguistically indicates that neither of these assumptions is correct.[1]

THE INITIAL WORK: THE IMPORTANCE OF STRUCTURES

As I have said, one of the central problems of speech processing is how the

[1]The argument that speakers of different languages use different words can be used to trivialize the issue under discussion. Speakers of different languages must have language-specific lexicons, but the important thing is that, apparently, properties of the sublexical units seem to be dependent on the phonological properties of the languages.

acoustic information makes contact with the lexicon. Two solutions have been proposed. First, acoustic information (almost) directly contacts the lexicon. This approach assumes that there are no intermediate (prelexical) representations between the speech signal and the lexicon. Various models, such as LAFS (Klatt, 1977, 1989) and Cohort (Marslen-Wilson, 1987), propose such a solution.

The second solution is that some kind of representation is computed between the acoustic signal and the lexicon. As just mentioned, this prelexical representation has commonly been considered to be the phoneme (Cutler & Norris, 1979; Foss & Blank, 1980; McClelland & Elman, 1986; Pitt & Samuel, 1990a). However, other researchers have proposed and considered larger units (Savin and Bever, 1979). In a seminal paper, Mehler, Dommergues, Frauenfelder, and Seguí (1981) provided clear experimental data in support of larger units in speech perception. In their experiments, subjects had to monitor for either consonant-vowel (CV) or CVC sequences in bisyllabic words that started with CV or CVC syllables. Experimental items were pairs of words starting with the same CVC sequence (e.g., for instance *PALace* and *PALmier*), but one of the members of each pair had an initial CV syllable (such as *PALace*), whereas the other had a CVC syllable (such as *PALmier*). If the syllable was a prelexical unit, it would be expected that when subjects had to detect fragments at the beginning of words matching their syllabic structure, they would be faster than when there was no such match. In contrast, if the phoneme was the speech segmentation unit no syllabic effect would be expected, but there would be an overall advantage of CV fragment detection times over CVC fragment detection times. Results showed that when subjects had to detect *pa* in *palace,* they reacted faster than when they had to detect *pa* in *palmier,* and the reverse occurred when subjects had to detect *pal.* From these results, Mehler et al. concluded that subjects had segmented the speech stream into syllable-sized units before accessing the lexicon.

Cutler, Mehler, Norris and Seguí (1983, 1986) tried to replicate in english the experiments of Mehler et al., which had been performed in French, but they could not obtain the original pattern observed in French: an interaction between the structure of the initial syllable of the word and that of the target fragment. English subjects showed a pattern that presented an overall advantage in detecting CV and CVC sequences in CV words over CV[C] words. In fact, it has been impossible, up to now, to show any syllabic effect in English in spite of the variety of experimental procedures used. Therefore, it seems safe to surmise that English speakers do not segment the speech stream into syllable-sized units before contacting the lexicon. What kind of strategy do English speakers use to segment the speech signal? Using a wide variety of experimental procedures and data, Cutler and her coworkers (Cutler, 1990; Cutler & Norris, 1988) have been able to establish that English speakers seem to segment the speech signal at the onset of every strong syllable. This strategy is considered in detail in the

following sections.

The consequences of these studies have been very important: They have proved the existence of language-specific mechanisms in speech segmentation. More recent research has found language-specific segmentation strategies in other languages, such as Japanese (Otake, Hatano, Cutler, & Mehler, 1993), Dutch (Zwitserlood, Schriefers, Lahiri, & Donselaar, 1993; Vroomen and de Gelder, in press), Portuguese (Morais, Kolinsky, Cluytens, & Pasdeloup, 1993), Spanish, and Catalan. In the following sections, I review the work carried out in these two last languages.

STUDIES ON THE STATUS OF THE SYLLABLE IN CATALAN AND SPANISH

In explaining the differences between the patterns of results obtained in French and English, Cutler et al. (1983, 1986) argued that they reflected differential ways the phonological properties of the languages are treated by native speakers. In short, French, being a Romance language, has clear syllabic boundaries, whereas English, a Germanic language, has widespread ambisyllabicity.[2] The lack of clear syllabic boundaries prevents English speakers from using syllables as suitable segmentation units. However, the phonological structure of English can be properly described in terms of metrical rhythmic structures, such as *feet*. Feet are suprasyllabic structures that characterize the rhythm of a language. English rhythm is characterized by groups of syllables all starting with a strong (not a reduced) vowel.

Cutler et al. predicted that the pattern of results obtained in French would be replicated in other syllabic languages. Nevertheless, the differences between the French and English experiments of Mehler et al. and Cutler et al. did not concern the existence, or nonexistence, of clear syllabic boundaries. First, French is a language with fixed stress: All words are stressed on the last syllable; English is a language with variable stress. Furthermore, the types of stimuli employed in the two experiments also differed in terms of stress value: Whereas the French words were stressed on the second (i.e., last syllable), the English words were stressed on the first. Second, French does not have vowel reduction,

[2]In English, a word like *lemon* can be syllabified as *le·mon, lem·on* or even *le[m]on* (the *m* belonging to both syllables at the same time). This phenomenon is known as *ambisyllabicity*, because the same phoneme can belong to two different syllables at the same time.

whereas English does. Given these differences between the two languages, it was worthwhile to run an experiment in other languages that could confirm or disprove the explanation proposed by Cutler et al. for the discrepancies between the French and English results in terms of the lack of syllabic boundaries. The differences observed between the two languages may simply have been due to a difference in the material, and may have had nothing to do with the phonological properties of the languages.[3]

Sebastián, Dupoux, Seguí and Mehler (1992) performed a replication of the French and English studies, controlling for these differences. Catalan and Spanish were the perfect choices: Both languages have clear syllabic boundaries; therefore, if the explanation in terms of the existence or non-existence of syllabic boundaries is valid, both languages would show the same pattern as French. However, both also have variable stress position. If this was the determining factor, they would show patterns of results close to the English case. Finally, Catalan has vowel reduction, whereas Spanish does not. If the existence of vowel reduction prevented subjects from showing a syllabic effect, Spanish would show a pattern close to the French, whereas Catalan subjects should perform the task without showing syllabic effects (as the English subjects did). The stimuli for the Catalan and Spanish studies included first- and second-syllable stressed words. The pattern of results are shown in Tables 1.1 and 1.2.

The Catalan pattern of results, that is, a lack of syllabic effect on reaction time (RT) in stressed syllables and a significant syllabic effect in unstressed syllables, supported the hypothesis that the differences between the French and English data were due to differences in the materials. However, the pattern of results in Spanish counter this explanation. No syllabic effects were found in Spanish for any type of material. This was surprising. First, all hypotheses predicted some syllabic effects in Spanish (if they had also been found in Catalan). Second, other research (Bradley, Sánchez-Casas and García-Albea, 1993; Sánchez-Casas, 1988) had found significant syllabic effects (although with different materials, and slightly different experimental procedures[4]) in Spanish.

---

[3]In fact, such an explanation was partially contested by the fact that the French subjects, when presented with the English stimuli, still showed a syllabic effect. When the English-speaking subjects were presented with the French stimuli, they did not show any syllabic effects in performing the task. Recent research, however, has shown that French subjects have difficulty perceiving stress in other languages (Dupoux, Pallier, Sebastián & Mehler, 1995), and it may also be the case that the way stress is encoded in French makes it very difficult for English speakers to perceive it correctly.

[4]In these experiments, trisyllabic items were employed, all second-syllable stressed. Moreover, catch trials were included in the filler lists; in these trials, the target shared either the first consonant or the first vowel of the critical word. This type of trial did not exist in any of the other reported

TABLE 1.1
Mean RTs (in ms) in the Fragment Detection Task in Catalan

	First syllable stressed		*Second syllable stressed*	
	CV word	*CVC word*	*CV word*	*CVC word*
Target CV	329	350	338	343
Target CVC	342	359	353	332

TABLE 1.2
Mean RTs (in ms) in the Fragment Detection Task in Spanish

	First syllable stressed		*Second syllable stressed*	
	CV word	*CVC word*	*CV word*	*CVC word*
Target CV	355	373	373	385
Target CVC	372	379	382	394

Sebastián et al. (1992) offered an explanation of this lack of effect in terms of the *acoustic transparency* of Spanish. Spanish is a language with few vowels (five) and a relatively reduced syllabic inventory. Given the characteristics of the task, it could be that, under certain circumstances (e.g., involving fast responses), subjects perform the task using low-level information of an acoustic type. This may account for the lack of effects in Spanish (for stressed and unstressed syllables) and partially in Catalan (stressed syllables). In fact, RTs in the Sánchez-Casas experiments were much longer than those obtained by Sebastián et al. (575 ms *vs.* 373 ms respectively).

To test this explanation, two more experiments were performed in which subjects' responses were slowed down by their having to perform a concurrent task (subjects were asked to pay attention to the semantic relations that could arise between words in the list). Results are shown in Tables 1.3 and 1.4.

As expected, clear syllabic effects (interaction between target structure and word structure) were found in both stressed and unstressed syllables in both languages. Therefore, the data obtained in Catalan and Spanish confirmed the original explanation of the differences between French- and English-speaking

experiments (not even the French and English ones).

subjects in terms of a contrast in the way the speech signal is analyzed by speakers of the two languages. Speakers of languages with clear syllabic boundaries (e.g. French, Spanish, and Catalan) seem to syllabify the speech signal, whereas speakers of languages with widespread ambisyllabicity do not.

TABLE 1.3
Mean RTs (in ms) in the Fragment Detection Task in Catalan With Slow Responses

	First syllable stressed		*Second syllable stressed*	
	CV word	*CVC word*	*CV word*	*CVC word*
Target CV	456	502	493	515
Target CVC	501	490	515	515

TABLE 1.4
Mean RTs (in ms) in the Fragment Detection Task in Spanish With Slow Responses

	First syllable stressed		*Second syllable stressed*	
	CV word	*CVC word*	*CV word*	*CVC word*
Target CV	589	643	586	640
Target CVC	614	625	612	616

These studies show that the picture is far more complex than was previously thought. Although syllabic effects were obtained in both Catalan and Spanish, subjects seemed to be able to respond without taking into account the full syllabic structure of the words. Syllabic effects may come and go, depending on the subjects' speed of response. Therefore, further research was needed to support the conclusion that Spanish speakers syllabify the speech signal. Pallier, Sebastián, Felguera, Christophe, and Mehler (1993; see also Sebastián & Felguera, 1992), used a totally different technique to assess this assertion.

In their experiments, they asked subjects to detect phonemes inside words or pseudowords. Experimental stimuli appeared in the third phonemic position, but they could be either the onset of a syllable (e.g., *p* in *capricho*) or the coda (e.g., *p* in *captura*).[5] These stimuli were embedded in two different lists; in one,

[5]In fact, there were other experimental conditions, but these two are enough for our purposes.

target fillers were almost always in the onset position, in the other, target fillers were almost always in the coda position (although, as with the experimental stimuli, the targets were in the third phonemic position). Half of the subjects were tested with the *onset list* (target fillers in the onset position), and the other half with the *coda list* (target fillers in the coda position). If subjects did not build the syllabic structure while listening to the speech stimuli, the two groups of subjects should display the same RTs for the two types of experimental stimuli, because all of them almost always detected stimuli in the third phonemic position. But if the syllabic structure of the words had been computed, then the two groups should be induced to expect the targets in a precise syllabic position: Subjects detecting most of the fillers in the onset position should be slowed down when experimental targets appeared in the coda (unexpected) position, but not when they appeared in the onset (expected) position, and the reverse pattern should be obtained for subjects detecting most of the fillers in the coda position.

Pallier et al. (1993) obtained a pattern of results consistent with the hypothesis that subjects computed the syllabic structure of the stimuli. This result was obtained with both French and Spanish subjects and materials. Interestingly, Pallier (1994), using the same technique and experimental setting, did not find this pattern with American English-speaking subjects.

THE IMPORTANCE OF METRICS: THE ROLE OF STRESS

The research just described clearly shows that in languages with clear syllabic boundaries (such as Romance languages), listeners segment the speech stream into syllable-sized units before accessing the mental lexicon. It also shows that listeners of languages like English compute stress while segmenting the speech signal. However, although French does not have contrastive lexical stress and English does not have clear syllabic boundaries, Spanish and Catalan have both clear syllabic boundaries and lexical stress. The research described in the previous section made it possible to test the segmentation of the speech signal into syllable-sized units by speakers of Catalan and Spanish. However, it did not test whether speakers of these two languages also use information concerning the stress value of the syllables in accessing the lexicon.

Before going into a description of my research, it is useful to describe how stress is encoded in different languages. Stress is a property that may vary in (mainly) three dimensions: intensity, duration, and pitch. Which dimensions are more important than others when stress is encoded differ from language to language. For instance, in Spanish, the most important difference between a

stressed vowel and an unstressed vowel is in intensity; the difference in duration is of secondary importance, and the difference in pitch is minimal. Contrary to this, in English, the main difference between stressed and unstressed segments is a difference in pitch and duration; differences in terms of intensity are not very important. It is fundamental to keep these discrepancies in mind when doing crosslinguistic research. Studies about stress have apparently led to contradictory results, but this may be because in some cases, the true subject under study has not been the same, although the name (*stress*) may have been.

Although the literature on the role of different structural units in speech perception is quite extensive, there is little on the role of stress. As stated earlier, Cutler and her colleagues have shown that English speakers segment the speech signal at the onset of every stressed syllable or, more exactly, at the onset of every strong syllable.[6]

Cutler and Norris (1988) proposed a strategy, based on a metrical structure, Metrical Segmentation Strategy (MSS), that listeners of languages like English appear to use to segment the speech signal. In a series of experiments, these authors found that listeners were slower to detect the embedded real word in *mintaif* (where the second syllable has a full/strong vowel), than in *mintef* (where the second vowel is reduced/weak). This is because English listeners, when perceiving continuous speech, are said to hypothesize a word beginning at the onset of every strong syllable. Predictions derived from MSS have been tested in a large variety of experimental situations (see Cutler, 1990, for a review) and computer simulations. Recently, Vroomen and de Gelder (in press) have found converging evidence in Dutch, a language metrically similar to English.

But the role of stress in speech perception has also been studied in other contexts. Using a phoneme monitoring task, Cutler and Foss (1977) found that RTs were faster when the target phoneme was in a stressed syllable than in an unstressed one. Cole and Jakimik (1980) and Bond and Garnes (1980) found that subjects were twice as fast in detecting mispronunciations in a stressed than in an unstressed syllable. Nonetheless, Pitt and Samuel (1990b) argued that some of these results may have been due to acoustic differences between stressed and unstressed syllables (intensity, duration, and pitch). However, they also proposed that the acoustic clarity of stressed syllables could make those syllables perceptually outstanding anchors. These anchors could, in turn, be used by the perceptual system to parse the speech signal. Cutler (1976) found that the perceptual system is sensitive to the presence of stress in sentence processing: In a phoneme detection task, subjects responded faster when the targets appeared

[6]Strong syllables (again according to Cutler) are defined in terms of vowel quality: syllables with full vowels are said to be strong, while syllables with reduced vowels are said to weak.

in places where (emphatic) stress was expected, even though, all acoustic correlates had been deleted by cross-splicing the materials. Moreover, Wanner and Gleitman (1982) proposed that, in the very first stages of language acquisition, the newborn may use stressed syllables as perceptual islands where speech segmentation is triggered.

However, some experimental data point in a different direction. Cutler (1986) and Cutler and Clifton (1984) maintained that stress plays no role in the process of attaining lexical access. The strongest experimental evidence comes from a series of experiments where the crossmodal priming technique was used. Cutler (1986) found that minimal pairs of words differing only in accent (like *trustee/trusty* and *foregoing/forgoing*) behaved as true homophones. Cutler's proposal was that stress appears to play a role in speech segmentation (it helps us in identifying where a word is most likely to start) and gives us anchors from which to start processing, but does not play a role in the specific processes of word recognition.

However, as I noted, stress is differentially encoded in different languages. Although differences in stress (as in *foregoing/forgoing*) can be of little importance for English listeners, they may be of paramount importance for speakers of Spanish. Spanish, unlike English, does not have the distinction between strong and weak vowels: the same vowels are found in stressed and unstressed positions. Therefore, the only difference between a stressed vowel and an unstressed vowel (e.g., in a bisyllabic word) is that the stressed vowel is where the primary stress falls. Although pairs of words differing only in the position of the primary stress are not very frequent in English, they are very common in Spanish. Given these differences between English and Spanish[7], let us explore the role of stress in speech perception in Spanish.

THE ROLE OF STRESS IN SPEECH PERCEPTION IN SPANISH

Several authors (Bradley et al., 1993; Pallier et al., 1993; Sebastián et al., 1992) have shown that Spanish speakers are sensitive to syllables in segmenting the speech signal. What about stress? This question has been addressed in two series

[7]A totally different case is Catalan, a language with full and reduced vowels (like English); however, given the fact that most of the research on stress perception has been carried out with Spanish, we will center our exposition on the latter language.

of experiments. Previous research has tended to divide languages according to whether speakers use syllables or stress in segmenting the speech signal. Although this distinction can be applied to French and English, other languages may use both types of information in speech perception. Indeed, French speakers could not use stress in speech perception, because French does not have contrastive stress; it therefore plays no role in differentiating lexical entries. English speakers would not parse the speech signal into syllable-sized units, because such units do not seem to be naturally used in their language. (From a phonological point of view, it is not possible to assume that French does not have metrical units, or that English does not have syllables. The point is that these theoretical phonological units seem not be used in the same way by speakers of the two languages). It may be, however, that speakers of Spanish make use of both types of information.

In a series of experiments, Sebastián (1995) has tested the hypothesis that Spanish speakers are also sensitive to metrical information when perceiving speech. In these experiments, subjects were asked to perform a generalized syllable detection task. They were presented with trisyllabic pairs of pseudowords. These pseudowords (all becoming pseudowords at the third phoneme) had a CVCVCV structure and differed in the position of stress. Subjects were presented with pairs, such as *pebádi–pebadí,* in which they had to detect the first syllable (*pe*), and pairs like *míbepa–mibépa*, where the syllable to be detected was the last one (*pa*); there were other types of pairs, too, but they are not critical to the hypothesis being discussed here. If subjects were not sensitive to the metrical structure, there would be no difference between the RTs of each two member of the pair; it should take the same amount of time to detect *pe* in *pebádi* as in *pebadí*, and to detect *pa* in *míbepa* and in *mibépa*. However, if subjects computed the metrical structure of the stimuli while listening, there could be statistically significant differences in the detection of the target syllables between the two members of each pair.

Spanish (like English) is a language with a trochaic metrical structure; that is, stress groups (feet) have the stressed syllable at the onset of the group. For instance, a stimulus like *pebádi* has a metrical structure of <*pe*>(*bádi*), whereas *pebadí* has a metrical structure of (*peba*)(*dí*). In a similar way, *míbepa* has a metrical structure of (*míbe*)<*pa*>, and *mibépa* of <*mi*>(*bépa*). If subjects compute this metrical structure while listening to speech, it should be easier to detect *pe* in *pebádi* than in *pebadí*, because in the first case there are both syllable and foot boundaries between the first and the second syllables, whereas in *pebadí* there is only a syllable boundary. The same reasoning can be applied to the *míbepa-mibépa* pair, so, it should be easier to detect *pa* in *míbepa* than in *mibépa.* Results showed a statistically significant advantage of 16 ms ($p < .02$), for

detecting syllables when both syllable and foot boundaries existed, over stimuli with only a syllabic boundary.

These results demonstrate that Spanish speakers compute not only the syllabic structure of stimuli when listening to speech, but the metrical structure, as well. However, the data tell us nothing about the question of the effective use of this information in lexical access. It could be that subjects compute the stress value of syllables before accessing the lexicon, but that this information is not relevant for lexical access. To assess this, another series of experiments was performed.

It has been found that RTs for detecting phonemes at the onset of stimuli are faster for words than for pseudowords, if the stimuli are monosyllabic (Cutler, Mehler, Norris, & Seguí, 1987; Rubin, Turvey, & van Gelder, 1976). However, if they are polysyllabic, RTs do not differ (Foss & Blank, 1980; Seguí, Frauenfelder, & Mehler, 1981). Several explanations for this have been proposed. One of the most popular is the race model (Cutler et al., 1987; Newman & Dell, 1978). To perform the task, subjects can use two different procedures. One of the procedures, the lexical route, involves parsing the speech signal into syllable-sized units and using these units to access the lexicon. Once a lexical candidate has been selected, information concerning its phonemes is available. The other procedure, the nonlexical one, is an *adhoc* strategy: Subjects determine which is the initial phoneme in a given stimulus. It is obvious that both procedures are available when stimuli are words, but only the latter can be used for pseudowords. Subjects are believed to base their responses on the first available information.

How does this model explain the word advantage only for monosyllabic stimuli? Let us assume that the individual parses the speech signal into syllable-sized units prior to accessing the lexicon and that these units are used to start the lexical search. In the case of monosyllabic units, this first package of information is the whole word, and therefore word recognition is fast. This implies that information concerning the initial phoneme is recovered through this route, and that it is faster than the nonlexical one. This explains why initial phonemes are detected faster in words than in pseudowords. For polysyllabic stimuli, however, this initial package of information (initial syllable) may not be large enough to allow word recognition. The lexical route needs more information (and hence more time) to identify longer words. This extra time makes the advantage of words over pseudowords disappear. It may be that the nonlexical route has completed the process of phoneme identification in a comparable time. Therefore, this model predicts that with longer words, the word advantage will disappear.

The present description of this model does not include any reference to the possible role of stress in accessing the lexicon. This possibility has been tested

(Sebastián, 1994; Sebastián & Dupoux, 1995) in a series of experiments comparing the performances of French-, Spanish-, Catalan- and English-speaking subjects. In these experiments, different types of monosyllabic (CVC-*pan*-CCVC-*tren*) and bisyllabic (CVCV-*bala*-CVCV(C)-*canal*) stimuli were presented. Wherever possible (i.e., in all languages but French), two types of bisyllabic stimuli were presented: first- and second-syllable stressed. If stress does not play a role in accessing the lexicon, no statistically significant differences would be esxpected between words and pseudowords. The pattern of results showed however, that subjects were faster at detecting the initial phoneme of a word than its matched nonword when the initial syllable of these stimuli was unstressed (e.g., subjects were faster at detecting *p* in *peral* than *p* in *peril*). This word advantage was not observed for first-syllable stressed stimuli (i.e., there were no significant differences in detecting the initial phoneme in pairs of stimuli like *capa* and *capi*). This pattern of results was obtained in all the languages with variable stress (Spanish, Catalan, and English), but not in French, a language with fixed stress. A possible explanation for this pattern of results is that lexical search starts with stressed syllables. Let us look at the mechanism proposed in slightly more detail. Both stress value and structure parsing are computed for each syllable. If the syllable is a stressed one, the lexical search is triggered; if the syllable is not stressed, the process waits until a stressed one is found. Thus, first-syllable stressed bisyllabic stimuli involve two information processing packages, whereas second-syllable stressed bisyllabic stimuli involve only one. The race model assumes that when two-package processes are involved in recognizing a word, words lose their advantage over pseudowords. As already stated, several authors have already proposed that in language acquisition (Wanner & Gleitman, 1982) and in adult speech processing (Pitt & Samuel, 1990b) stressed syllables may function as anchors of information from which speech processing could proceed. The present explanation is along the same lines.

But what happens with French subjects? French subjects did not show any word advantage for bisyllabic items stressed on the second syllable. Stress has no contrastive value in this language; so it is possible that French subjects do not compute stress values when listening to speech. Current research (Dupoux, Pallier, Sebastián, & Mehler, 1995) seems to point in this direction.

In fact, a detailed analysis of the patterns of data obtained in Spanish, Catalan, and English seems to indicate that the parameters of stress (accent) studied in these experiments could play slightly different roles in the three languages. In fact, the effect was stronger in Spanish than in the other two languages, whereas in English it was only significant in the subjects analysis (and marginally significant in the item analysis). This is not surprising. Spanish, unlike Catalan and English, does not have vowel reduction; therefore, the only way stress is encoded is through the accent. English and Catalan also encode stress

through the difference between full and reduced vowels. Although no data are available about the importance of this distinction for Catalan listeners, Cutler and her coworkers have provided extensive proof of its enormous importance for English speakers.

CONCLUDING REMARKS

Slightly over a decade has elapsed since Cutler et al. (1983) tried to replicate the pattern of data obtained by Mehler et al. (1981) with French subjects. The original explanation of the differences between the data obtained with French and English subjects, though still partially valid, cannot explain the whole picture. Research conducted in Spanish and Catalan (as well as in other languages) has shown that when listening to the speech stream, we parse it at different levels: structural and metrical. More important, the precise nature of this parsing depends on the phonological properties of each language. French speakers seem to pay little (if any) attention to the stress value of the segments, probably because French has no stress-based differences at the lexical level. English speakers seem to rely primarily on stress, and more specifically, on the differences between strong (full) and weak (reduced) vowels when segmenting the speech stream; and Spanish subjects seem to make use of both types of information.

In the introduction of this chapter, I asserted that there were both theoretical and practical reasons for conducting crosslinguistic research. From a theoretical point of view, the current knowledge of how speech is perceived has advanced greatly. Nevertheless, there are many questions still to be answered. The developmental question of how babies acquire a language must take into consideration what is now known about adult speech perception. The process of developing a system to compute speech is not a convergent one, but a divergent one. Adult speech segmentation seems to contrast in a multidimensional grid in which different dimensions have different weights. The way these different weights are established in the process of language acquisition is currently an important focus of research.

Another key theoretical question is the relationship between speech perception and production. Most of the data available for speech production have come from studies of speech errors. Detailed analysis of these corpora has shown some divergences in the phonological encoding of information (Igoa, this volume, chap. 11). The development of experimental techniques, such as the *picture-*

naming interference task[8] will probably help us in understanding how phonological information is encoded. Indeed, Costa (1994) has found on-line evidence for syllabic representation in speech production in Spanish. Using the picture-naming interference task, he observed lesser interference when the auditory and visual stimuli shared segmental and structural information, and both types of variables were significant and additive. Future research should try to extend this line of research to other variables, languages, and different techniques. Fuller knowledge of the nature of the phonological representations in speech production will help us to understand how perception and production are related.

A final theoretical question concerns the relationship between the different variables that play a role in speech perception (and, probably, production). If, as the data seem to suggest, Spanish speakers use both structural (syllabic) and metrical (stress) information when parsing the speech stream, the relationship between the two should be determined. Are both computed at the same time? Is there a preferential way to order them?

A final group of interests in studying crosslinguistic differences in speech processing is applied. In 1977, two Boeing 747s crashed in what was the worst civil aviation accident on record: 583 people were killed. Many causes have been put forward to explain why the KLM plane was trying to take off, in spite of the fact that it had not received clearance to do so, or why the Pan American aircraft was on the runway, when it should not have been there. One of the reasons was that "there was considerable misunderstanding between the pilots and the air traffic controllers" (Norman, 1988, p. 130). The pilots and the air traffic controllers were either native speakers or highly skilled second-language speakers of English (only English is spoken in air traffic communications), but even so, "misunderstanding" took place (in an already quite chaotic situation or, maybe, because of it). Listening to a foreign language in a bad acoustic environment or under extreme pressure is not an easy task. Determining the language-specific properties of speech perception will be of considerable help in preventing accidents of this type.

[8]In this technique, subjects are asked to name a picture aloud while they are hearing auditory stimuli. Depending on the stimulus onset asynchrony (SOA) between the visual and the auditory stimuli, either semantic or phonological interferences may be observed.

ACKNOWLEDGMENTS

Preparation of this manuscript and the research described here was made possible by the following research grants: HFSP project, *Processing Consequences of Contrasting Language Phonologies;* Spanish Ministerio de Educación y Ciencia contract CE90-008; Human Capital project, *Language as a Cognitive Activity;* and special funding from the Catalan Government (Generalitat de Catalunya). I would like to thank the members of the LSCP laboratory of the CNRS (in Paris) for their continuous support throughout the research, especially Jacques Mehler and Emmanuel Dupoux. Finally, I acknowledge the help of Sergi Pérez, Joaquim Llauger, Teodora Felguera, Ana Parreño, Jordi Pons, Perfecto Herrera, Ventura Fábregas, and especially Laura Bosch and Albert Costa, for their valuable help all these years.

REFERENCES

Bond, Z.S., & Garnes, S. (1980). Misperceptions of fluent speech. In R.A. Cole (Ed.), *Perception and production of fluent speech* (pp. 115–132) Hillsdale, NJ: Lawrence Erlbaum Associates.

Bradley, D.C., Sánchez-Casas, R., & García-Albea, J.E. (1993). The status of the syllable in the perception of Spanish and English. *Language and Cognitive Processes, 8,* 197–233.

Cole, R.A., & Jakimik, J.A. (1980). A model of speech perception. In R.A. Cole (Ed.), *Perception and production of fluent speech* (pp. 133–163). Hillsdale, NJ: Lawrence Erlbaum Associates.

Costa, A. (1994). *El papel de la sílaba en la producción del lenguaje.* [The role of the syllable in speech production]. Unpublished master thesis, University of Barcelona, Spain.

Cutler, A. (1976). Phoneme-monitoring reaction time as a function of preceding intonation contour. *Perception & Psychophysics, 20,* 201–220.

Cutler, A. (1986). Forbear is a homophone: Lexical prosody does not constrain lexical access. *Language and Speech, 29,* 201–220.

Cutler, A. (1990). Exploiting prosodic probabilities in speech segmentation. In G.T.M. Altmann (Ed.). *Cognitive models of speech processing: Psycholinguistic and computational perspectives* (pp. 105–121). Cambridge, MA: MIT Press.

Cutler, A., & Clifton, C. (1984). The use of prosodic information in word recognition. In H. Bouma & D.G. Bouwhuis (Eds.), *Attention and performance X: Control of language processes* (pp. 183–196). Hillsdale, NJ: Lawrence Erlbaum Associates.

Cutler, A., & Foss, D.J. (1977). On the role of sentence stress in sentence processing. *Language and Speech, 20,* 1–10.

Cutler, A., Mehler, J., Norris, D., & Seguí, J. (1983). A language-specific comprehension strategy. *Nature, 304,* 159–160.

Cutler, A., Mehler, J., Norris, D., & Seguí, J. (1986). The syllable's differing role in the segmentation of French and English. *Journal of Memory and Language, 25,* 385–400.

Cutler, A., Mehler, J., Norris, D., & Seguí, J. (1987). Phoneme identification and the lexicon. *Cognitive Psychology, 19,* 141–177.

Cutler, A., & Norris, D.G. (1979). Monitoring sentence comprehension. In W.E. Cooper & E.C. Walker (Eds.), *Sentence processing: Psycholinguistic studies presented to Merrill Garrett* (pp. 113–134). Hillsdale, NJ: Lawrence Erlbaum Associates.

Cutler, A., & Norris, D.G. (1988). The role of strong syllables in segmentation for lexical access. *Journal of Experimental Psychology: Human Perception and Psychophysics, 14,* 113–121.

Dupoux, E., Pallier, C., Sebastián, N., & Mehler, J. (1995). *A distressing deafness in French?* Manuscript submitted for publication.

Foss, D.J., & Blank, M. (1980). Identifying the speech codes. *Cognitive Psychology, 12,* 1–31.

Igoa, J.M. (1995). The relationship between conceptualization and formulation processes in sentece production: Some evidence from Spanish. In M. Carreiras, J.E. García-Albea, & N. Sebastián (*Eds.*) *Language Processing in Spanish.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Klatt, D. (Ed.). (1977). Review of the ARPA speech understanding project. [Special Issue]. *Journal of the Acoustic Society of America, 62(6).*

Klatt, D. (1989). Review of selected models in speech perception. In W.D. Marslen-Wilson (Ed.) *Lexical representation and process.* Cambridge, MA: MIT Press.

Marslen-Wilson, W.D. (1987). Functional parallelism in spoken word recognition. *Cognition, 71,* 71–102.

McClelland, J.L., & Elman, J.L. (1986). The TRACE model of speech perception. *Cognitive Psychology, 18,* 1–86.

Mehler, J., Dommergues, J.Y., Frauenfelder, U., & Seguí, J. (1981) The syllable's role in speech segmentation. *Journal of Verbal Learning and Verbal Behavior, 20,* 298–305.

Morais, J., Kolinsky, R., Cluytens, M. & Pasdeloup, V. (1993). Unidades no reconhecimento da fala em Portugues [Speech recognition units in Portuguese]. *Actas do Primero encontro de processamento da lingua portuguesa.* Lisbon, Portugal: Fundaçao Calouste Gulbenkian.

Newman, J.E., & Dell, G.S. (1978). The phonological nature of phoneme monitoring: A critique of some ambiguity studies. *Journal of Verbal Learning and Verbal Behavior, 17,* 359–374.

Norman, D.A. (1988). *The psychology of everyday things.* New York: Basic Books.

Otake, T., Hatano, G., Cutler, A., & Mehler, J. (1993). Mora or syllable? Speech segmentation in Japanese. *Journal of Memory and Language, 32,* 258–278.

Pallier, C. (1994). *Rôle de la syllabe dans la perception de la parole: Études attentionnelles* [The role of the syllable in speech perception: Attentional studies]. Unpublished doctoral dissertation, École des Hautes Études en Sciences Sociales, Paris, France.

Pallier, C., Sebastián, N., Felguera, T., Christophe, A., & Mehler, J. (1993). Attentional allocation within the syllabic structure of spoken words. *Journal of Memory and Language, 32,* 373–389.

Pitt, M.A., & Samuel, A.G. (1990a). Attentional allocation during speech perception: How fine is the focus? *Journal of Memory and Language, 29,* 611–632.

Pitt, M.A., & Samuel, A.G. (1990b). The use of rhythm in attending to speech. *Journal of Experimental Psychology: Human Perception and Performance, 16,* 564–573.

Rubin, P., Turvey, M.T., & van Gelder, P. (1976). Initial segments are detected faster in spoken words than in non-words. *Perception & Psychophysics, 19,* 394–398.

Sánchez-Casas, R. (1988). *Access representation in visual word recognition.* Unpublished doctoral dissertation, Monash University, Melbourne, Australia.

Savin, H., & Bever, T. (1979). The non-perceptual reality of the phoneme. *Journal of Verbal Learning and Verbal Behavior, 9,* 295–302.

Sebastián, N. (1994). The role of accent in speech perception. *Dokkyo International Review, 7,* 231–248.

Sebastián, N. (1995). *Feet and rhythmic structure perception in Spanish.* Unpublished Manuscript.

Sebastián, N., & Dupoux, E. (1995). *Stress effects in phoneme monitoring: An investigation in Spanish, Catalan, English, and French.* Manuscript submitted for publication.

Sebastián, N., Dupoux, E., & Mehler, J. (1995). *Lexical superiority effects in phoneme monitoring. An investigation in French, Catalan, Spanish, and English.* Manuscript submitted for publication.

Sebastián, N., Dupoux, E., Seguí, J., & Mehler, J. (1992). Contrasting syllabic effects in Catalan and Spanish. *Journal of Memory and Language, 31,* 18–32.

Sebastián, N., & Felguera, T. (1992). Detección de fonemas en ataques y codas silábicos [Phoneme monitoring of syllable's onset and coda]. *Cognitiva, 4,* 173–191.

Seguí, J., Frauenfelder, U., & Mehler, J. (1981). Phoneme monitoring, syllable monitoring and lexical access. *British Journal of Psychology, 72,* 471–477.

Vroomen, J., & de Gelder, B. (in press). Competition in spoken word recognition. Response competition or lateral inhibition? *Journal of Experimental Psychology: Human Perception and Performance.*

Wanner, E., & Gleitman, L. (Eds.). (1982). *Language acquisition: The state of the art.* Cambridge, MA: Cambridge University Press.

Werker, J.F., Gilbert, J.H.V., Humphreys, G.W., & Tees, R.C. (1981). Developmental aspects of cross-language speech perception. *Child Development, 52,* 349–355.

Werker, J.F., & Tees, R.C. (1983). Developmental changes across childhood in the perception of non-native speech sounds. *Canadian Journal of Psychology, 37,* 278–286.

Werker, J.F., & Tees, R.C. (1984). Cross-language speech perception: Evidence for perceptual reorganization during the first year of life. *Infant Behavior and Development, 7,* 49–63.

Zwitserlood, P., Schriefers, H., Lahiri, A., & van Donselaar, W. (1993). The role of syllables in the perception of spoken Dutch. *Journal of Experimental Psychology: Learning, Memory and Cognition, 19,* 260–271.