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Native & non-native perception of casual speech: English & Catalan

Doctoral Dissertation

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Abstract

A fundamental problem concerning speech perception is how listeners transform the acoustic signal into meaningful units and recognize words. Normal speech is often (heavily) affected by common, productive reduction processes, *e.g.,* assimilation, weakening, deletion, etc. Despite this, (native) listeners are easily able to undo the acoustic consequences of these processes and understand the speaker's intended message. This study examines native and non-native processing of casual speech. Research related to the Perceptual Assimilation Model (PAM, *e.g.,* Best, 1995) evidences that listeners tend to assimilate foreign sounds to the closest L1 category and that perception of L2 sounds may be predicted on the basis of how they assimilate to L1 sounds. This study extends the predictions of PAM to the processing of English and Catalan casual speech in native and non-native speakers. Specifically, it examines whether non-natives are better at interpreting the results of common L2 reduction processes that occur in contexts similar to the L1 (same process, same context) than L2 processes which occur in different contexts (same process, different context) or L2 processes which do not occur in the L1 (different process). A highly reduced English sentence, *Is your friend the one that can't go to bed by ten*, and Catalan sentence, *Em sap greu que cap dels dos xicots no em pugui donar un cop de mà*, affected by assimilation, weakening, and deletion, were gated in 80 ms steps as in Shockey (1997, 1998, 2003). Gates were presented to 24 natives (12 English and 12 Catalan) and 24 non-natives (12 Catalan and 12 English) with an advanced command of the language. Responses were examined in terms of successful recognition and "confusions." Results show that non-native speakers exhibit generally lower and later lexical recognition, in addition to greater bottom-up (phonetic processing) than native speakers, both for the English and Catalan data. Moreover, the data bear out that non-natives are generally better at recognizing words affected by reduction processes existing in the L1 in the same context, than those occurring in a different context or not occurring in the L1. Other factors, particularly frequency, were identified as also important. Finally, the results are considered in terms of relevant issues in speech processing modeling.

Resumen

Un aspecto fundamental en la percepción del habla es cómo se transforma la señal acústica en unidades significativas y se reconocen palabras. El habla coloquial se ve frecuentemente afectada por procesos de reducción fonética que son comunes y productivos, p.e., asimilación, lenición, elisión, etc. Los oyentes (nativos), sin embargo, pueden reconocer fácilmente las consecuencias acústicas de estos procesos y entender el mensaje del hablante. Este estudio examina el procesamiento del habla informal por parte de nativos y no nativos. Estudios sobre el Modelo de Asimilación Perceptivo ('Perceptual Assimilation Model,' p.e., Best, 1995) muestran que los hablantes tienden a asimilar los sonidos de una lengua extranjera (L2) a la categoría más próxima en su lengua materna (L1) y que la percepción de los sonidos de la L2 se puede predecir en base a cómo se asimilan a los sonidos de la L1. Este estudio elabora las predicciones de PAM y las extiende al procesamiento del habla coloquial en inglés y catalán por parte de hablantes nativos y no-nativos. En particular, examina si los hablantes no nativos tienen más facilidad para interpretar los procesos de reducción en la L2 que también se dan en su lengua (L1) en contextos parecidos (mismo proceso, mismo contexto), que procesos que se dan en contextos distintos (mismo proceso, contexto distinto) o procesos de la L2 que no ocurren en la L1 (proceso distinto). Con este objetivo, una frase en inglés, *Is your friend the one that can't go to bed by ten*, y una frase en catalán, *Em sap greu que cap del dos xicots no em pugui donar un cop de mà*, que presentaban diversos casos de asimilación, lenición y elisión, fueron segmentadas en fragmentos de 80 ms como en Shockey (1997, 1998, 2003). Los fragmentos se presentaron a 24 hablantes nativos (12 ingleses y 12 catalanes), y 24 no nativos (12 catalanes y 12 ingleses) con un nivel avanzado de la L2. Las respuestas se analizaron en función del reconocimiento de palabras y de las "confusiones." Los resultados muestran que los hablantes no nativos presentan porcentajes de reconocimiento de palabras más bajos y el reconocimiento ocurre más tarde en general, además de más procesamiento de abajo hacia arriba ('bottom-up' o procesamiento fonético), tanto para los datos del inglés como del catalán. Los resultados también muestran que los no nativos son mejores a la hora de reconocer palabras reducidas por procesos existentes en la L1 en el mismo contexto, que por procesos que se dan en un contexto distinto o por procesos que no se dan en la L1. También se han identificado otros factores importantes en el reconocimiento del habla reducida, en particular factores relacionados con la frecuencia.

Por último, se considera cómo los resultados contribuyen a la modelización del procesamiento del habla.

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1 INTRODUCTION

How do we perceive and process speech? This is the big question faced by speech perception researchers. How exactly do individuals transform the acoustic signal produced by any given speaker into a meaningful message? It is well known that the acoustic stream is highly variable and may be affected by a number of factors, including those stemming from the individual speaker (*e.g.*, sex of the speaker; dialectal, prosodic and rate differences, etc.) and/or from the context in which the speaker is talking (*e.g.*, pragmatic or environmental, such as, noise). No two words, no two sounds for that matter, uttered by even a single speaker show the exact same acoustic properties. This theoretically makes identifying the signal and its sub-components difficult. But to understand speech we not only have to recognize sounds, we have to break up the continuous stream into meaningful bits of information. Segmentation and word recognition is, in principle, an extremely challenging task. An oft-used metaphor is that speech is unlike written words on the page. The speech signal is continuous and does not have beginnings and endings clearly marked for the listener. Yet, listeners are routinely able to overcome the potential difficulty posed by the continuous flow of speech and all the variability that may occur in order to successfully segment the speech signal and recover the message.

It is generally held that perceiving speech in a second language (L2) is not the same as perceiving speech in one's mother tongue (L1), that is, it is not typically as effortless. Research on cross-language speech perception underscores that perceptual attunement to the L2 requires active effort and language use (*e.g.*, Flege and Liu, 2001; MacKain, Best and Strange, 1981), as well as robust exposure and training over time. Thus, perceiving speech in a second language is not inherent, but a skill that must be learned. This is attested in the number of models that have been proposed which aim to account for how individuals perceive a second language, *e.g.*, the Perceptual Assimilation Model (Best, 1993, 1994a, 1994b, 1995; Best, McRoberts and Sithole, 1988), and particularly how their perception evolves over time, *e.g.*, the Speech Learning Model (Flege, 1995, 1999, 2002) and the Native Language Magnet Model (Kuhl, 1992, 1993a, 1993b, 1994, 2000; Kuhl and Iverson, 1995). These models however tend to focus on perception of very basic units—individual phonemes. But, understanding spoken language or even short strings of phonemes in context is much more complex than identifying phones in isolation.

This study aims to explore the fundamental problem of how listeners process speech. More specifically, this study analyzes how natives and learners segment highly coarticulated, reduced speech and recognize words. Since it is assumed that natives' and learners' processing is different, we strive to ascertain whether ease of processing is related to similarities between L2 and the native language, as suggested by models of L2 perception. To test these predictions, natural English and Catalan sentences, composed of frequent vocabulary and presenting a number of common, productive reduction processes, were gated in 80 ms steps in the manner of Shockey (1997, 1998, 2003). These gates were presented to natives and learners with an intermediate to advanced command of the language. Their responses were analyzed to create and compare timelines of individual as well as cumulative recognition for native and non-natives for each lexical item.

The languages considered in this dissertation are English and Catalan. Though the two come from different language families and are classified differently in terms of their rhythmic structures—English is labeled a stress-timed language, while Catalan is generally viewed as a syllable-timed language—both show strong vowel reduction and feature a relatively similar phoneme inventory. The balance of similarities and dissimilarities is believed to make for an interesting comparison of native versus non-native processing.

The questions addressed in this study are relevant not only to the current debate on cross-language speech perception and modeling, but also to the debate on certain issues in spoken word perception modeling, for example, there is empirical evidence pertinent to a number of topics such as the direction in which information is processed (bottom-up only *vs.* bottom-up and top-down), goodness-of-fit, constraints on segmentation, how segmentation may be conducted (lexically *vs.* sequentially), and whether or not an intermediate prelexical interface is necessary.

The dissertation is structured as follows. The rest of this chapter focuses on background information relevant to concepts under analysis in the study. Section 1.1 provides a review of relevant theoretical literature concerning speech perception and connected speech processing. Section 1.2 gives special attention to cross-linguistic speech perception modeling, while section 1.3 focuses on general spoken word recognition models. Chapter 2 then details the present study and the methodological procedures. Chapters 3 and 4 provide the results for English and Catalan respectively and chapter 5 compares these results. Chapter 6 discusses observations of the data and chapter 7 offers some concluding remarks. All references and appendices are included at the end.

1.1 Speech Perception

1.1.1 General Speech Perception

Generally speaking, understanding spoken language may be described as a process of extracting acoustic cues from the speech signal and mapping them onto stored linguistic representations. Difficulties in doing so may stem mainly from two sources: the language itself or the speaker. The language itself may pose problems because an inexperienced listener may not know how to interpret language-specific cues, or problems may arise from a listener's long-term phonological representations in the L2 differing from those of a native speaker. Difficulties may be incurred by the speaker if he/she has produced such a degraded acoustic signal it is unintelligible to the listener. Impediments to perception related to language or variety-specific properties are clearly more of an obstacle to non-natives, while speaker-related variations may be detrimental for any listener depending on how extreme they are.

Language as a system exploits the use of contrasting sounds strung together to form words, which grouped in particular orders communicate a larger message. As the contrasting sounds utilized vary from language to language, it is logical that a listener, be it a baby learning its mother tongue or a student learning a second language, must learn which contrasts are important in the language (*i.e.*, the phoneme inventory along with possible allophonic realizations) and how they are indicated in that language. It is generally held that the sounds of language are replete with multiple, redundant phonetic cues (duration, spectral features, periodicity, noise, intensity, etc.), which contribute to making verbal communication a maximally efficient task. If some cues to contrast are lost in degraded speaking conditions or reduced speech or they are somehow not picked up by the listener, others serve as back-ups to secure transmission of the utterance (Pisoni & Lively, 1995).

Cues and their hierarchy of relevance as to segments' identities differ cross-linguistically; therefore, the cues that speakers attend to, or prioritize (often called *cue-weighting*), make for a relevant issue to speech perception and language acquisition. For example, Iverson *et al* (2003) examined acoustic cue use in English /ra/ and /la/ categorization by Japanese, German and American adults and found that Germans were highly sensitive to the same cues that Americans were, namely differences in F3, while Japanese listeners showed greatest sensitivity to F2, which is not used by natives to discriminate this contrast. Other research involving vowel discrimination has shown that in differentiating between American English /iː/ (tense) and /ɪ/ (lax), Mandarin Chinese learners rely on temporal (durational) differences rather than spectral information (Bohn, 1995; Flege, Bohn, & Jang, 1997), while natives were shown to rely on both (Bohn & Flege, 1990). Related research on Catalan perception of a General American English /iː/ (tense) - /ɪ/ (lax) - /e/ (lax) continuum (Cebrian, 2006) evidenced that Catalan speakers also routinely depended on temporal cues in contrast to natives[1]. Thus, differences in phoneme perception between L1 and L2 listeners may be explained by L2 listeners not prioritizing cues to contrast in the same way as L1 listeners or they may be processing L2 speech through a "filter," using, most likely, an L1-appropriate hierarchy of cues when possible. Hence, perceptual attunement to the L2 may be said to require language-specific prioritization of acoustic cues.

It may be expected that learning to perceive contrasts in a second language will take time; but, when learning a language, not all feature contrasts are necessarily unfamiliar. Some features may be familiar, but not occur in the same segmental context

[1] In this study however, in slight contrast to the early work by Bohn & Flege on American English speakers, Canadian English speakers were seen to rely most on vowel quality (spectral) differences.

as in the L1, thus requiring active (re)assessment of the implications of the contrast, which also takes time. For example, English-speaking students required five years of Hindi instruction to learn a new L2 contrast—the unfamiliar dental-retroflex place contrast—and up to a full year to correctly perceive certain L2 voicing contrasts (breathy *vs*. voiceless aspirated stops) (Tees & Werker, 1984). Though voicing contrasts exist in English obstruents, students needed time to correctly perceive breathy and voiceless aspirated stops.

One way to improve perception is by providing variability in the training of unfamiliar contrasts. It appears that listeners encode very detailed talker-specific information in long term memory, which later helps them to recognize novel words spoken by familiar voices and which may be used to generalize to unfamiliar voices. Findings in this area (Pisoni and Lively, 1995; Bradlow, Akahane-Yamada, Pisoni, and Tohkura, 1999) demonstrate learners' long-term retention of L2 phonetic categories and support that the more varied the perceptual input during training, the more successful learners may be.

But sometimes mere exposure is not enough. Experience, that is, the combination of exposure and active use, makes the difference. Indeed, a number of studies have shown that greater experience yields better discrimination of L2 sound contrasts. A study testing Chinese ESL learners' identification of English /b, d, g, p, t, k/ in final position, a context where obstruents do not usually occur in Chinese, thus yielding a new L2 contrast, found that participants with a longer length of residence (LOR) in an English-speaking environment achieved higher, but not nativelike, scores than those with a shorter length of residence. And, more importantly, participants with a non-student worker status achieved higher scores than those with student status (Flege & Liu, 2001). Non-student workers presumably were required to actively use their

English, likely in a variety of contexts, while students may have had more passive language contact: attending class lectures likely requires more listening than speaking, as the authors suggest that performance in this study was linked to how substantial the learners' input was over time. Thus, though length of stay, or exposure, in an L2-speaking environment can improve perception, it is active language-use that is critically important. The importance of language-use is further supported by a study on the unfamiliar [ɹɑ-lɑ] English contrast with Japanese ESL learners which found that students with greater experience as a result of intensive conversational-type instruction were better at perceptually distinguishing the contrast than those students with less experience (MacKain, Best & Strange, 1981).

Understanding a language's basic sound contrasts and the variation in the realization of phonemes that may occur due to context or other factors is basic for non-native listeners. There are many other features however that differ from language to language that learners must be aware of. Phonotactics, or permissible strings of sounds in a language, plays an important role because it limits which phonemes may appear in the company of others. Awareness of transitional frequency, or the probability of sounds following one another, and prosodic factors, among others, is also significant. Both phonotactics and transitional frequency will be considered further in relation to prelexical accounts of segmentation in section 1.3.2.1.

Speakers exert great control over the way they talk including the amount of effort expended on producing clear speech, which depends on the listener and the context. As a favor for the listener, speakers may manipulate speech in regard to: structural constraints, for example by using predictable over marked word order; prosody, by highlighting new or difficult information with emphatic stress for example; their speech rate and volume; as well as vocabulary, by using more rather than less frequent words, when they speak. In addition to these choices, speakers may also manipulate phonetic reduction. Across speech rates and contexts, it has been found that speakers will show less reduction for words that are less predictable from the sentential context than for the same words in a more predictable context (Lieberman, 1963). Frequency may also affect speakers' amount of reduction on particular lemmas, that is, words that have the same gloss in the dictionary but have different meanings or grammatical functions. For example, Jurafsky, Bell & Girand, (2002), using a corpus-based methodology with a focus on lexical frequency effects, found that the phonologically-realized form of the different lemmas of TO (as an infinitive marker *vs.* a preposition/particle), THAT (as a pronoun, complement, relative pronoun, determiner, or part of an idiom *vs.* an intensifier), and OF (as the complement of a verb/preposition *vs.* a partitive) varied as a function of frequency. Along the same lines, Johnson (2007), using the VIC Corpus (*Variation in Conversation*) (Pitt *et al*, 1995) reports differences in the pronunciation of homophones (*e.g.*, RIGHT *vs.* WRITE) also related to frequency.

Therefore, there exist a number of features of speech, both language-dependent, speaker-dependent, and context-dependent, that listeners, both native and non-native, must deal with in order to analyze and understand the acoustic signal.

1.1.2 Describing Connected Speech

In natural speech, sounds typically do not occur in isolation. Sounds occur in planned groups or words. Because articulation of speech is so fast, it is natural that phonemes have some effect upon their neighbors, resulting in extreme coarticulation and reduction. The degree to which reduction processes take place is to a certain extent under the control of the speaker. Though the speaker is generally sympathetic to the listener and will make efforts to adjust speech so that it may be more easily processed, when the situation does not demand clear speech, either because the situation is more informal, there is a great deal of shared information, or the environmental conditions are non-detrimental (*i.e.*, not noisy), ease of articulation may prevail over complete articulatory accuracy and perceptual distinctiveness. As a consequence, speech may be considerably reduced.

The "deviations" that occur in fluent speech may occur due to variations in prosodic context, speech rate and style, as well as lexical frequency, issues which have already been touched upon. There are different ways to describe highly-coarticulated, phonetically-reduced speech. Two sets of description are Articulatory Phonology (AP) (Browman and Goldstein, 1986, 1989, 1990, 1992) and traditional Featural Phonology (FP).

Within Articulatory Phonology, reduction processes are modeled in terms of *reduction* of gestures (weakening and elision processes) and gestural *overlap* (assimilation and elision processes). The consequences of gestural reduction and overlap depend on whether consecutive gestures are realized on the same or different articulatory tiers, that is, whether the gestures involve independent articulators (different tiers) or not (the same tier). Across separate tiers, for example the tongue tip and the lips, the gestures may be executed relatively independently and not perturb one another's trajectories. In fast speech, however, gestures for independent articulators may overlap in time due to time constraints leading to 1) the *hiding* of gestures possibly leaving no local acoustic evidence (*elision* in FP) or 2) the (perceptual) assimilation of gestures. Examples of overlapped gestures are the combination /stb/ in MUST BE, where the tongue tip movement for the [t] towards the alveolar ridge and back again may overlap with and occur during the lip closure for the bilabial [b] gesture, leaving no acoustic trace of the [t] (/stb/ > [sb]) (Browman & Goldstein, 1990: 360), and the /np/ in SEVEN PLUS SEVEN, where reduction in magnitude for the alveolar [n] and overlapping movements for the labial [p] may lead to the percept of a labial nasal, thus [np] is heard as assimilated [mp] (366).

Within tiers, gestures cannot overlap in time without perturbing each other because the same vocal tract variables or articulators receive programming instructions for different targets. Time constraints determine the degree of overlap. Holst & Nolan (1995: 325) have schematized a potential continuum of increasing overlap (*assimilation* in FP) under the AP view, seen in Figure 1 below. Type A represents two separate, stable patterns of energy for [s] and [ʃ] and shows no assimilation. Types B and C show "gliding" between a more [s]-like and a more [ʃ]-like energy distribution, the connecting line sloping downward represents the transition between the two. B represents a stable portion of [s]-like energy at the onset of friction, while C shows the transition to [ʃ] beginning immediately. In both cases, the gestures overlap in time, as schematized at the bottom of the figure. D shows a single period of friction, with the acoustic features of two overlapped gestures.

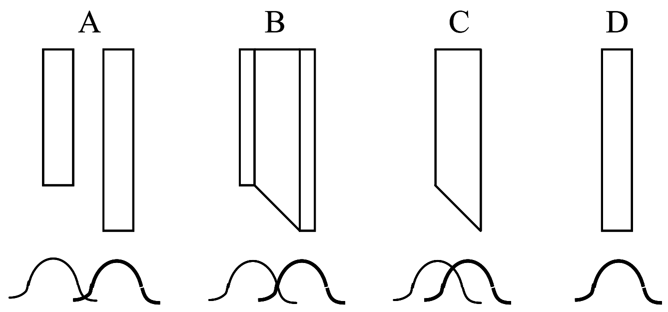

Figure 1: Schematic of Holst & Nolan's (1995) an Articulatory Phonology view of assimilation. Increasing degrees of overlap in time of [s] and [ʃ] gestures, represented by the thin and thick curves respectively, are associated with the schematic spectral patterns A-D. The fricative event is predicted to become progressively shorter as overlap increases (325).

Featural Phonology is a highly abstract description which uses tiers, nodes and feature values to describe processes such as assimilation, insertion, elision, and lenition. Articulatory Phonology is a more phonetic-based description, in which casual speech processes are accounted for in terms of reduction in the magnitude of individual gestures (in both time and space) and increased overlap among gestures (Browman & Goldstein, 1989). Reduction processes or casual speech processes may be accounted for using both views. There are some advantages of AP over FP to account for gradient reduction processes such as those exemplified in types B and C in Figure 1. However, as Holst & Nolan (1995) point out, Articulatory Phonology makes predictions that critically fail to be supported by their data, particularly in the case of type D, Figure 1. In the case of two completely overlapping gestures (C_1 and C_2) on the same tier, AP predicts an intermediate articulation, showing acoustic properties intermediate between a "canonical" C_1 and a "canonical" C_2; yet, this fails to be supported by Holst & Nolan's [sʃ] spectral data, which instead show properties of a "canonical" C_2, *i.e.*, full assimilation to C_2. Therefore, in some cases, traditional methods of description seem to provide a cleaner interpretation of the reduction at hand.

1.1.3 Connected Speech Perception

Reduction processes induce a good deal of variability in the signal, yet connected speech perception is usually as instantaneous and effortless as clear speech perception. Hence, the experienced listener is tolerant of variation. However, because the contexts where processes occur as well as their acoustic outcomes are language-specific, not all deviations from clear speech are acceptable for listeners. Several studies have evidenced that a mismatch between the acoustic input and the listener's lexical representation can cause a breakdown in the process of speech perception (Marslen-Wilson & Zwitserlood, 1989; Marslen-Wilson & Gaskell, 1992; Marslen-Wilson, 1993). For example, in a cross-modal priming study (Gaskell & Marslen-Wilson, 1996), it was found that the assimilated form of the English word LEAN in a phonologically legal context (*e.g.*, Sandra only eats LEAN [ˈliːm] bacon) facilitated lexical decision in response to the presentation of the visual form, LEAN, as strongly as the unassimilated prime. However, assimilated LEAN in an illegal context (*e.g.*, Sandra only eats LEAN [ˈliːm] gammon) eliminated any facilitation. Therefore, listeners are tolerant of predictable changes in reduced and coarticulated speech, that is, those that are deemed phonologically legal. In the case of illegal changes, the wider context (as opposed to segmental context) is necessary to backtrack and decipher the intended meaning (Coenen, Zwitserlood & Bölte, 2001).

For experienced listeners then, predictable variation does not cause a breakdown in perception; instead, it may actually aid perception by providing clues to upcoming material. For example, in a phoneme monitoring experiment, Gow (2001) found that in sequences showing no regressive assimilation, *e.g.,* TEN [ten] BUNS, versus appropriate (or legal) assimilation, *e.g.,* [tem] BUNS, and inappropriate (or illegal) assimilation, *e.g.*, [teŋ] BUNS, listeners were fastest at identifying the labial of BUNS in sequences which showed legal assimilation. Thus, listeners were able to use the assimilation to their advantage to predict the following segment, making its recognition easier.

What a listener accepts as legal or illegal variation is critically important in the perception of speech, and even more so in perception of a second or foreign language, since the type of connected speech process (*e.g.*, place assimilation in the examples above), the input (*e.g.*, alveolar /n/) and the context (*e.g.*, a following obstruent) may differ from language to language. In an experiment conducted by Shockey (1997, 1998, 2003), using the gating technique[2] with reduced, connected speech, the test sentence: *The screen play didn't resemble the book at all*, [ðəˈskɹĩmpʰlɛɪdɪᵈn̩ɹizɛ̃mbɫ̩ðəˈbʊkətˈɔɫ][3], was presented in 50ms bits or gates to sixteen native British English speakers and sixteen Hong Kong teachers of English (native speakers of Cantonese). That is to say, in the first gate, informants were presented with the sentence up to the middle of the word SCREEN. With each new token, participants heard all previously presented acoustic information with an additional 50ms of new information, until the final token, when they heard the sentence in its entirety. The results were that thirteen out of sixteen natives eventually arrived at a correct interpretation of the test sentence; however, none of the sixteen Hong Kong teachers that formed the test group reported hearing the correct sentence or any grammatical sentence at all. Though the non-natives included a great deal of correct phonetic information in their responses, and even identified most word boundaries correctly, they were unable to identify the cases of reduction and backtrack in order to arrive at the intended form.

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[2] The gating technique involves segmenting the stimulus according to a set length of time, the results of which are called *gates*. Subjects are presented with the stimulus gate by gate, so that there is a progression in the amount of information available.

[3] Shockey's (2003) transcription.

1.2 Cross-language Speech Perception Models

A number of theoretical cross-language speech perception models have been postulated to account for how second-language listeners process speech. Three of them, the Perceptual Assimilation Model (PAM) (Best 1993, 1994a, 1994b, 1995; Best, McRoberts and Sithole, 1988), the Speech Learning Model (SLM) (1995, 1999, 2002), and the Native Language Magnet Model (NLM) (Kuhl, 1992, 1993a, 1993b, 1994, 2000; Kuhl and Iverson, 1995) share a number of underlying assumptions. All three focus on how the L1 phonological system shapes or influences L2 perception. In each, L1 and L2 sounds are seen to share a common phonological space. L1 forms a filter through which second language speech or, more specifically, L2 sound contrasts are processed. Because of this, phonetic similarity of the L2 to the L1 plays an important role as to how L2 segments are categorized in the phonetic space. L2 experience is also important, particularly in new category development. New category development is possible because the processes and mechanisms which were used to learn L1 are viewed as available for L2 acquisition.

1.2.1 Perceptual Assimilation Model

The Perceptual Assimilation Model (PAM) (Best 1993, 1994a, 1994b, 1995; Best, McRoberts and Sithole, 1988) is a model which focuses on how naïve listeners (*i.e.*, monolinguals) perceive phones in a second language. Perception or discrimination of L2 contrasts in this model may be predicted based on how they assimilate to L1 sounds. Learning does not play a role in this model.

According to PAM, listeners tend to assimilate non-native sounds which are similar to L1 sounds to L1 phoneme categories, assigning them to the nearest matching phonetic category, that is to say, the category to which they are phonetically most similar. L2 sounds which fall between L1 categories are heard as "uncategorizable," while sounds which are assimilated as non-speech sounds, *e.g.*, choking, are not assimilated to the phonological space at all.

The predictions of PAM in terms of L2 contrasts are the following (Best, 1995). It is predicted that discrimination should be excellent when each L2 phone is assimilated to a different L2 category (Two-Category Assimilation (TC Type)). Discrimination should be moderate to good when the two L2 sounds are assimilated to the same L1 category, though they differ in the degree to which they deviate from the native ideal exemplar (Category-Goodness Difference (CG Type)). Discrimination is predicted to be poor (though above chance) when the two L2 sounds are assimilated to the same L1 category, though they deviate equally from the native ideal exemplar (Single-Category Assimilation (SC Type)). Discrimination is expected to show a range of poor to good when the L2 contrasts are heard as speech sounds, but fall outside of any particular L1 category. In this case, success in discrimination depends on the similarity of the L2 sounds with respect to each other and with respect to L1 categories (Both Uncategorizable (UU Type)). Discrimination is predicted to be very good when one sound in the L2 pair is assimilated to an L1 category, while the other is heard as a speech sound that cannot be assimilated to any native category (Uncategorized versus Categorized (UC Type)). And, finally, discrimination is predicted to be good to very good when both L2 sounds are heard as non-speech sounds (Nonassimilable (NA Type)).

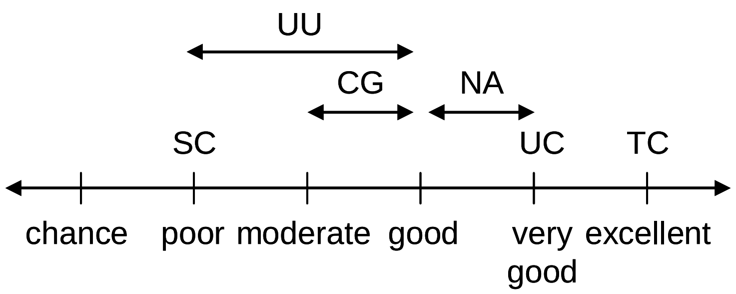

Figure 2 : Best's Perceptual Assimilation Model predictions.

There is a good deal of research in line with the model which supports the idea that not all non-native segmental contrasts are equally difficult to perceive. Some are perceived moderately well and others at nativelike levels (*e.g.,* Best, Hallé, Bohn, and Faber, 2003; Best, McRoberts, & Goodell, 2001; Best, Traill, Carter, Harrison, and Faber, 2003; Kochetov, 2004; among others). Moreover, a number of studies support that the relative degree of difficulty is a function of the native language (*e.g.*, Best, Hallé *et al*, 2003; Best & Strange, 1992; Flege, 1989; Hallé, Best, & Levitt, 1999, among others)—the more foreign a contrast is, often the easier it is to discriminate (Best *et al*, 2003).

1.2.2 Speech Learning Model

The Speech Learning Model (SLM) (1995, 1999, 2002) is a comprehensive model which attempts to account for how individuals, typically fluent bilinguals, learn to perceive and produce phonemes in a foreign language. Learning in this model is seen as a process of evolution over time. This evolution is influenced by input and experience and is guided by representations stored in the learner's long term memory.

As regards perception, the SLM's basic hypotheses (H) (Flege, 1995) are the following. First, L1 and L2 sounds are viewed as perceptually related to each other on a position-sensitive allophonic level (H1). New phonetic categories can be established for L2 sounds which differ from L1 sounds (H2). The more an L2 sound is perceived to be dissimilar from L1 sounds, the more likely it is that a new perceptual category will be formed (H3). The likelihood of category formation is a function of the learner's age of arrival (AOA). The older the learner, the less probable it is that phonetic differences between L1 and L2 sounds and between L2 sounds that are not contrastive in L1 will be perceived (H4). When new categories are not formed, L2 sounds are likely assimilated to an existing L1 category, forming an L1-L2 category merger (H5). Categories may also be dissimilated in the effort to maintain contrast, thus a bilingual's categories may not be the same as a monolingual's (H6). Notably, dissimilarity is viewed on a continuum (as of 1994), rather than as concretely "identical," "similar" or "new."

Research in line with the SLM's hypotheses has supported the idea of learners' *equivalence classification*. For example, if an L2 sound is heard as equivalent to an L1 sound, then it is assimilated to an existing L1 category and the formation of a new category in the L2 is impeded. This is particularly true in the case of bilinguals (Flege, 1987). In the event that a new category is created for an L2 sound, it will then be dissimilated from the nearest L1 category (Flege & Eefting, 1986, 1987). As mentioned earlier, children are more likely to form new categories than adults; however, the capacity to form new categories is retained by adults. The formation of new categories for L2 sounds is crucial, since it is believed to be a requirement for successful L2 perception, which in turn is believed to be a requirement for successful L2 production. In line with the age issue, research has underscored that AOA in a country, or the point at which a second language begins to be actively used by a bilingual, is influential. Later AOA tends to affect perception more heavily (*e.g.*, MacKay, Meador, and Flege, 2001; Flege, MacKay, and Meador, 1999), though many late bilinguals attain high levels of proficiency (*e.g.*, Flege and MacKay, 2004; MacKay, Flege, Piske and Schirru, 2001) and early bilinguals may not develop underlying perceptual systems identical to native monolinguals (Højen and Flege, 2006; Flege and MacKay, 2004).

1.2.3 Native Language Magnet Model

The Native Language Magnet Model (NLM) (Kuhl, 1992, 1993a, 1993b, 1994, 2000; Kuhl and Iverson, 1995) was conceived under the assumption that language exposure may cause changes in the phonological space. It was originally developed to explain the observation that infants progress through general-language perception to more refined language-specific perception by the end of the first year of life. Though the model was created to explain early L1 acquisition, it may be extended to account for how listeners deal with L2 (adult) discrimination.

Working off a traditional view of prototype-based classification, each instance of a phoneme heard is stored as an exemplar. Through early development, categories are formed by the best exemplars (the ideals or prototypes) becoming a phonetic reference. The notion is that, through a magnet-like effect, the prototypes attract other similar exemplars, causing a warping of the perceptual space near category centers. All new instances of sound are then classified according to the existing prototype categories. In this way, each prototype has a specific neighborhood of reference, which may be developed by as early as six months of age (Kuhl, Stevens, Hayashi, Deguchi, Kiritani, and Iverson, 2006). This neighborhood of reference is continually being updated as new exemplars are heard.

Like the other models, the NLM hypothesizes that degree of difficulty in discriminating L2 sound contrasts increases as similarity to L1 sounds increases. In this model, this idea is defined as the *proximity principle*. According to Kuhl, (1991), it is predicted that more prototypical exemplars of a phonetic category should show lower discrimination accuracy than less prototypical exemplars. Though the idea of a phonetic prototype functioning as a perceptual magnet is elegant, some researchers have challenged the explanatory power of the postulated phonetic prototype (*e.g.,* Lively and

Pisoni, 1997; Lacerda, 1995). Despite this, it is indisputable that early language experience affects low-level language processing and that the phonological space is to some degree (if not completely) moldable later in life.

1.3 Spoken Word Recognition Models

1.3.1 Theories & Models of Lexical Access

There are a number of central issues in the current debate on modeling lexical access in speech processing. In terms of speech perception, lexical access refers to phonological processing: how we locate word-form representations, consistent with a given input, from the mental lexicon. Issues related to the debate include what is the best type and architecture of the model. This relates to the permitted direction of flow of information, as well as to the way in which segmentation is accounted for. Models such as TRACE (McClelland & Elman, 1986), Shortlist (Norris, 1994), Merge (Norris, McQueen & Cutler, 2000), and the Distributed Cohort Model (Gaskell & Marslen-Wilson, 1997; Gaskell & Marslen-Wilson, 1999) are all connectionist models, which attempt to understand neural information processing, and may be used to illustrate the main concepts related to word recognition in speech processing.

One of the most fervent debates in the field is focused on the way information flows through the network and whether or not levels may communicate or influence decision-making on other levels. TRACE (McClelland & Elman, 1986), which functions as an interactive-activation simulation, is set up according to a parallel distributed system. Simulated neural connections are distributed in parallel among serial pathways, which are engaged in different types of processing conducted via excitatory and inhibitory interactions among a large number of simple processing units. TRACE functions on three levels: feature, phoneme and word. As the signal is received, feature units are activated. The degree of activation is a reflection of the strength of the unit's *hypothesis* (McClelland & Elman, 1986) as to the identity of the signal. As units exceed their thresholds, activation begins to spread. Since TRACE permits bidirectional information flow, activation is continually being updated: units which share hypotheses are mutually excitatory, while units which show a mismatch in their hypotheses are mutually inhibitory. Once a pattern of features has achieved strong enough activation, it triggers phoneme activation. Upon the activation of a phoneme, all lexical items consistent with the phoneme receive activation at the word level and enter into competition. As more acoustic information is input, items which maintain a match dominate, while those which show a mismatch enter into decay. In the event of a lack of a one-to-one phoneme/word match, *e.g.*, due to noise in the signal, final selection is carried out through goodness-of-fit.

TRACE attempts to conduct word recognition in a coordinated progression, moving from feature to phoneme to the word level (bottom-up), sending feedback (top-down information) whenever necessary to make adjustments; thus, communication is encouraged between levels, allowing higher levels the possibility of influencing decisions on lower levels. In this manner, all information and knowledge available to the listener from a variety of sources (bottom-up and top-down) may be accessed and incorporated into any stage of processing. For example, if a particular feature pattern, activated by the input, does not show a one-to-one match with a phoneme, the phoneme is instead selected by closeness-of-fit with a canonical phoneme pattern which is then imposed onto the feature level. The same may also happen across the phoneme and word levels. If an impossible string of phonemes becomes activated, that is, a string that shows no one-to-one match with any lexical item, *e.g.*, */ʃteɪl/, the closest representation, /steɪl/, STALE, would dominate competition on the word level and impose itself, specifically impose the /s/, back onto the phoneme level. Negotiation therefore takes place bidirectionally regarding the feature patterns activated by the acoustic input and what is recognizable by the lexicon.

Shortlist (Norris, 1994), similar to TRACE, is a competition-driven model; but, unlike TRACE, processing is described as autonomous rather than interactive. Interactive models allow for the type of bidirectional (bottom-up/top-down) information flow described in the *SHTALE/STALE example. Autonomous models instead allow only unidirectional or serial information to flow in a feed-forward manner, that is, bottom-up only. As illustrated schematically in Figure 3, the output of stage one becomes the input for stage two and so on. There is no negotiation between higher levels with lower levels, in other words, there is no feedback or backtracking.

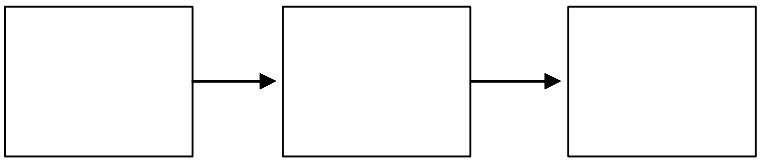

Figure 3: Schematic of serial or autonomous processing.

Given that Shortlist processes unidirectionally, it must rely heavily on low-level phonological cues and statistical strategies. For example the Metrical Segmentation Strategy (MSS) is a strategy for parsing the signal and looking for words. Formally, the MSS states that strong syllables, or syllables that receive greater prominence, are privileged points for hypothesizing word boundaries and initiating lexical searches (Cutler & Norris, 1988). In languages like English, where word-initial syllables are typically stressed, or Dutch, for example, this strategy appears to hold true; however, research on other languages such as French, Spanish, Catalan or Japanese, has suggested that applying a metric based on stress-timing is not useful. This issue is to be explored further in later sections. A second strategy associated with Shortlist is the Possible Word Constraint (PWC), which incorporates lexical knowledge and serves to limit segmentation such that all parsed input must form an acceptable word (Norris, McQueen, Cutler & Butterfield, 1997). The sequence [ənˈdʒɔɪəbl̩ˈoʊvəɹɪnˈdʌldʒəns][4] may initially lead to the activation of ENJOY, ENJOYABLE, JOY, BELOW, OVER, IN, OVER-INDULGENCE, INDULGENCE, DULL, etc; however, the PWC would constrain the parsing of the signal to ENJOYABLE OVER-INDULGENCE, simply because all other parses fail to account for the totality of acoustic information present (McQueen, 1998:22). Though the PWC is a logical constraint, it does not clearly address how ambiguity may be resolved in strings with multiple potential parses, for example, [ˈlesn̩ˈsevn̩] could be segmented as LESSON SEVEN or LESS THAN SEVEN (Lindblom, 1988) or [ˈtreɪdr̩] as TRAITOR/TRADER (in American English) or TRADE HER for example.

While Shortlist attempts to account for normal word recognition, Merge (Norris, McQueen & Cutler, 2000), its updated extension, aims to explain how listeners access and incorporate prelexical information in recognition. The most outspoken assertion associated with Merge is that feedback is never necessary in lexical access (Norris *et al*, 2000). Therefore, Merge is conceived as a completely autonomous, feed-forward component. It does however allow for the merging of information, hence the name, from lower-level input phoneme and lexical nodes to finalize selection in the phoneme decision-making nodes, see Figure 4. The idea is that the more solid and well-analyzed the information taken directly from the acoustic signal is, the more accurate recognition will be. Some researchers however have called into question whether or not Merge is truly autonomous. Though there are no feedback loops built into the architecture, see Figure 4, there is communication between lexical and phonemic knowledge. In the

[4] Standard IPA symbols have been used for all transcriptions made by the author. At times certain combinations of symbols were used over others to provide better descriptions of the sounds in American English. For example, the vowel in GO has been transcribed with the symbols /oʊ/ rather than /əʊ/.

example schematized in Figure 4, given [dʒɒ], /b/ and /g/ would dominate /v/ and /z/ for selection because of an existing lexical match (JOB and JOG).

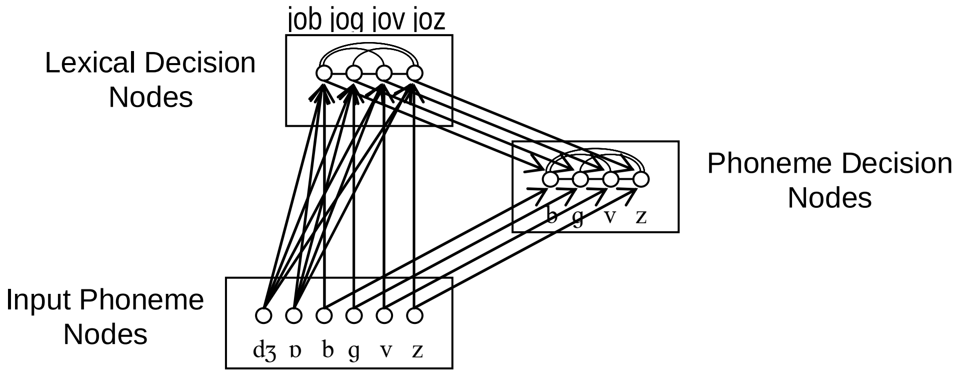

Figure 4: Schematic of the architecture of Merge (Norris *et al*, 2000).

The last model to be described is the Distributed Cohort Model (DCM) (Gaskell & Marslen-Wilson, 1997; Gaskell & Marslen-Wilson, 1999), another bidirectional, parallel distributed processing model, like TRACE. One of the ways the DCM differs from TRACE, however, and also from Shortlist, is that the Distributed Cohort Model includes no word nodes (or the equivalent); thus, it is distributed at the word level. Lexical access is conducted via activation of the semantic and phonological output nodes, see Figure 5, each of which is placed on a separate dimension of a multi-dimensional space. The model has a less hierarchical structure than other models, like TRACE, for example, which starts with a feature-level representation, then moves to the phoneme level, then later to the word level. Here the acoustic signal is directly mapped onto both phonological and semantic lexical representations without an initial (categorical) labeling stage in terms of features or phonemes, making it better able to preserve subphonemic detail via relatively abstract representations throughout the entirety of lexical access rather than compounding information into larger sublexical units. Such abstraction has advantages and disadvantages. Though it promises great accommodation of variation as a consequence of connected speech processes, it leads directly to the model's intolerance of random deviations in phonological form. As a consequence, strings initially perceived as non-words are problematic because they inhibit access of the appropriate set of lexical candidates (or "cohort") and thus are unable to receive lexical feedback activation via goodness-of-fit, making distortions early on in the word an obstacle. However, distortions later on in the word are less problematic because the proper cohort would have already been selected and available top-down information would assist in resolving the distortion.

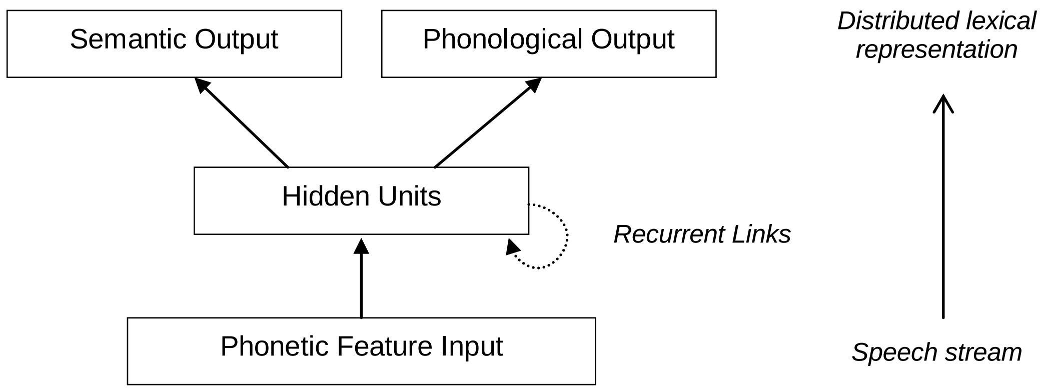

Figure 5: Schematic of the Gaskell & Marslen-Wilson (1997) Distributed Cohort Model.

Table I provides a brief summary of the type and architecture of the models discussed, the allowed direction of information processing, as well some of their associated concepts.

Table I: Some common models of word recognition: their type, architecture, permitted direction of information flow, and associated concepts.

	TRACE	**Shortlist**	**Merge**	**DCM**
Type	interactive/Parallel Distributed Processing Model	autonomous/serial □□		interactive/Parallel Distributed Processing Model
Architecture	feature > phoneme > word	input phoneme nodes + lexical decision nodes > phoneme decision-making nodes		phonetic feature input > semantic + phonological nodes
Flow of information	bottom-up & top-down feedback	bottom-up only Feed-forward		bottom-up & top-down feedback
Associated concepts	goodness-of-fit	Metrical Segmentation Strategy (MSS) & Possible Word Constraint (PWC)		early distortion blocks access: no goodness-of-fit

1.3.2 Segmentation Accounts

Segmentation accounts form the basis for the manner in which lexical access is carried out. As may be inferred, segmentation deals with the way the acoustic signal is broken up and at which point word boundaries are placed and lexical items are isolated. Lexical accounts approach segmentation in a manner opposite to that of prelexical accounts. Essentially, under the prelexical approach, lexical identification is a two-step process: potential word boundaries are first identified and then a lexical search is carried out. Under the lexical approach, identification of word boundaries is simply a byproduct of word recognition. Words are recognized and boundary locations become self-evident. Lexical approaches thus rely heavily on lexical knowledge, while prelexical accounts are guided by transitional probability.

1.3.2.1 Prelexical Accounts

Prelexical accounts (*e.g.*, Cutler, Mehler, Norris, and Seguí, 1986; Cutler and Norris, 1988) of segmentation rely on both information from acoustic cues found in the signal, as well as statistical regularities of the language being processed, and act as an interface between acoustic and lexical processing. Some researchers (Scharenborg, Norris, ten Bosch, McQueen, 2005) have argued that such accounts are necessary to solve the *invariance problem*, that is, that the highly variable acoustic signal must be mapped onto discrete lexical representations. Proponents of such accounts have suggested that, as acoustic input is received, listeners first scan the signal and divide it into smaller chunks by identifying acoustic cues marking word boundaries. This is the first step in the direction of word recognition. Listeners begin the process of lexical access only after having located a word onset. In the effort to locate onsets, listeners may take into account a number of cues and statistical information.

In terms of acoustic cues, allophonic variation, which is sensitive to syllable position (onset versus coda), might assist in recognition of syllable onsets, which may also be potential word onsets. Examples in English include clear /l/ (syllable-onset) *vs.* dark [ɫ] (syllable-coda), the burst of aspiration in voiceless stops /p/, /t/ and /k/ (stressed syllable-onset), t/d flapping (usually syllable coda), and increased vowel nasalization in the presence of neighboring nasals when the nasal is in coda rather than onset position. Durational differences (relative to other factors such as phonetic, prosodic and interspeaker variation) are another cue which may be taken into account when locating word boundaries. For example, the vowel in /sliːp/ (Lehiste, 1972) is increasingly shorter in the items SLEEPY and SLEEPINESS with respect to SLEEP. Such a cue may guide listeners' expectations as to what is to come.

Statistical regularities involve phonotactics, distributional regularity, (both mentioned in section 1.1.1) as well as metrical properties. Phonotactics refers to the strings of permissible phonemes in a given language. Knowledge of possible sequences may be used to constrain or guide the lexical search. Research involving the detection of words in nonsense strings shows that listeners are better able to detect words when they are aligned with phonotactic boundaries, *e.g.*, LAMP in "fen.lamp," than when they are misaligned, "fe.vlamp," (McQueen 1998; Weber 2000). Moreover, the role played by phonotactics may indeed be so critical that listeners may in fact impose the illusion of segments at low levels of perception so as to conform to phonotactic constraints. Work with Japanese listeners (Pallier, 2000; Dupoux, Pallier, Kakehi, & Mehler, 2001) shows that upon hearing illegal (C)VCCV clusters, an epenthetic /u/, *i.e.*, (C)VCuCV, is frequently perceived, thus making the clusters conform to Japanese phonotactics. This sort of phonological "deafness" to illegal combinations, *e.g.*, [ebzo – ebuzo] for Japanese listeners, or the inability or extreme difficulty to discriminate between certain non-native contrasts, *e.g.*, [r] – [l] for Korean listeners, has been argued to be at the basis of the adaptation of loan words, *e.g.*, [sɯfiŋkɯsɯ] < SPHINX, for Japanese speakers, or [rəntən] < LONDON, for Korean speakers (Peperkamp & Dupoux, 2003:367).

Distributional regularity or transitional probability/frequency has to do with phonemes' distribution and frequency in a language's repertoire and the likelihood that one phoneme follows another. This is something which seems to be part of the knowledge of the speaker (*e.g.,* Costa, Cutler, Sebastián-Gallés, 1998). It is highly related to phonotactics and relies on the statistical hypothesis that sequences which are common and occur in a variety of contexts are better candidates for a lexical search than those that are less common or occur in limited contexts. Thus while phonotactics constrains exactly which strings may or may not occur, distributional regularities focus on frequency of particular sounds or combinations.

A language's metrical properties relate to its timing. In English, for example, the dominant stress pattern is strong-weak (trochaic), such that the first syllable is typically stressed (Lehiste, 1960). The stressed syllable is thus longer in duration, usually higher in pitch, more intense, and would include a full vowel. Consequently, stress may have "delimitative effects" (Kaye, 1989), indicating to listeners the beginnings and ends of words and serving as a cue for commencing lexical searches. This is the essence of the Metrical Segmentation Strategy (MSS) (Cutler & Norris, 1988), which is based on results of experiments using word-spotting techniques and involving misparsing which have supported that English (Cutler & Norris, 1988; Cutler & Butterfield, 1992) and possibly Dutch (Vroomen, van Zon & de Gelder 1996;

Vroomen & de Gelder, 1997; though see Quene & Koster, 1998) listeners may use metrically-strong syllables to segment the acoustic signal. Speakers of other languages such as French, Catalan, and Spanish, however, have been shown to not use stress to the same degree as posited in the MSS and to show greater sensitivity to the syllable, though stress is an important parameter for Catalan and Spanish speakers (Sebastián-Gallés, Dupoux, Seguí, & Mehler, 1992). Speakers of Japanese and Telugu, a Dravidian language, have been shown to exhibit sensitivity to the mora (Cutler, Murty, Otake, 2003). Such cross-linguistic patterning supports the idea that languages may fall into rhythmic classes, *i.e.*, stress-timed, syllable-timed, and mora-timed, and that speakers, when acquiring their native language, may adapt their processing to exploit strategies appropriate for their language. The MSS focused on locating stressed syllables as possible word onsets may not be at work in languages such as French, Catalan, Spanish, Japanese and Telegu, and may explain why when attempting to prelexically process a language of a different class, like English, listeners may apply inappropriate strategies and thus encounter greater difficulty (Cutler *et al*, 2003).

1.3.2.2 Lexical Accounts

There are two main types of lexical accounts. The first relies on lexical competition across possible word boundaries (McClelland & Elman, 1986; Norris, 1994). The second concerns the sequential recognition of individual words in the speech signal (Cole & Jakimik, 1980; Marslen-Wilson & Welsh, 1978).

The lexical competition account of segmentation involves the activation of many potential candidates at a time and relies on the listener's ability to perform multiple, parallel, simultaneous lexical searches. Word recognition under this view is a race between every lexical item consistent with a given input vying for final selection. The greater the number of candidates, the greater the distribution of activation is spread across candidates. Models such as TRACE and Shortlist, the Neighborhood Activation Model (Luce & Pisoni, 1998), and earlier versions of the Cohort Model (Marslen-Wilson, 1987, 1990; Marslen-Wilson, Moss, & van Halen, 1996) all make use of a competitor environment and lexical activation in final word selection.

The effects of lexical competition have been evidenced in a number of studies using a variety of techniques: lexical decision-making, where listeners must state whether a string of letters is a word or not; shadowing, where informants listen to a stimulus over headphones and repeat it back as rapidly as possible (Slowiaczek & Hamburger, 1992); and cross-modal priming, where stimuli in one modality are used to test whether they affect access of stimuli in another. Results suggest that how quickly a word will be selected as a result of competition is influenced by two factors: the number of phonologically-similar words, *neighborhood density* (Luce, 1986), and the frequency of the target word in relation to its phonological neighbors (Wright, 2003), such that words with few and infrequent neighbors are recognized faster than words with more and frequent neighbors, commonly known as the *neighborhood density effect*. Other studies exploring connected speech have found that non-aligned items, that is, units spanning word boundaries, *e.g.*, BETRAY or BETRAYED detected in BE TRADING, and embedded words, *e.g.*, BED spotted in EMBED, may be activated as lexical competitors (McClelland & Elman, 1986; Norris, 1994). Moreover studies comprising tasks using ambiguous prime stimuli, which activate multiple competitors, have shown reduced facilitation (Marslen-Wilson, Moss & van Halen, 1996), evidenced by longer response times. Thus, the ambiguous string [tuːlɪps], which is phonemically identical for TULIPS and TWO LIPS, has been shown to prime the meanings of both TULIPS and LIPS when paired with KISS (Gow & Gordon, 1995). Therefore, there is evidence that conflicting segmentations and interpretations of ambiguous stimuli may be considered simultaneously at various stages of processing. Multiple competitors may sometimes delay instead of assist recognition.

The sequential recognition account of segmentation also allows for the initial activation of more than one candidate, a so-called "cohort," consisting of a group of phonetically-related words; however, under this view, recognition is not a race. It is conducted sequentially. First, an initial cohort is selected. As more acoustic information is input, members of the cohort which show a mismatch are progressively eliminated until the uniqueness point (UP) is achieved and only one candidate remains. Recognition may occur before the offset of the word in question, particularly if the number of members in the cohort is low and the UP is achieved early, or it may happen well after. Upon hearing [ɹæm] in the sentence: THE RAM ROAMED AROUND (Altmann, 1997:74), the string [ɹæm] may not be decisively identified as RAM, without analyzing successive input: RAM could quickly become RAMBLE, RAMPAGE, RAMPANT, etc. Therefore, all possibilities would initially be activated as candidates. Some of the following word ROAMED would necessarily have to be heard before the other candidates could all be seen to mismatch, causing their successive deactivation and elimination, and allowing the ultimate selection of RAM.

An important point distinguishing sequential recognition accounts as simulated in distributed models from lexical competition accounts is that, after initial activation, no two members of the cohort may share the same level of activation (Gaskell & Marslen-Wilson, 1997). In models based on competition, since activation is spread across candidates, any number may show equal activation. Activation in distributed models is a dynamic process which may be visualized as multi-dimensional vectors plotting word representations in a lexical space. At the beginning stages of input, the network functions with a cohort of potential matching candidates and plots near the middle of the space. As more information is received, it moves outward, sequentially eliminating mismatching candidates while searching for a match and waiting to reach the UP. The activation level of a candidate at any given point is calculated to be inversely related to the distance between the network output and the fixed, binary word representation in the vector space, such that the smaller the distance, the higher the activation level. A zero distance indicates maximum activation; greater distances indicate lesser activation. Thus, in the above example, given [ɹæm], though RAM cannot be definitively selected until some of ROAMED has been input, RAM would likely have the highest level of activation because it would show the best match with [ɹæm] and the smallest distance among the cohort's candidates. Once ROAMED is made available, the UP for RAM is achieved and the output of the network shifts to the fixed point in the vector space representing RAM and proceeds with further processing of ROAMED. In distributed models, since a zero distance from the target represents a one-to-one match between the input and the representation in the vector space, by definition all other candidates must mismatch. The more a lexical item diverges phonemically or phonetically from other items in its potential cohort, the earlier the UP will be achieved and the word will be selected (Marslen-Wilson, 1984, 1990; Zwitserlood, 1989). Moreover, if words are detected early on in the stream, *i.e.*, before their final boundary, such information may be used to prepare for and predict the next word onset.

2 THIS STUDY

As established, prosodic and rate-induced reduction in speech occurs across languages. Yet, legal types of reduction and contexts for reduction are known to differ from one language to another. American English and Central Catalan[5] both show a number of common reduction processes that occur in similar contexts in the two languages. For example, vowels weaken in unstressed syllables, *e.g.,* the proper name LORETTA /loʊˈretə/ > [ləˈɹeɾə] in American English or GOSETA, 'female puppy,' /goˈsɛta/ > [guˈsɛtə] in Catalan, and place assimilation occurs regressively in the case of final alveolars, *e.g.,* THAT CAN /ˈðætˈkæn/ > [ˈðæk˺ˈkæn] in English or SET CASES, 'seven houses,' /ˈsɛtˈkazəs/ > [ˈsɛk˺ˈkazəs] (Recasens, 1993:185) in Catalan.

In other cases, processes may be common to both languages, but the legal contexts in which reduction occurs may differ. For example, in English /z+j/ contexts, palatalization in conjunction with progressive manner assimilation may lead to [ʒʒ] or [ʒ], as in IS YOUR /ˈɪzjʊər/ > [ˈɪʒəʳ]. In similar cases in Catalan, though there may be some degree of palatalization in DOS IOGURTS, 'two yogurts,' /ˈdozjuˈɣurs/, *e.g.,* [ˈdozᶾjuˈɣurs] or possibly [ˈdoʒjuˈɣurs], progressive manner assimilation is not known to occur in this context, *[ˈdoʒ(ʒ)uˈɣurs]. Another example is consonant deletion in final /-ndC/ and /-ntC/ clusters, which may reduce in English, but are phonologically non-existent in Catalan (Recasens, 1993:166).

Some processes however are not found in the two languages. The weakening (or flapping) of medial /t/ and /d/ when between vowels (the second of which is unstressed)

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[5] Note that all Catalan examples and reference refer to the Central Catalan dialect.

(Ladefoged, 1993:92), *e.g.*, SLATED [ˈsleɪɾɪd], is typical of American English though not Catalan. Similarly, syllabification of word-final /r/, /l/, /m/, and /n/, *e.g.,* SADDER [ˈsæɾɹ̩], IT'LL [ˈɪɾl̩], ATOM [ˈæɾm̩] and SADDEN [ˈsæɾn̩], occurs in English but not in Catalan.

Given the differences concerning legal types of and contexts for reduction which exist across languages, we aim to test whether non-natives show greater facility in perceiving casual speech processes that are (i) present in L1 and L2 in the same contexts (same process, same context), (ii) present in both languages but appear in different contexts (same process, different context), or (iii) processes that are present in L2 but not L1 (different process).

According to the Perceptual Assimilation Model (PAM) (Best, 1993, 1994a, 1994b, 1995; Best, McRoberts and Sithole, 1988), listeners assimilate non-native sounds to L1 phoneme categories, assigning them to the phonetic category containing phonetically-similar phonemes. Therefore, non-native contrast discrimination may be predicted based on an L2 phoneme's occurrence and status in L1. If a mechanism like PAM were involved in L2 connected speech perception, L2 listeners would tend to assimilate the result of reduction to the closest L1 category, if they are working at the phonetic level, or they would be able to undo the acoustic consequences of reduction, if that process is present in their L1, if they are working at the phonological level. If this is the case, we would expect recognition to be better for those processes which are similar in both languages (same process, same context) than for those which are similar but appear in different contexts (same process, different context) or for L2 processes that do not occur in L1.

This study is thus aimed at exploring recognition of casual, reduced speech by natives and relatively fluent non-natives to determine whether or not perception depends on experience in the manner of PAM. Experience is used with a double meaning, in terms of degree of exposure and familiarity with reduction. In overall degree of exposure, clearly natives are more experienced than non-natives. With respect to familiarity with reduction, for processes that occur in the same contexts in the L1 and the L2, L2 experience with the acoustic consequences may be equal to L1 experience.

The dependent variable in the experiment was perception and recognition of reduced speech, English or Catalan. The independent variables were language background, native or non-native English or Catalan, and presence or absence of the reduction process in the native language as realized in the context of the test sentence. The variable has three levels: (1) same process, present in the same context in both languages, (2) same process, present in different contexts, and (3) processes found in one language, but not the other.

2.1 Technique & Materials

In order to study cross-linguistic perception of casual speech by L1 and L2 listeners, data was collected using the gating technique applied in Shockey (1997, 1998) and Pearman (2003). An English sentence, *Is your friend the one that can't go to bed by ten?*, was read by a female speaker of General American English and a Catalan sentence, *Em sap greu que cap dels dos xicots no em pugui donar un cop de mà.*, was read by a female speaker of Central Catalan. The sentences were recorded and digitized at a sampling rate of 10,000Hz using the Multispeech, Model 3700 software program. Both sentences were gated in the same manner according to the gating paradigm developed by Grosjean (described in Grosjean, 1980[6]), such that gate 1 was made after the first word in each sentence, and successive gates were made every 80ms thereafter. Thus, each new token included any previously-presented material and the addition of 80ms more of the acoustic signal. 500ms of Brown noise[7] at 5% intensity was added at the end of each gate in order to soften the forced abrupt ending induced by the cut and to prevent listeners from hearing a confounding bilabial-type "blip".

Sentences were constructed to include common vocabulary items and, although they are not overly predictable semantico-syntactically, all the information necessary to understand the utterance is found in the utterance, *i.e.*, neither contains anaphora. Both sentences included a variety of reduction types, that is, processes which occur in both English and Catalan in the same contexts, processes which occur in both languages but in different contexts, and processes that may occur in one language but not the other. In

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[6] In the original experiment (Grosjean, 1980), subjects were asked to provide a confidence rating after each response. Since it was found that listeners' rarely rated their confidence 100%, no confidence rating was included in the present study.

[7] Brown noise has a spectrum where energy decreases at a rate of 6dB/octave. Pink noise decreases at a rate of 3dB/octave and white noise does not decrease. Brown noise was used because it is considered less irritating to listen to.

order to achieve a similar balance of reduction processes in the two sentences, the Catalan sentence ended up being slightly longer.

The sentences are transcribed below according to the way that they were uttered at the time of recording, labeled "reduced." A "canonical" transcription of each word is provided just above the reduced transcription and a translation is given for the Catalan sentence. The reduced transcriptions may be compared with the spectrograms of the English utterance in Figure 6 and the Catalan utterance in Figure 7. These figures also illustrate the acoustic information available to the listeners at each gate, shown between the vertical lines. The gates are numbered at the bottom of the figures.

English sentence:

Is your friend the one that can't go to bed by ten?
canonical: [ˈɪzjʊərˈfɹẽndðəˈwʌ̃nðætˈkʰæ̃ntˈgoʊtuˈbedbaɪˈtʰẽn]
reduced: [ˈɪʒəʳˈfɹẽn̪əˈwʌ̃n̪əˈkʰæ̃ŋg̊ərəˈbedbaɪˈtʰẽn]

Catalan sentence:

Em sap greu que cap dels dos xicots no em pugui donar un cop de mà.
translation: I am sorry that neither of the two boys can give me a hand.
canonical: [əmˈsapˈgɾeu̯kəˈkapdəlzˈð̞osʃiˈkɔtsˈnoə̯mˈpuɣið̞uˈnau̯nˈkɔpdəˈma]
reduced: [əmˈsag̊ˈg̊ɾeu̯kəˈkab̚dəlz̥ˈð̞osᶴʃiˈkɔtsˈnomˈpuɣið̞uˈnau̯ŋˈkɔb̚dəˈma]

The reduction processes that were included in the test sentence were all common, productive reduction processes. According to traditional Featural Phonology, the sentence involved cases of assimilation (either place, manner or nasality assimilation), elision, and consonant or vowel lenition involving feature substitution and segment deletion. Such processes may also be described according to Articulatory Phonology (AP) (Browman & Goldstein, 1986, 1989, 1990, 1992) in terms of reduction in the magnitude of the gesture, both in time and space, and gestural overlap. As explained previously, there are many advantages to an Articulatory Phonology description, however, in some cases, traditional descriptions appear to provide a cleaner interpretation of the reduction at hand. Thus, both will be employed here.

2.1.1 English test material: Is your friend the one that can't go to bed by ten?

The English sentence, *Is your friend the one that can't go to bed by ten?*, will now be detailed using Featural Phonology and Articulatory Phonology as tools to describe the acoustic result of the reduction processes that took place during the production of the sentence. For each reduction process, the following was taken into account: whether or not the process is applied in both English and Catalan, and, if so, if each is applied to the same sounds in the same context and to the same extent in Catalan. Examples are provided.

Assimilation occurred in a number of contexts in the English test sentence. Progressive manner assimilation and anticipatory palatalization affected /z/ and /j/ at the beginning of the sentence, IS YOUR, such that it resulted in [ʒʒ]. /z/ and /j/ involve independent articulatory structures (*i.e.*, are on different tiers), the tongue tip and the tongue predorsum, but they have some coupling effects because they belong to the same articulatory structure, the tongue. Palatalization may be described as the motor commands for the /j/ gesture overlapping the commands for the alveolar fricative, /z/, palatalizing it, resulting in blending of the two gestures, /zj/ > [ʒʒ]. Time constraints in this case led to a reduction of [ʒʒ] to [ʒ]. As Holst and Nolan (1995) have found with similar sequences, see Figure 1, English may show a continuum of assimilation, from zero to complete, which they posit may be accounted for by gestural overlap for partial assimilations, types B and C, and "an explicitly cognitive phonological assimilation (330)," type D, as in the English sentence. In Catalan, as mentioned, though there may be some degree of coarticulatory palatalization in similar contexts, e.g., DOS IOGURTS, 'two yogurts,' /ˈdozjuˈɣurs/ > [ˈdoz^{ʒ}juˈɣurs] or possibly [ˈdoʒjuˈɣurs], extreme reduction of a D type, *[ˈdoʒ(ʒ)uˈɣurs][8], is unlikely to occur in this context. The effects for all possibilities in Catalan are judged to be coarticulatory, that is, automatic and phonetic—the phonological features remain unaffected[9] (Recasens, 1993:54)—versus partial or complete assimilation in English.

The combination of progressive manner and nasality assimilation paired with regressive dentalization occurred twice in the sentence, first in FRIE<u>N</u>(D) <u>TH</u>E, after elision of the /d/, and second in O<u>N</u>E <u>TH</u>AT, /nð/ > [n̪ð] > [n̪n̪]. In both instances, the anticipatory gestures for the upcoming dental, /ð/, affected the target alveolar contact for the /n/, which became dentalized, [n̪ð], while the nasality and stop constriction for the /n/ carried over onto the dental, resulting in [n̪n̪]. Additionally, in the case of FRIEND THE, the articulation for /d/ would be said to have been overlapped by the upcoming /ð/ and perceptually hidden, *i.e.*, inaudible. Such articulatory trajectories and overlap would be observable in the articulatory data but it is not obvious in the spectrogram. The output [n̪n̪] may thus be described as a blending or an intermediate articulation between the nasal gesture for C_1, [n], and the place target of C_2, [ð]. Time constraints led to a reduction of [n̪n̪] to [n̪]. Generally regressive dentalization may occur in Catalan *e.g.*, QUI<u>N D</u>'ELLS, 'which of them,' [ˈkin̪ˈdeʎz] (Recasens, 1993: Appendix), though Catalan speakers do not have L1 experience with regressive dentalization in [nð]

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[8] This may be confirmed with the spectrogram for an additional Catalan sentence *En Pau és aquest que pren dos iogurts per berenar*, 'Pau is the one that takes/eats two yogurts as a snack?,' found in Appendix D.

[9] There are actually very few Catalan words that begin with /j/ and few of them, besides perhaps IOGURT, 'yogurt,' or IAIA/IAIO, 'Grandma/Grandpa,' are very frequent. This is a context in Catalan that deserves to be studied further, as it appears that the language is changing in terms of acceptable pronunciation, particularly among younger generations. Among older speakers, however, coalescent palatalization and progressive manner assimilation in this context does not seem to occur (Recasens, personal communication 2003).

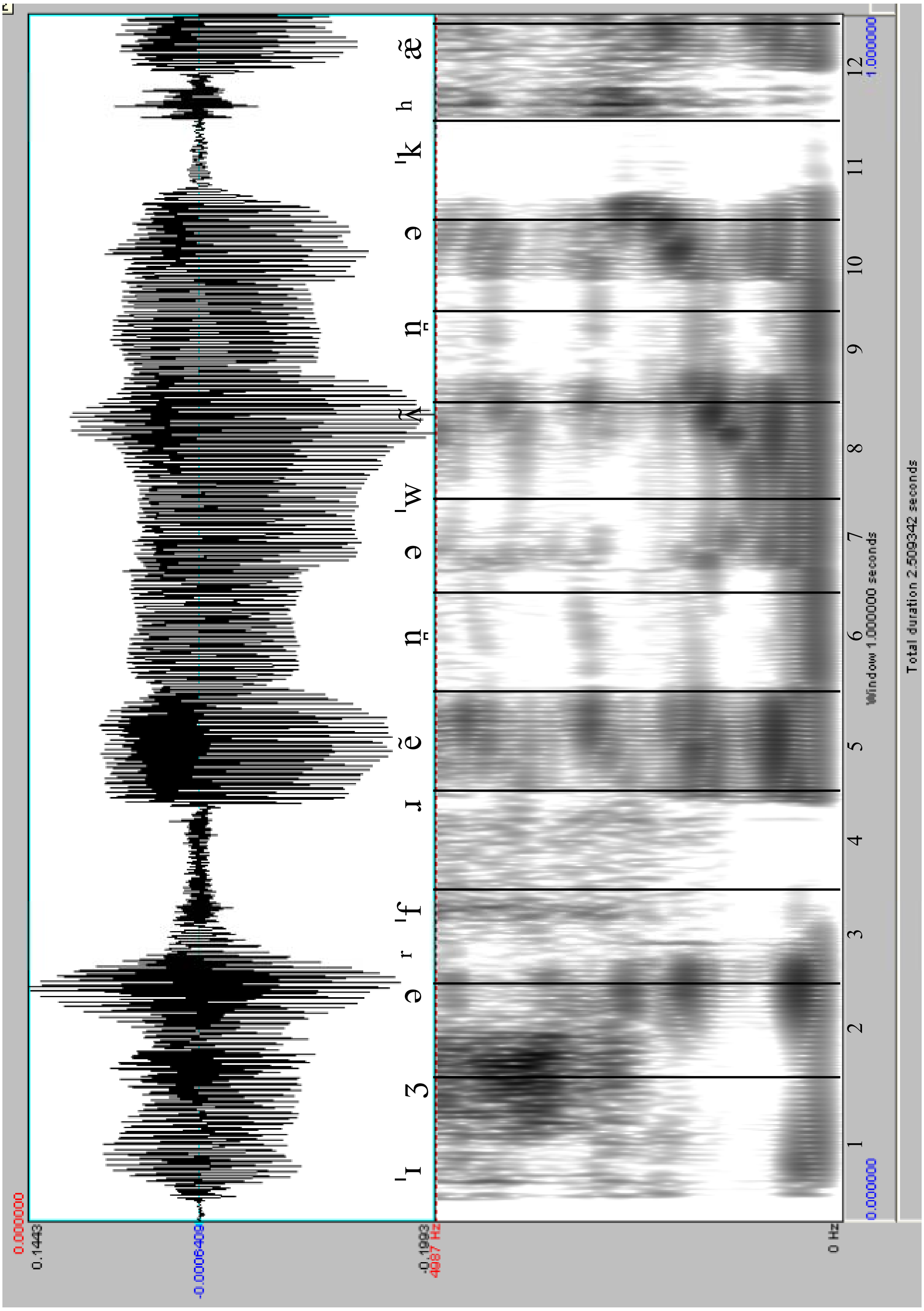

Figure 6. Waveform and spectrogram of *Is your friend the one that can't go to bed by ten?* broken into two parts. The transcription is shown above the spectrogram and the corresponding gate numbers are shown below.

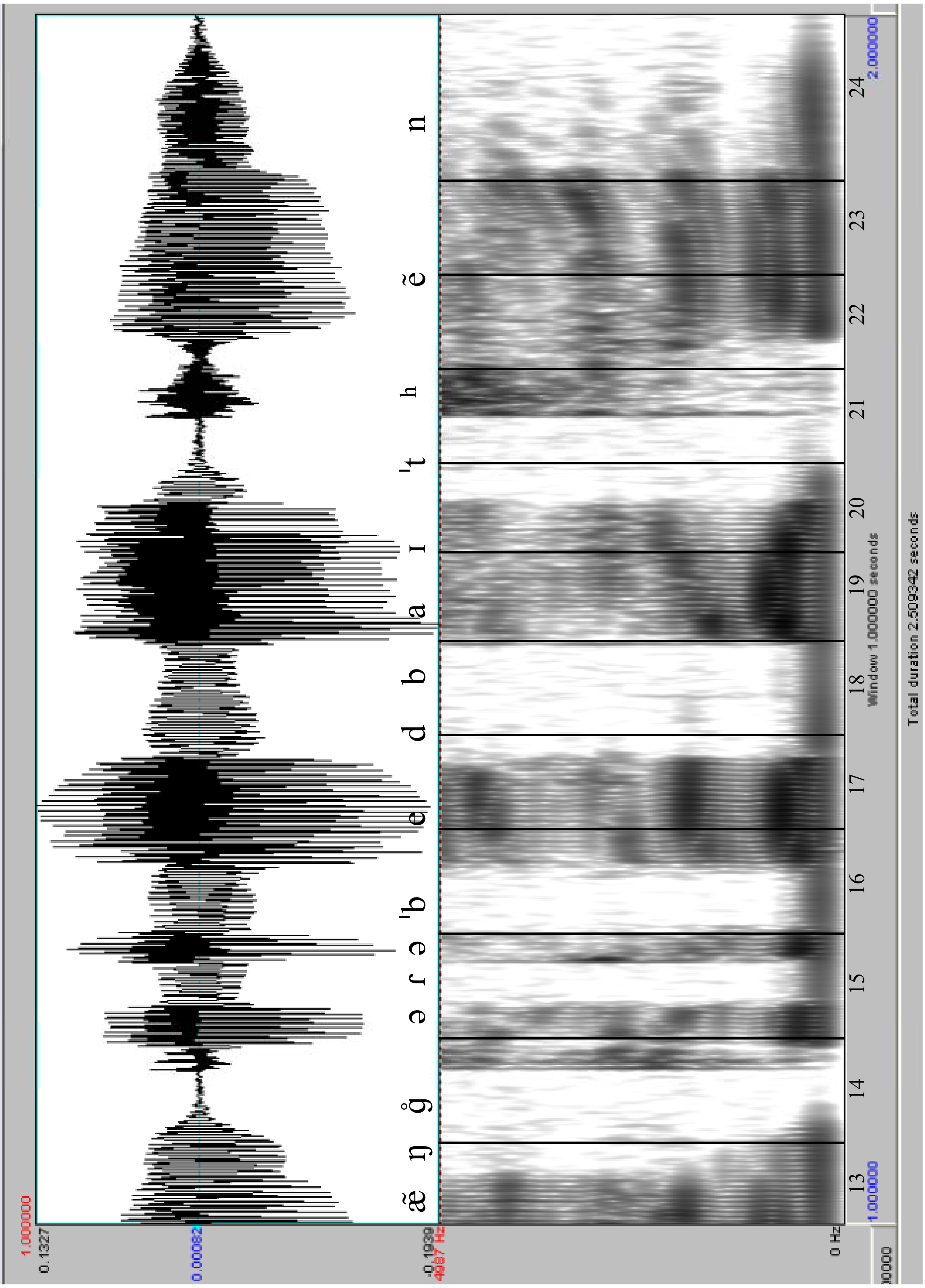

Figure 6. Waveform and spectrogram of *Is your friend the one that can't go to bed by ten?* broken into two parts. The transcription is shown above the spectrogram and the corresponding gate numbers are shown below.

sequences because they do not occur in Catalan. In Catalan, /d/, when it is realized following a nasal stop is always realized as a stop (Recasens, 1993: 190). Though orthographically words may end in '-nd' or '-nt,' word-final oral stops following nasals are never pronounced when phrase-final or preconsonantal (Recasens, 1993:166), *e.g.*, DIVIDEND, 'dividend,' [diβ̞iˈðen] or VINT GOSSUS, 'twenty dogs,' [ˈbiŋˈgosus]. Compare to DIVIDEND [diβ̞iˈðend] ACTUAL, 'current dividend,' and VINT [ˈbint] ANYS, 'twenty years.' Note that in VINT GOSSUS, the /t/ is dropped and the /n/ may become [ŋ] through regressive place assimilation, very much like in CAN'T GO /n(t)g/ > [ŋg], to be discussed.

Regressive place assimilation occurred twice in the test sentence. First, it appears in THAT CAN('T), where a diminished gesture for the syllable-final alveolar consonant hypothetically occurred during the time of the closure for the velar gesture, /k/, yielding [k̚k] or a time-reduced [k̚], rendering the /t/ acoustically inaudible. An identical context where this process may occur in Catalan is SET CASES, 'seven houses,' [ˈsɛt̚ˈkazəs] > [ˈsɛk̚ˈkazəs]. Second, regressive place assimilation appears with the /n/ in contact with the /g/ of CAN('T) GO, after elision of the /t/, allowing /n(t)g/ to become [ŋg]. As discussed with FRIEND THE, in AP terms we may assume that the /t/ of CAN'T is perceptually elided when the commands for the adjacent gesture, /g/, overlap the commands for the reduced alveolar gesture /t/, leaving no acoustic evidence of it. The nasal assimilation, /ng/ > [ŋg], can be described as the velar gesture for /g/ being anticipated during the nasal segment, /n/, thus overlapping the diminished alveolar articulation and resulting in the perception of [ŋg]. In Catalan, assimilation of an alveolar nasal to a velar stop takes place within morphemes or if the nasal is part of a prefix, *e.g.,* BANC, 'bank/bench,' /nk/ > [ŋ], or INGRAT, 'ungrateful,' /ng/ > [ŋg]; however, it is optional across word boundaries or in compounds, *e.g.,* UN COP, 'one time,' or BENCARAT, 'good faced' (meaning to appear a pleasant, likeable person) /nk/ > [nk] or [ŋk] (Recasens, 1993:185).

Both consonant and vowel lenition occurred in the test sentence. Consonant lenition, or t-flapping, occurred only once in GO TO. Flapping may be described as a reduction in magnitude and time of the tongue tip gesture for alveolar /t/ or /d/ due to the time constraints, resulting in diminished alveolar contact. Although flapping may be described as a phonetic effect, for most speakers it may be considered an allophonic variant of /t, d/ involving a different target gesture. Though the process of flapping does not exist in Catalan, the acoustic properties of the flap are more or less equivalent to those of a tap (Romero & Recasens, 2000), found in medial single 'r's in Catalan, *e.g.,* ERA, 'he/she/it was,' [ˈeɾə].

Finally, vowel lenition, or a reduction in gestural displacement and time leading to a more centralized vowel, occurred in four contexts: YOUR, THAT, GO, and TO, such that the vowels /ʊə/, /æ/, /oʊ/ and /uː/ all reduced to schwa, [ə]. Though the process of vowel reduction takes place in unstressed syllables in standard Catalan, it must be noted that three of the four vowels in the English sentence are not part of the standard Catalan vowel inventory. Furthermore, while English vowels in normal speech commonly reduce to schwa, /ʊ/ or /ɪ/, Catalan vowels /ɑ, e, ɛ/ reduce to schwa and vowels /o, ɔ, u/ reduce to /u/. /i/ is only slightly more centralized when unstressed. Consider, GOS, 'dog,' [gos], a monosyllable, which has one stressed, full vowel in contrast to GOSSETA, 'female puppy,' [guˈsɛtə], which has one stressed and two unstressed syllables, causing /o/ to reduce to [u] and /a/ to reduce to [ə].

The remainder of the sentence: BED BY TEN, was not affected by any type of reduction process, although it could have been. BED BY provides a prime site for regressive place assimilation, /db/ > [bb], or overlap between oral gestures, though it did not occur. BED however still provides an interesting point of observation. In English, the voicing of final obstruents is known to be cued by the length of the preceding vowel. Vowels are thus about one third shorter before tautosyllabic voiceless consonants, *e.g.*, BET [be·t], than before tautosyllabic voiced consonants, *e.g.*, BED [beːd]. This phenomenon is known as vowel clipping (Bailey, 1985; Ladefoged, 1993). It is known that vowel length is used by native English listeners to identify the voicing of following obstruents, most likely due to the fact that obstruents are generally devoiced word-finally; hence, vocal fold vibration is not a reliable cue to consonant voicing. In Catalan, on the other hand, the voiced/voiceless contrast in absolute word-final position is neutralized, such that only voiceless obstruents appear word-finally. Therefore, for those informants with greater experience, that is, native English speakers, the length of the vowel in BED would be expected to be utilized as a cue to the voicing of the following stop; whereas for participants with less experience, *i.e.*, Catalan speakers, vowel length would be expected to be of little assistance. Additionally, if Catalans attempt to apply L1 phonological rules to [bed], they are likely to report hearing BET or some other variant ending in a voiceless obstruent.

Table II below summarizes the processes in the English test sentence. The table may be read as such: a given input, for example /zj/ produces a given output, [ʒ], because it is affected by a particular process, described in terms of Featural Phonology (FP), *e.g.*, palatalization and manner assimilation, and Articulatory Phonology (AP), *e.g.*, blending. Catalan examples complement the English examples and are labeled according to whether or not the process is the same in Catalan as in English (=P/≠P) and, if the process is the same (=P), whether or not it occurs in the same context in the two languages (=C/≠C). Reduction of processes and contexts to the categorical distinction "same" or "different" involves a good deal of simplification. For example, whereas coarticulatory palatalization in /zj/ sequences may take place in English and Catalan, the nature and extent of the process differ in the two languages. Thus Table II provides a clear, if oversimplified, categorization of the processes in the two languages.

Table II. Summary of the processes, according to Featural Phonology (FP) and Articulatory Phonology (AP), realized in the English test sentence (input & output) compared to Catalan examples. Each is labeled same or different process (=P/≠P), and if =P, same or different context (=C/≠C). All Catalan citations are from Recasens (1993).

FP PROCESS	AP PROCESS	IN-PUT	OUT-PUT	English	Catalan	=/≠
Progressive Manner Assimilation	Blending	/zj/	[ʒ]	IS YOUR, [ˈɪzjʊər] > [ˈɪʒəʳ]	DOS IOGURTS, '2 yogurts,' [ˈdozjuˈɣurs]/[ˈdozᶾjuˈɣurs]/ [ˈdoʒjuˈɣurs], *[ˈdoʒ(ʒ)uˈɣurs]	≠P
Palatalization						=P ≠C
Vowel Lenition	Reduction in magnitude & time	/ʊə/	[ə]		Vs weaken in Catalan unstressed syllables, GOS, 'dog,' [ˈgos] *vs.* GOSSETA, 'female puppy,' [guˈsɛtə] (/o/ > [u] & /a/ > [ə])	=P =C
Consonant Deletion	Gestural reduction & overlap	/ndð/	[nð]	FRIEN(D) THE, [ˈfɹɛ̃ndðə] > [ˈfɹɛ̃n̪ə]	Catalan word-final and pre-consonantal oral stops '-nd' and '-nt' following nasals are systematically deleted (p.166): DIVIDEND, 'dividend,' > [diβiˈðen]; VINT GOSSUS, '20 dogs,' [ˈbiŋˈgosus] *vs.* VINT ANYS, '20 years,' [ˈbintˈaɲʃ]	=P =C
Regressive Place Assimilation: Dentalization	Blending	/nð/	[n̪]	ONE THAT, [ˈwʌ̃nðæt] > [ˈwʌ̃n̪ə]	Regressive dentalization may take place in Catalan, QUIN D'ELLS, 'which of them,' > [ˈkin̪deʎs] (Appendix); however, [nð] is not a possible sequence: /d/ is always realized as a stop after a nasal stop (p.190).	=P =C
Vowel Lenition	Reduction in magnitude & time	/æ/	[ə]	THAT CAN('T), [ðætˈkʰæ̃nt] > [n̪əˈkʰæ̃ŋ]	(see IS YOUR)	=P =C
Regressive Place Assimilation/ Deletion	Gestural reduction & overlap	/tk/	[k]		SET CASES, '7 houses,' [ˈsɛt˺ˈkazəs] > [ˈsɛk˺ˈkazəs] (p.185)	=P =C
Consonant Deletion	Gestural reduction & overlap	/ntg/	[ŋg̊]	CAN('T) GO, [ˈkʰæ̃ntˈgoʊ] > [ˈkʰæ̃ŋg̊ə]	(see FRIEND THE)	=P =C
Regressive Place Assimilation	Reduction in magnitude & overlap				within words /n/ + /g/ > [ŋg]; across boundaries [ng] or [ŋg] (p.185), VINT GOSSUS, '20 dogs,' [ˈbinˈgosus] or [ˈbiŋˈgosus]	=P =C
Consonant Lenition: Flapping	Reduction in magnitude & time	/VtV/	[ɾ]	GO TO, [ˈgoʊtuː] > [g̊əɾə]	flapping does not occur in Catalan	≠P
Vowel Lenition	Reduction in magnitude & time	/oʊ/, /uː/	[ə]		(see IS YOUR)	=P =C

2.1.2 Catalan test material: Em sap greu que cap dels dos xicots no em pugui donar un cop de mà.

The Catalan sentence, *Em sap greu que cap dels dos xicots no em pugui donar un cop de mà.*, will be described using Featural Phonology and Articulatory Phonology to account for the acoustic result of the reduction processes that occurred during the production of the sentence. For each process, an English sequence parallel to the Catalan context under analysis will be provided. The context will be analyzed for whether or not the type of reduction exemplified by the Catalan sentence may occur in the parallel context in English. If reduction may occur, the question is whether or not it may occur in a similar direction in English, and whether or not it does to the same degree.

Assimilation is the major recurring process in the Catalan test sentence. The most common case is voicing assimilation, as seen in SAP GREU, /pg/ > [g̊g̊] (which also involves regressive place assimilation, see below), and both CAP DELS and COP DE, /pd/ > [bd]. In contrast to English, Catalan phonology presents two voicing rules which are consistently at work in spoken Catalan: final obstruent devoicing, which has already been superficially mentioned, and regressive voicing assimilation. In Catalan, obstruents show a voicing contrast in (absolute) word initial and word medial position; but, this contrast is seen to neutralize in word final position due to a final obstruent devoicing rule. When there is a following consonant, regressive voicing assimilation allows the glottal state of C_2 to spread to C_1, resulting effectively in a single glottal gesture. Thus, if C_2 is voiced, C_1 will be voiced, even if it is phonologically voiceless, and if C_2 is voiceless C_1 will be voiceless. For example, CAP [kap], 'no/none,' is realized with a final [p] in CAP CARTA (CA[p] CARTA), 'no letter,' but with a final [b] in CAP DELS (CA[b] DELS), 'none of them' (Cebrian, 2000). This is not the case in English, where the voicing state for a consonant does not usually spread to neighboring consonants and, if it does, it is usually voicelessness that spreads, devoicing preceding or following obstruents, *e.g.*, BI[g̊] CASE *vs*. BACK [d̥]OOR.

As mentioned, SAP GREU also shows regressive place assimilation, as does UN COP. /nk/ > [ŋk] contexts showing regressive place assimilation similar to UN COP have already been discussed, see the English test material explanation of CAN'T GO. SAP GREU on the other hand deserves attention in that, this assimilatory process involving a diminished labial gesture and extreme overlap of the velar gesture on the labial segment, so that the labial gesture is perceptually-masked and missed, is not productive in Catalan. Solé and Ohala (1991) have suggested that this sequence has most likely been lexicalized as a frequently occurring unit, hence it has become stored in the lexicon as such, because reduction of /pɡ/ to [ɡɡ] is not productive in this language.

It is worth mentioning that one type of assimilation that we do not see in the Catalan test sentence is complete palatalization, as found in the English sequence IS YOUR, /zj/ > [ʒ(ʒ)], in the sequence DOS XICOTS. The Catalan sequence shows /sʃ/ > [sʲʃ] rather than [ʃʃ]. That is, the Catalan sequence shows a gliding movement from a most likely retracted alveolar constriction to a palatal constriction as suggested by a drop in the center frequency of the noise as shown in the spectrogram, Figure 7. Thus, in Catalan, as suggested previously, palatalization is due to coarticulatory effects rather than extreme gestural overlap resulting in assimilation. Online responses to this item will likely shed light on the degree of palatalization in the two languages and whether complete assimilations or coarticulatory effects have a different perceptual result.

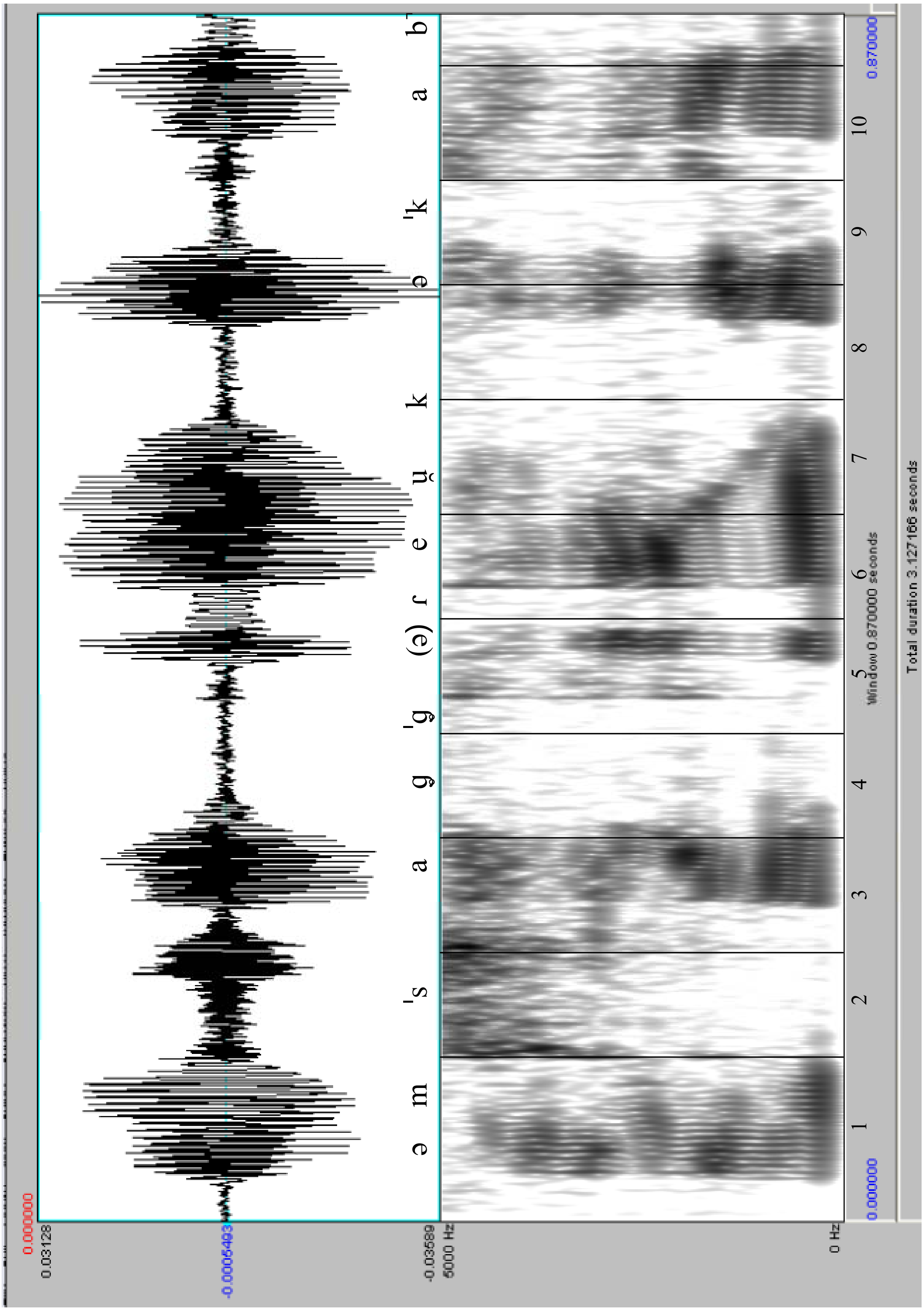

Figure 7. Waveform and spectrogram of *Em sap greu que cap dels dos xicots no em pugui donar un cop de mà*? broken into three parts. The transcription is shown above the spectrogram and the corresponding gate numbers are shown below.

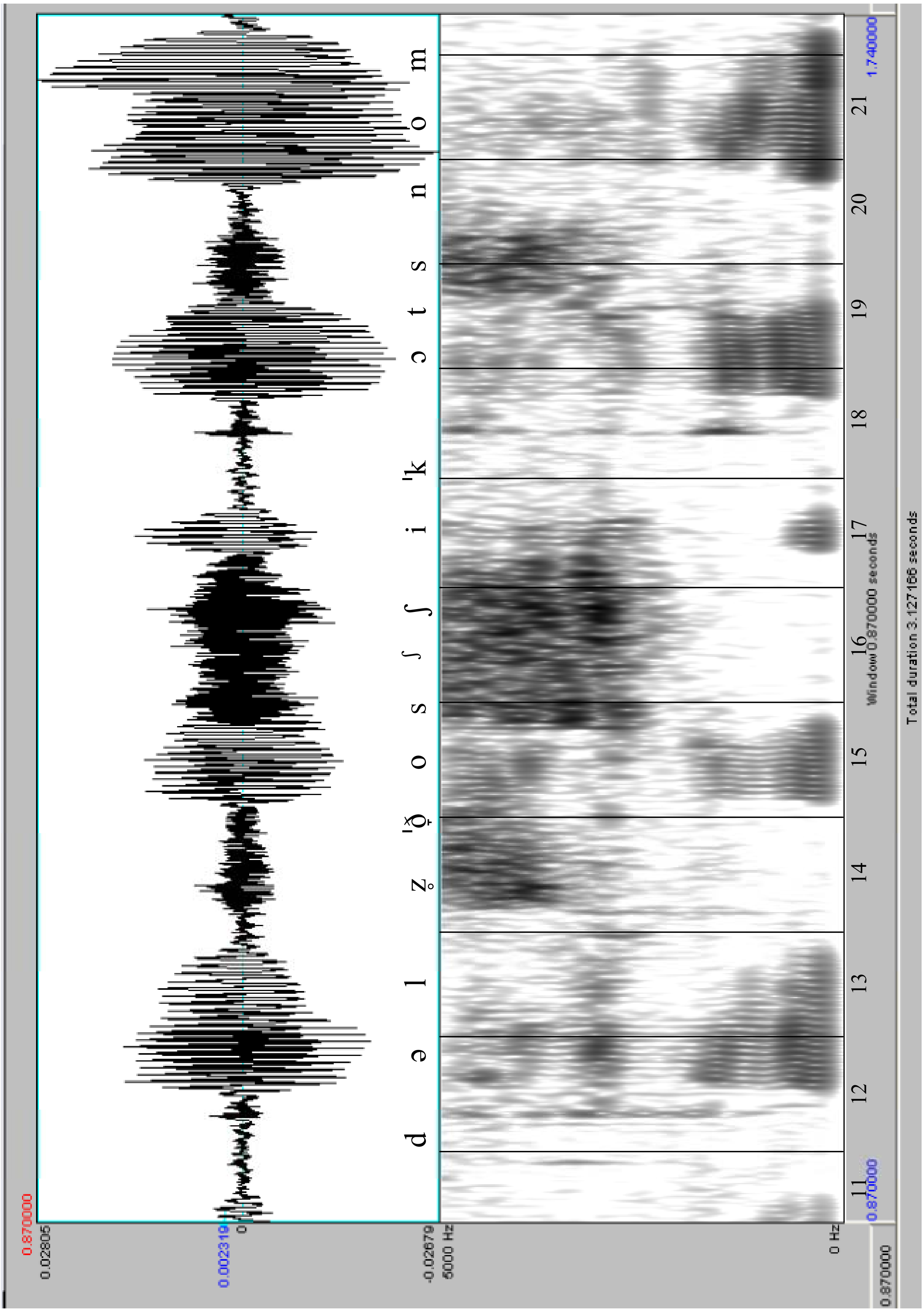

Figure 7. Waveform and spectrogram of *Em sap greu que cap dels dos xicots no em pugui donar un cop de mà*? broken into three parts. The transcription is shown above the spectrogram and the corresponding gate numbers are shown below.

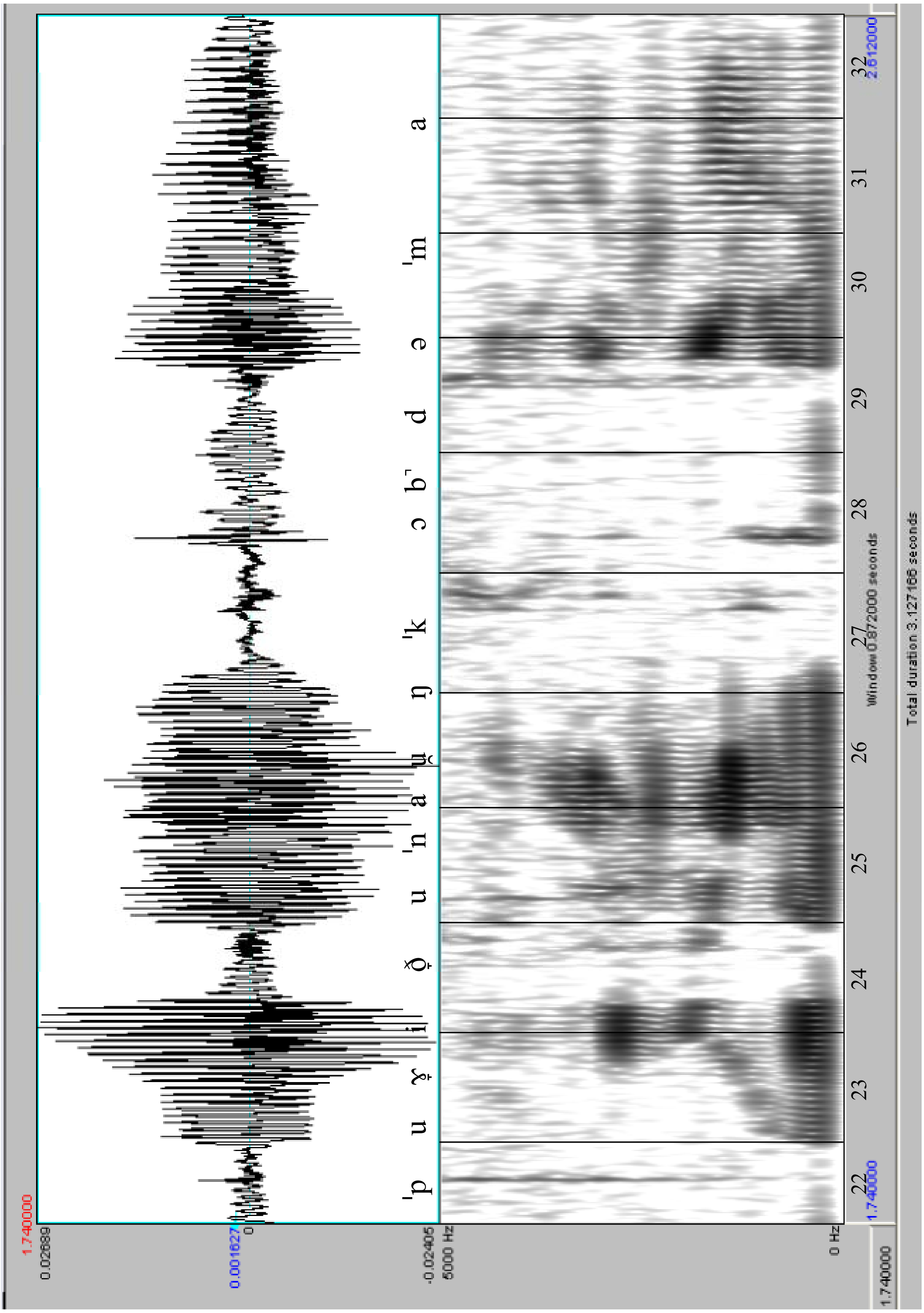

Figure 7. Waveform and spectrogram of *Em sap greu que cap dels dos xicots no em pugui donar un cop de mà*? broken into three parts. The transcription is shown above the spectrogram and the corresponding gate numbers are shown below.

Elision in the Catalan test sentence occurs in only one case, the reduction of NO EM, /noə̯m/ to [ˈnom]. Such smoothing of the vowel sequence, *i.e.*, articulatory undershoot due to time constraints, is common in Catalan (Recasens, 1993). Lenition, however, is found in four cases. Vowel lenition is seen in, DONAR, /o/ > [u], EM, QUE and DELS, /e/ > [ə]. It should be reiterated that weakening in Catalan is phonological, in contrast to the English examples, which are phonetic, that is, the English examples show online reduction of time and magnitude to schwa rather than the articulation of the full vowel. In the Catalan case, reduction is not a phonetic effect, but is dictated by Catalan phonology as described in the English test material section on vowel lenition. Consonant lenition, more specifically spirantization, occurred in three cases: DOS, PUGUI, and DONAR. Spirantization is the result of the reduction in time and gestural magnitude of intervocalic voiced stops. The failure to achieve the full target stop closure results in the articulation of fricatives or approximants. Spirantization is known to occur in voiced stops, /b, d, g/ > [β̞, ð̞, ɣ̞], in all contexts except when following a nasal, in the case of /d/, after lateral /l/, and optionally in utterance initial position. (Romero, 1995).

A summary of the reduction seen in the Catalan test sentence may be found in Table III, which may be read the same as Table II.

Table III. Summary of the processes, according to Featural Phonology (FP) and Articulatory Phonology (AP), realized in the Catalan test sentence (input & output) compared to English examples. Each is labeled same or different process (=P/≠P), and if =P, same or different context (=C/≠C).

FP PROCESS	AP PROCESS	IN-PUT	OUT-PUT	Catalan	English	=/≠
Vowel Lenition	Reduction in magnitude & time	/ə/	[ə]	EM, [ˈəm] > [ˈəm]	The English sentence shows online reduction accommodating style and rate constraints.	=P =C
Regressive Voicing Assimilation	Reduction & gestural overlap	/pg/	[g˺g]	SAP GREU, [ˈsapˈgreu̯] > [ˈsag̊ˈg̊reu̯]	An English equivalent, *e.g.*, TOP GRADE, would show devoicing effects of the [g̊], rather than voicing of the /p/.	≠P
Regressive Place Assimilation						=P ≠C
Vowel Lenition	Reduction in magnitude & time	/e/	[ə]	QUE, [ˈke] > [ˈkə]	The English sentence shows online reduction accommodating style and rate constraints.	=P =C
Regressive Voicing Assimilation	One glottal gesture	/pd/	[bd]	CAP DELS, [ˈkapdəlz] > [ˈkab˺dəlz̥] - - - - - - - - - COP DE, [ˈkɔpdə] > [ˈkɔb˺də]	see SAP GREU	≠P
Vowel Lenition	Reduction in magnitude & time	/ə/	[ə]	DELS, [ˈdəlz] > [ˈdəlz] - - - - - DE, [ˈdə] > [ˈdə]	The English sentence shows online reduction accommodating style and rate constraints.	=P =C
Palatalization	Gliding	/sʃ/	[sᶴʃ]	DOS XICOTS, [ˈð̞osʃiˈkɔts] > [ˈð̞osᶴʃ iˈkɔts]	English RESTOCKS SHELVES (Holst & Nolan, 1995) may show a continuum of assimilation, /sʃ/ > [ʃʃ], from zero to complete	=P =C
Spirantization	Reduction in gestural magnitude	/VdV/; /VgV/	[ð̞]; [ɣ]	DOS, [#ˈdos] > [ˈð̞os]; DONAR, [#duˈna] > [ð̞uˈna]; PUGUI, [ˈpuɣi]	Not known to occur regularly in English.	≠P
Smoothing	Reduction in magnitude & time	/oə̯/	[o]	NO EM, [ˈnoə̯m] > [ˈnom]	Unstressed Vs in English, particularly schwas, may disappear, *e.g.*, BUTTON, [ˈbʌtən] > [ˈbʌʔn̩]	=P =C
Vowel Lenition	Reduction in magnitude & time	/o/	[u]	DONAR, [ð̞uˈna] > [ð̞uˈna]	The English sentence shows online reduction accommodating style and rate constraints.	=P =C
Regressive Place Assimilation	Reduction & gestural overlap	/nk/	[ŋk]	UN COP, [u̯nˈkɔp] > [u̯ŋˈkɔb˺]	see English CAN'T GO	=P =C

In addition to the two sentences that are to be analyzed in detail in this study, a second English sentence, *This year or next they don't believe it'll be said.* [ˈðɪʃʃəʳɹ̩ˈneksð̥eɪˈdoʊmbəˈliːvɪɾɫ̩biˈsed], and a second Catalan sentence, *En Pau és aquest que pren dos iogurts per berenar?*, 'Pau is the one who eats (literally, takes) two yogurts as a snack?,' [əmˈpau̯ezəˈkekkəˈpren̪ˈdozʒjuˈɣurspərbɾəˈna], were also gated and presented to the same English and Catalan informants for identification. The data from the additional sentences present results pointing in the same direction as the sentence studied here; however because the data from the primary test sentences is so rich, due to time and space constraints, the additional sentences will not be treated in the present study.

2.2 Participants

Forty-eight listeners participated in the study, that is, twenty-four per sentence, all of whom participated voluntarily. For the English sentence, the control group consisted of twelve native North American English speakers, pooled from students at the University of Missouri (Columbia, Missouri) and Tulane University (New Orleans, Louisiana). The mean age for this group was twenty-two and listeners reported having studied at least one other language: French, German, Italian, Latin or Spanish. The experimental group was twelve Catalan-dominant Catalan/Spanish bilinguals enrolled in the English Philology program at the Universitat Autònoma de Barcelona. All of the Catalan students were attending class full-time, meaning that they were exposed to and practiced English every day, and were nearing the end of their degree. Before studying English at the university, they had been studying English in a formal classroom setting for approximately 8 to 10 years. They had a level of English approximate to the Cambridge Proficiency Certificate. The mean age for this group was twenty-four and subjects reported having studied at least one other additional foreign language: Dutch, French, German, Italian or Portuguese.

The Catalan sentence was tested one year later and therefore different groups of informants had to be recruited. The control group was twelve Catalan-dominant Catalan/Spanish bilinguals from the Barcelona area. All of the members of this group were either nearing the end of, or already held, a university degree. Their mean age was thirty and all reported knowing at least one other foreign language: English, French or German. The experimental group was twelve Americans who had been living in the Barcelona area for a minimum of five years (range: 6-20, mean length: 15). About half the group had had some formal training in Catalan, the other half had none. The participants self-described their level as: beginning/intermediate (eight subjects) and advanced (four subjects). The group's self-reported average listening time to Catalan was approximately two to three hours per day involving approximately one to two hours of speaking time. It might be noted also that all of the participants in this group were or had been English instructors at some point. Their mean age was 38 and, in addition to Catalan and Spanish, most had studied another foreign language: Chinese, French, German, Italian, Portuguese or Russian. Table IV provides a brief summary of the various groups.

Table IV. Summary of groups involved in the study. NS = Native speakers, NNS = Non-native speakers.

Test sentence:	Control Group: NS	Experimental Group: NNS
English	Americans	Catalans
Catalan	Catalans	Americans

For each sentence the control groups may be said to be more or less comparable—all the participants were native speakers with university education. On the other hand, it was extremely difficult to assemble comparable experimental groups. The Catalans tested on the English sentence were learning English in a formal, foreign environment and working towards a degree in English Philology. The Americans tested on the Catalan sentence were learning or had learned Catalan in a "second language" environment, that is, while living in Catalonia. Attempts were made to recruit two groups of non-natives who had studied English/Catalan as a foreign language or, alternatively, as a second language. In the case of Americans, very few American universities offer the possibility of studying Catalan and no universities offer a B.A. in Catalan. Catalan is typically an optional complement to a degree in Spanish Language and Literature. Professors at these select universities were contacted and an online version of the experiment was created; however, it was difficult to get much complete data. Also, the informants who did submit data presented varying backgrounds—many had spent time in Catalonia previously and often, despite some training, their level of Catalan was not comparable to the English level of the Catalan participants. Additionally, it might be asked why Catalans living in the United States were not recruited. The main reasons have to do with difficulty in recruiting a coherent group of participants and the scant results found to be provided with online versions of the experiment. As Beddor and Gottfried (1995) point out concerning listeners tested on non-native phones, "in this case subjects' experience with languages *other* than their native language is of primary interest, with special attention to experience with languages in which the target distinction occurs contrastively or allophonically. In addition, studies that investigate adult subjects who are learners of a specific language would focus on the extent and nature of subjects' experience with that *particular* non-native language (p. 212)." This was taken into account in this study with the use of a questionnaire (see Appendix A) as well as the comparison of the L1 and L2 distinctions and phonological processes, as presented. However we have to bear in mind that it was virtually impossible to come up with two completely comparable test groups. Therefore, differences between the two groups must be kept in mind when analyzing the results.

2.3 Design & Experimental Procedure

For both the English and Catalan test presentations, informants were read a set of written instructions and completed a questionnaire, a practice session and the test session; however, it was decided that the order of presentation had to be modified for the Catalan test. As mentioned the Catalan sentence was tested one year after the English sentence. As the data for both sentences were collected by a native English speaker and the entire sitting was intended to be conducted in the language being tested, in order to avoid any effects of switching between language modes, the procedure was modified so that all instructions for taking the Catalan test presentation were given via a recording of the native Catalan speaker who had uttered the test sentence. In this way, the informants received the same "habituation" period that participants for the English presentation had received. Also, since during the English presentations, it was seen that participants took varying amounts of time to fill out the questionnaire, it was decided that the questionnaire for the Catalan test could be filled out after having completed the experiment. Table V provides the order in which different sections were presented for the English and Catalan sentence.

Table V. Presentation order for the English and Catalan sentence.

English:	Catalan:
questionnaire	instructions
instructions	practice session
practice session	test session
test session	questionnaire

At the beginning of each presentation, listeners were provided a set of written instructions along with the questionnaire and a response sheet. The instructions were also read aloud by the experimenter or via recording. Participants were informed that the presentation consisted of an English/Catalan sentence that would be presented bit by bit. For each gate, they were asked to listen to the sounds and then write down what they had just heard in normal English/Catalan spelling on the response sheet. As they continued through the presentation, if they heard no change in the beginning of the sentence, they were told they only needed to write down any new information; but, if they changed their minds about what they were hearing, they should re-write the sentence from the beginning. At the final gate, they were instructed to write the complete sentence. Informants were allowed to advance through the presentation at their own pace and listen to sounds more than once if they felt it necessary; but they were asked not to change or cross out any of their previous responses. The response sheet consisted of numbered lines to write their interpretations (See Appendix A).

Both the Catalan and the English test presentation were conducted with Microsoft Power Point on a Sony PCG-GRZ530 portable computer. The participants listened to the gated sentences over headphones and completed a short practice session with the phrase *I like English* [ˈaɪˈlaɪkˈɪŋglɪʃ] / *M'agrada l'anglès* [məˈɣraðələŋˈglɛs], where after each gate, they were presented an example of how the responses were to be recorded. The practice session was identical to the presentation style of the actual test session. The gate number and a small loudspeaker icon, which informants were to click to prompt the sound, were displayed on a screen. Each gate was presented on a separate screen. The main difference between the practice section and the test session was that the practice session included only five bits of unreduced speech, spoken at a slightly slower pace, with gates of a longer duration.

The questionnaire for the English test asked for: name, contact address, age, place of birth, places lived for any significant length of time, and languages studied. For the Catalan test the questionnaire was modified to adapt to a bilingual

(Spanish/Catalan) and also second-language context. Native speakers were asked to provide: name, contact address, age, place of birth, which languages they speak (since all participants were expected to be at least bilingual), which languages they speak at home and with friends along with percentages. Additionally, non-native speakers of Catalan were asked to provide: the number of years which they have spoken Catalan, how long they have lived in Catalonia, which Catalan courses they have completed, the number of hours per day that they listen to and speak Catalan, and their self-assessed level of Catalan.

2.4 Analysis

After the data for the two experiments was collected, all responses per informant were systematically analyzed first in terms of word recognition, see Appendix B for this analysis. For each participant, first correct recognition for each lexical item was noted and histograms were created to display the results which are communicated in the following chapters.

To compare the results and timecourse of recognition, ANOVAs[10] were chosen as the method of providing statistical support. There were several options of where to look for variance. First, in terms of magnitude of recognition, an analysis of each group's percentage of recognition at the last gate for each item in the two test sentences was conducted. For Figure 8, which shows the results for CAN'T, the percentage of recognition for each group at the last gate was 83% for Americans compared to 25% for Catalans. Second, it seemed interesting to compare each group's highest point of recognition for each lexical item (labeled "peak" in Figure 8), therefore an analysis was conducted on these results. This peak is viewed as important because it indicates that there was some cue available in the signal at that particular point which led to a peak number of participants' first correct recognition. However, peaks for each group do not necessarily occur at the same gate and it seemed more reasonable to compare results at the same point in time. Therefore, based on a suggestion by Dr. James Flege (June 2005), analyses were run at the gate where natives achieved or surpassed 50% recognition ("NS 50%+" gate in Figure 8). Though the results of ANOVAs on the peaks and ANOVAs on the gate where 50% recognition occurred provide somewhat similar results, it was decided that the 50% mark is the most stable measure for conducting comparisons.

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[10] $p < 0.05$ was chosen as the level of significance.

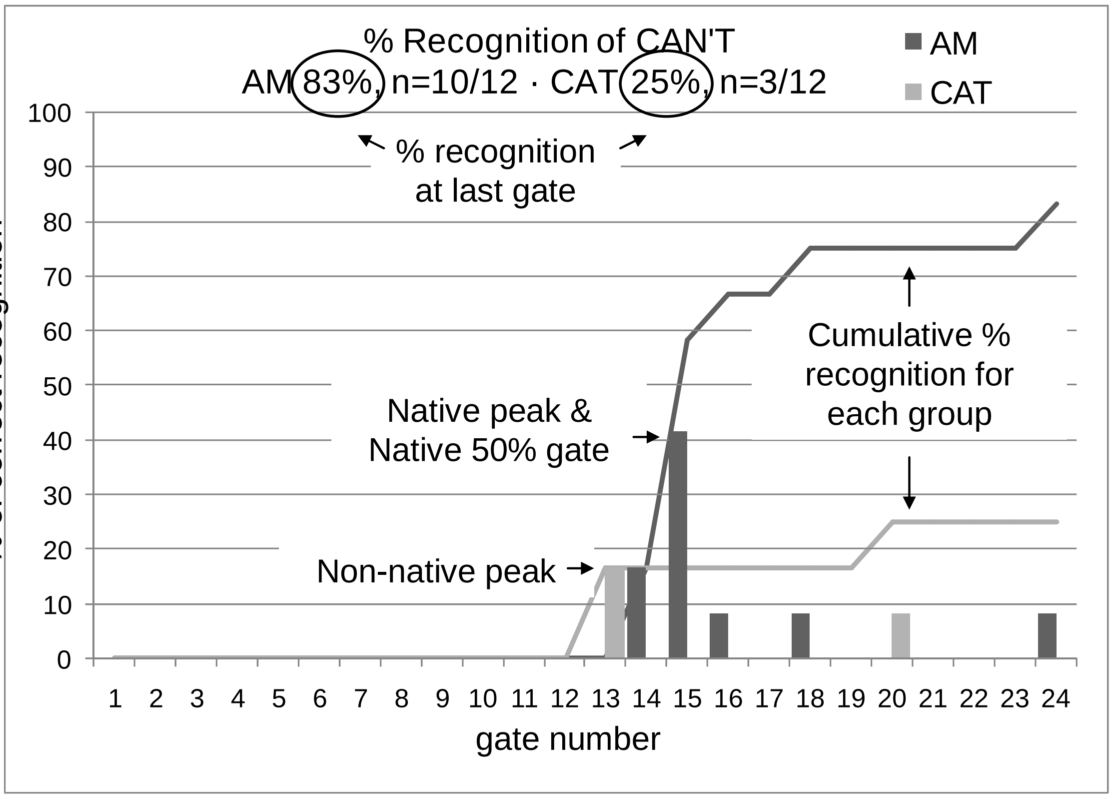


Figure 8. Examples of points at which ANOVAs were run for each group.

Finally, we wanted to investigate variance concerning the timecourse of recognition, that is, the distribution of recognition across gates, illustrated by the dotted curves in Figure 9. This provides an interesting comparison because although the two groups may show similar percentages of total recognition by the last gate, the distribution across gates may show significant differences. Note that for these comparisons, for those listeners who showed no recognition for an item, the ANOVAs were calculated by assuming recognition after the final gate for each sentence, that is, by assuming a hypothetical gate 25 for the English sentence and a hypothetical gate 33 for the Catalan sentence, adding weight to the right tail of the distribution curve, as seen in Figure 9. Not including non-recognizers leads to very different results. In the text, though peaks will be noted and discussed for each lexical item in the Results section, only the results for the ANOVAs recognition at the 50% mark and the distribution of recognition across time will be commented on. Results for all comparisons may be found in Appendix C.

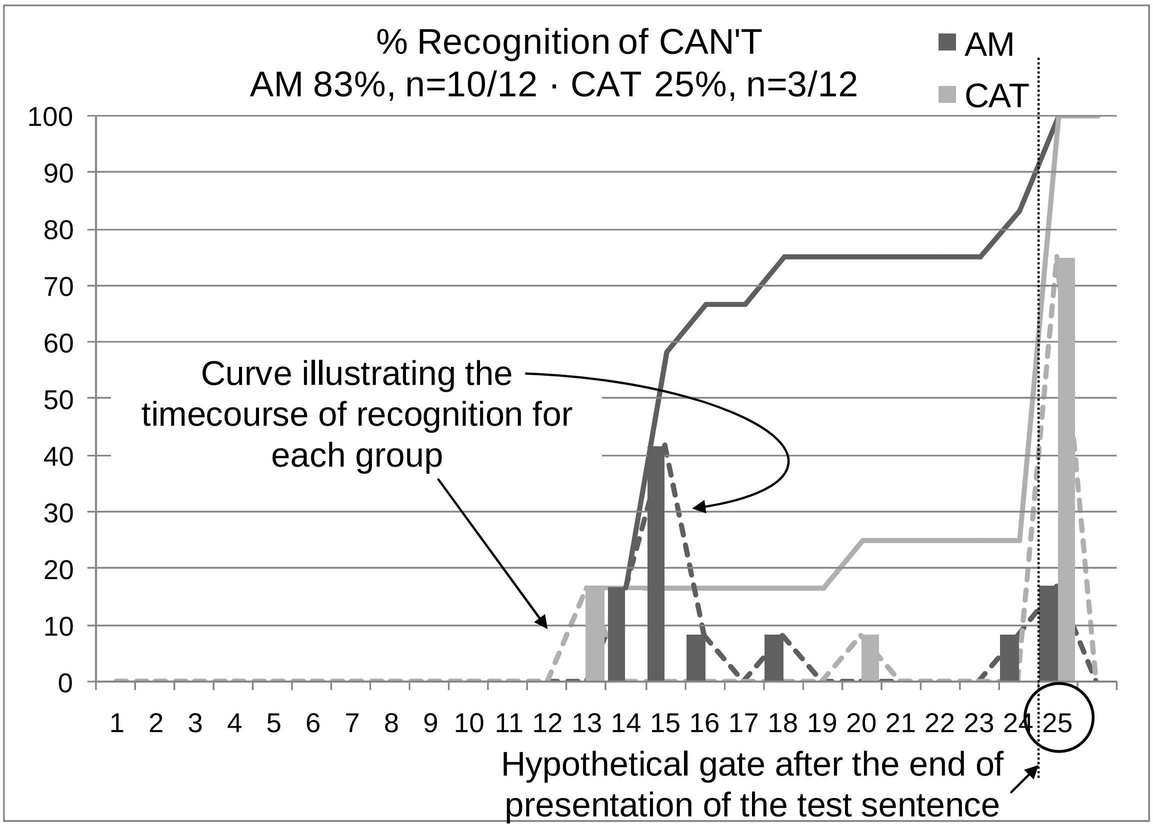


Figure 9. Examples of points at which ANOVAs were run for each group.

In addition to the histograms and the statistical data for each lexical item, an analysis was made of all of the unintended responses or "confusions" up to the point of first correct recognition for each informant. Confusions are analyzed for phonetic composition as indicated by the spelling provided by the informants. Providing a phonetic label in terms of English or Catalan spelling is challenging due to the lack of one-to-one sound spelling correspondence, therefore at times more than one possible phonetic interpretation is listed. A sound like /ʒ/, which appeared as the result of progressive manner assimilation and palatalization for IS, has no set letter symbol in the

English alphabet. Instead, the sound may be represented several ways in the language, as seen in BEIGE, AZURE, PLEASURE, and VISION. In a confusion like "ij," then, 'j,' which often translates to /dʒ/ (and does not appear in word final position), may have been the only way the listener found to transcribe /ʒ/. In cases where we cannot confirm that 'j' really represents /ʒ/ and not /dʒ/, 'j' must be interpreted as either /ʒ/ or /dʒ/. Moreover, at times, it is difficult to discern whether non-natives are trying to express what they hear using L2 phonotactics or if they are transferring L1 phonotactics. For example, in Catalan, final '-ig' would be used to represent palatal /tʃ/, *e.g.*, LLEIG, 'ugly;' while 'j' and 'g + front vowel' would be used to represent the sounds /ʒ/ or /dʒ/, *e.g.*, JO, 'I,' GERANI, 'geranium,' or FUGIR, 'to escape.' In English, these combinations would most likely be translated as /g/ for final '-ig' and some cases of 'g + front vowel or between vowels' *e.g.*, BIG, GIFT, ENGAGE, or AGATE, and /dʒ/ for 'j' and some cases of 'g + front vowel,' *e.g.*, JOKER, INJUSTICE, GIPSY, ENGINE, or AGENDA. The process of categorizing the confusions is consequently at times somewhat subjective, however it provides insight particularly in terms of language-specific effects.

3 RESULTS FOR ENGLISH

3.1 English Online Acoustic Processing

The results of online processing for the English test sentence, *Is your friend the one that can't go to bed by ten,* have been analyzed for individual word recognition and are presented in histograms in Figures 10-21. This data was originally analyzed in terms of lexical units affected by reduction processes within and across word boundaries, *e.g.*, IS YOUR, FRIEND THE, ONE THAT, etc., and presented in Pearman (2003). It has been reanalyzed in terms of individual lexical items for this study. For each figure, the percentage of listeners (n = 12) per language group reporting their **first** correct recognition[11] of the test item is plotted in bars along the ordinate. The gate number where this occurred is shown along the abscissa, underneath which is displayed the acoustic/phonetic information available at that time. Total final recognition percentage for each group, see Figure 8, is presented at the top of the histogram. Cumulative recognition across time has been plotted in a line graph for each group as well. For each histogram, the timecourse of recognition is commented on. The point of each group's peak recognition, in other words, the gate at which the greatest magnitude of recognition took place, is noted. Then the results of the ANOVAs conducted for the native and non-native language groups at the gate where native recognition reached 50% as well as for the two groups at gate 24 are presented and commented on.

Misinterpretations or "confusions" up to the point of first correct recognition for each lexical item have also been analyzed and are presented in Tables VI-XVII. Each confusion has been labeled according to the phonetic composition indicated by the spelling. For a confusion like "ish," which was frequently listed for IS, the 'sh' is

[11] The terms "recognition" and "identification" will be used synonymously throughout this section because, as Grosjean (1980:268) states, "it is not a priori clear that isolation in the gating sequence necessarily corresponds to recognition."

interpreted as a face-value reading of the overlap of /zj/, [ʒ], as an alveolopalatal fricative, and is assigned the label [ʃ]. In a confusion like "isa," though the 's' appears to be correctly interpreted phonologically as [z], it is considered a confusion because it reflects a problem of parsing from successive acoustic information.

The tables are arranged so that each confusion (provided in the "confusion" column) is listed by the first gate (in the "gate#" column) in which it appeared as a response, see Table VI as an example. Successive gates where it was still given as a response are also reported, as are the total number of subjects who listed the confusion (given in the "# of subjs" column). Note that not all of the informants counted may have given the confusion at all the gates listed, at least one participant however had to provide it as a response at a particular gate for that gate to be mentioned. Material in parentheses refers to acoustic information interpreted as pertaining to a previous or following lexical item that was not parsed from the item under analysis. Slashes separate various unparsed interpretations, where the pertinent phonetic material relating to the item under analysis does not change. For example in "gi(f/et)" for YOUR, found in Table VII, the 'f' and later 'fet' are considered interpretations of FRIEND, thus the 'gi' is analyzed as what is perceived for YOUR. Since the interpretation of YOUR does not change, the confusion is not counted more than once, so as not to add more weight to the total number of confusions for the group. Any dashes or other punctuation marks were listed by the participants themselves. Totals, provided at the top of the table, are calculated by summing the total number of participants (rather than totaling the number of confusion entries), so that the idea of the relative weighting for each confusion is more obvious. Line numbers (see the first column) have been included for reference purposes within the text. For all responses per subject see Appendix B.

3.1.1 RECOGNITION OF "IS"

3.1.1.1 IS: Word Recognition

Figure 10 shows first recognition of IS by Americans and Catalans. The offset of IS was affected by progressive manner assimilation and anticipatory palatalization, that is, an overlap of the motor commands for the upcoming /j/ of YOUR with the /z/ of IS creating a blending, [ʒ]. The gate which shows the highest amount of recognition for this item, that is, peak recognition, for Americans is gate 1 which reflects 58% recognition (7 subjects). Peak recognition for Catalans also occurred at gate 1, though the peak is not as high as the American peak, 25% or 3 subjects.

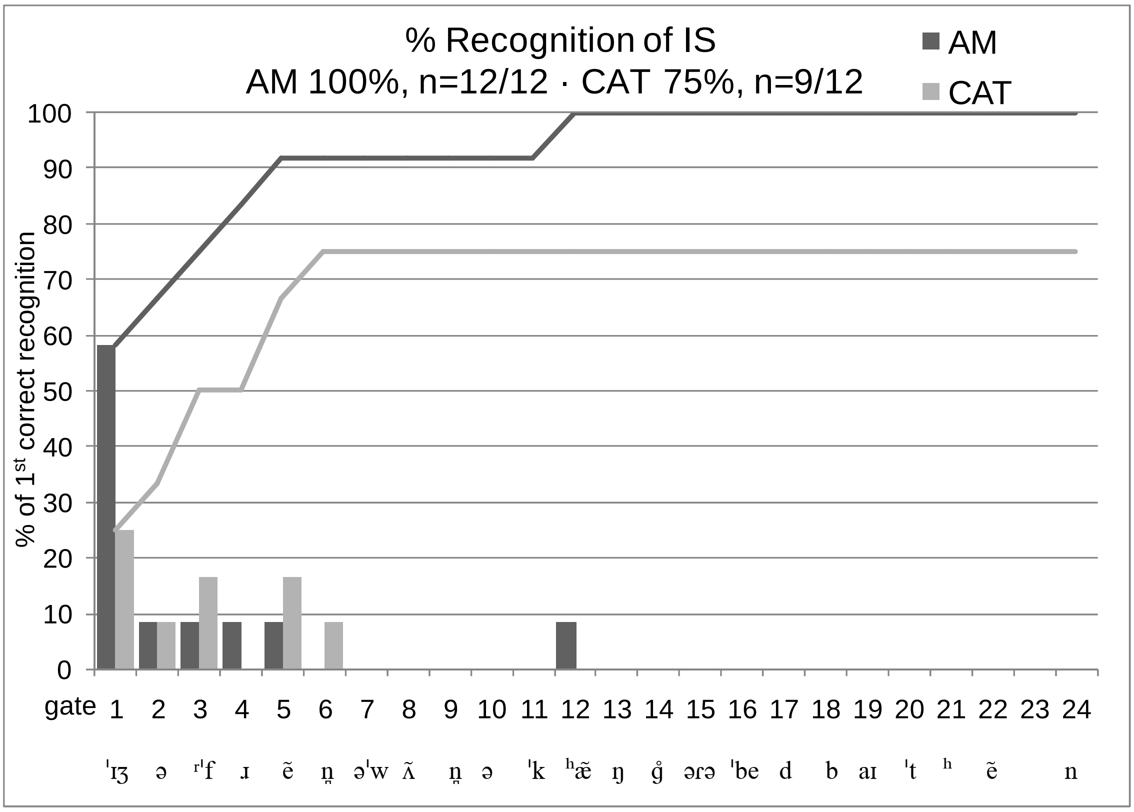


Figure 10. Percentage of Americans' & Catalans' first correct recognition of IS occurring at the gate number shown on the abscissa.

Americans achieved 50% at gate 1, however Catalans did not show 50% or more until gate 3 with the onset of FRIEND. By gate 24, Americans achieve a total of 100% recognition; Catalans also show a very high total, 92%.

ANOVAs for the American and Catalan groups for IS were conducted at gate 1, which is the point at which 50% of natives achieved recognition ($F(1,22) = 2.839$, $p = 0.106$), and on the distribution of recognition for each group across gates to analyze the timecourse of recognition ($F(1,22) = 3.557$, $p = 0.073$). For IS, neither comparison shows significant differences, this underscores the performance for both groups, which showed a high level of recognition concentrated in the first six gates.

3.1.1.2 IS: Segment Perception

Confusions for IS for Americans and Catalans are listed in Table VI, below. This item was specifically analyzed for the interpretation of what appeared in the acoustic signal as [ʒ], that is, the result of the blending of /zj/ at the offset of IS and the onset of YOUR.

Table VI. Americans' & Catalans' confusions for IS, analyzed for interpretation of [ʒ].

AM total confusions = 7									
line#	gate#	confusion	label	# of subjs	line#	gate#	confusion	label	# of subjs
1	1	Itch	tʃ	1	4	1--4	Ish	ʃ	2
2	1--2	Ij	dʒ/ʒ	1	5	3	I (jut)	dʒ/ʒ	1
3	1--2	Is(a)	z	1	6	2--11	Ij(i)	dʒ/ʒ	1
CAT total confusions = 24									
line#	gate#	confusion	label	# of subjs	line#	gate#	confusion	label	# of subjs
7	1	Ish	ʃ	6	16	2--5	E(gy)	dʒ/ʒ	1
8	1	Ij	dʒ/ʒ	1	17	3	ig(ep)	dʒ/ʒ	1
9	1--23	Each	tʃ	2	18	3--4	I-	V	1
10	2	Ish(a)	ʃ	1	19	4	ig(e)	dʒ/ʒ	1
11	2	Is-(you)	zj	1	20	4--5	A	V	1
12	2	Is-	z	1	21	5--24	If	f	2
13	2	ish(ap)	ʃ	1	22	6--7	As(ia)	z/ʒ	1
14	2--3	E(gypt)	dʒ/ʒ	1	23	24	Joe	dʒ/ʒ	1
15	2--4	i(je)	dʒ/ʒ	1					

Americans provide a total of 7 confusions for IS; Catalans show a total of 24. For both groups, the most common confusion involves a face value, phonetic interpretation of the acoustic signal, yielding responses including alveolar and alveolopalatal fricatives and affricates, “ish,” “itch,” “each,” and “Egyp(t),” rather than an analyzed phonological interpretation, /z/, “is.” Responses such as “Is-you” and “Is-” (lines 11 and 12) are considered confusions because they reflect parsing problems, in this case, it specifically shows that the informant did not view the item as a lexical unit on its own, but as the buildup to a longer word.

3.1.2 RECOGNITION OF "YOUR"

3.1.2.1 YOUR: Word Recognition

Recognition for YOUR by Americans and Catalans is plotted in Figure 11. The onset of YOUR was affected by progressive manner assimilation and anticipatory palatalization or the overlap between the offset of IS, /z/, with the onset of YOUR, /j/, yielding [ʒ]. The vowel of YOUR was also reduced to schwa. Peak recognition for this item for Americans, 33% or 4 listeners, falls very early at gate 2, when only the vowel of YOUR has been introduced in the signal. The peak for Catalans, 25%, falls slightly

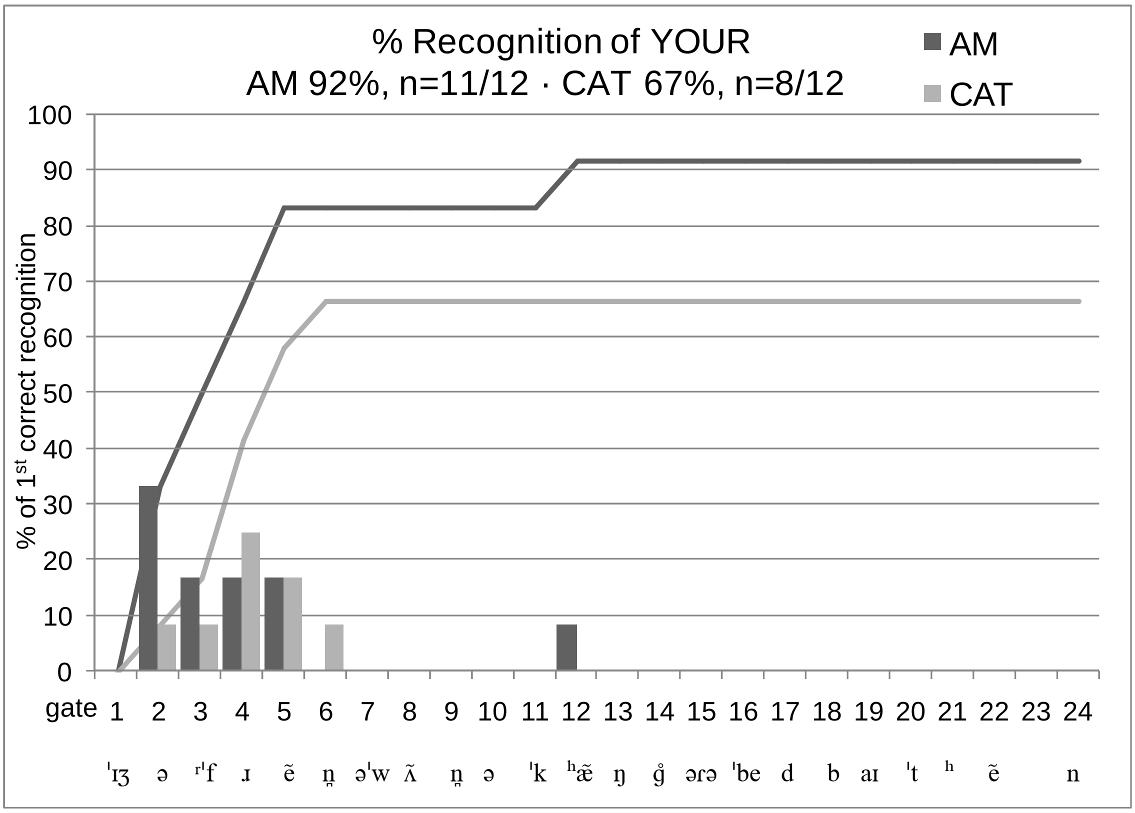


Figure 11. Percentage of Americans' & Catalans' first correct recognition of YOUR occurring at the gate number shown on the abscissa.

later at gate 4, after the next word FRIEND has already been introduced in the signal and after Americans have already reached 50% recognition (gate 3). The total amount of recognition for Americans remains at 92%, while Catalan recognition is 67%.

The first ANOVA for YOUR was run at gate 3 ($F(1,22) = 3.143$, $p = 0.090$), at the onset of the following word in the acoustic signal. Though there is a difference of 33% between the two groups at this point, this difference is not large enough to be significant[12]. The second ANOVA's results ($F(1,22) = 2.266$, $p = 0.146$) does not show significant differences either. Like IS, YOUR shows the majority of recognition for both groups concentrated in the first six gates.

3.1.2.2 YOUR: Segment Perception

Confusions for YOUR are listed below in Table VII. The American total is 16; the Catalan total is 27. Confusions for YOUR were analyzed with respect to interpretations of the progressive manner assimilation and palatalization, /zj/ → [ʒ], at the onset of the word. The table shows that a quarter of the American confusions and well over a third of the Catalan confusions reflect backtracking of the reduction to /zj/ (marked /j/ in the "label" column). This suggests that once Americans identified [ʒ] as the result of reduction, they did not take long to correctly recognize YOUR. Catalans on the other hand needed more time to identify the item, resulting in a greater number of confusions and fewer correct recognitions of the item (four of the Catalan informants did not recognize YOUR). The remainder of the confusions for both groups involve

[12] That this difference is not significant is somehow surprising. Results were double checked however and the result is correct. Each informant represents 8.33% of the total. In cases where the difference in recognition percentages between the two groups at the gate at which Americans achieved 50% or more fell within the range of 0 to 33%, the differences were not significant. If the difference fell within the range of 42 to 100% (though the maximum difference was only 66%), the differences were significant.

underanalysis (those marked /ə, ɪ/ for example) and thus result in responses involving a misinterpretation of the onset of the item.

Table VII. Americans' & Catalans' confusions for YOUR, analyzed for interpretation of [ʒ].

AM total confusions = 16										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	1--3	(Is)a	ə	2		7	3	you(f)	j	2
2	2	(ij)a	ə	1		8	3	jut	dʒ/ʒ	1
3	2	it	ɪ	1		9	4	ga(f)	ʒ/g	2
4	2	(ij)it	ɪ	1		10	5	ja(fa)	dʒ/ʒ	1
5	2--4	ya	j	2		11	6	e(ffect)	ə	1
6	2--4	(Ish-)uv	ə	1		12	7--24	i(f I)	ɪ	1
CAT total confusions = 27										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
11	1	Y	j	1		22	3	(I)yu	j	1
12	2	(Is)-you	j	1		23	3	(ig)ep	ə	1
13	2	(Is)u	j/u	1		24	3--23	o(f)	ʌ	1
14	2	(Ish)a	ə	1		25	3--24	you	j	4
15	2	(ish)ap	ə	1		26	4	(ig)e(fa)	ə	1
16	2	ya	j	1		27	4--5	(iz)e	ə	1
17	2	e	ə	1		28	4--5	gi(f/et)	ʒ/g	1
18	2--3	(E)gypt	dʒ/ʒ	1		29	6	just	dʒ/ʒ	1
19	2--3	yo	j	2		30	6--7	(As)ia	ə/i	1
20	2--4	(i)je	dʒ/ʒ	1		31	7--23	ju(v had)	dʒ/ʒ	1
21	2--5	(E)gy	dʒ/ʒ	2		32	8--24	I		1

3.1.3 RECOGNITION OF "FRIEND"

3.1.3.1 FRIEND: Word Recognition

American and Catalan first recognition for FRIEND is shown in Figure 12. FRIEND'S offset, /nd/, was affected by regressive place assimilation involving dentalization and deletion of the following dental fricative. That is, there was an overlap of the motor commands for the onset gesture for THE, /ð/, with the offset of FRIEND, /nd/, causing a blending—a nasal alveolar articulated at the constriction location for the dental fricative, [ð], which itself did not reach target articulation.

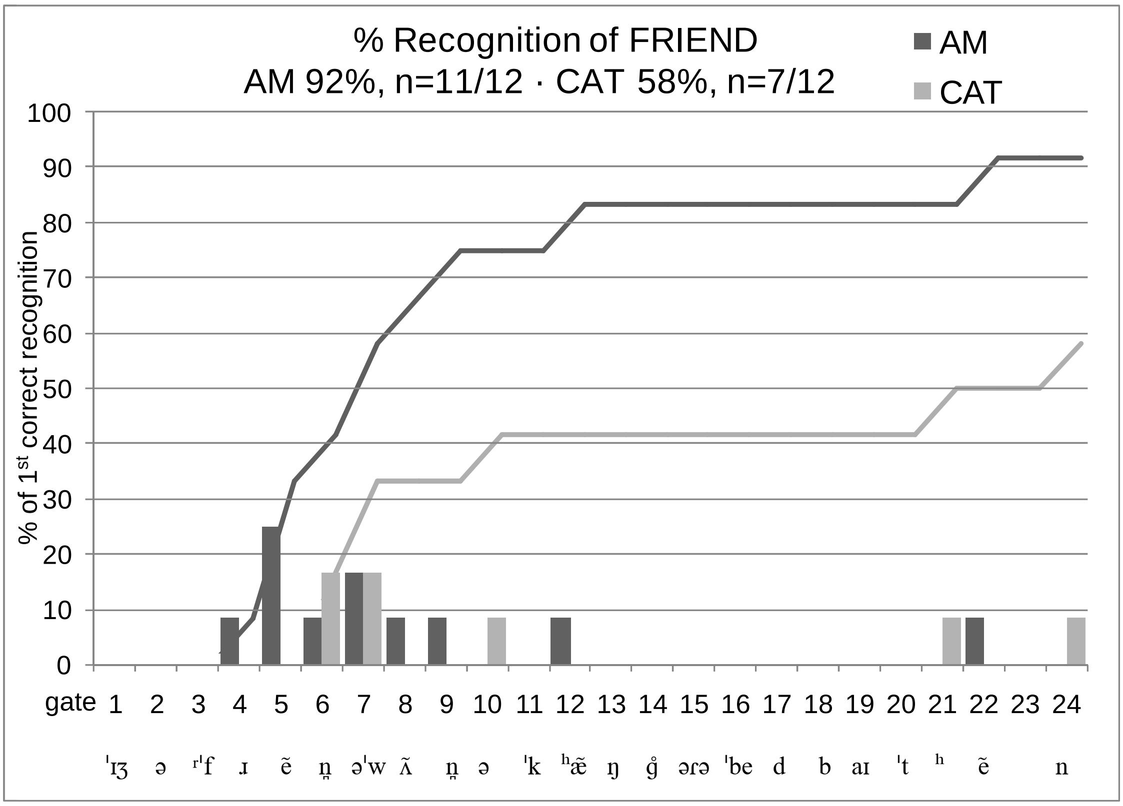


Figure 12. Percentage of Americans' & Catalans' first correct recognition of FRIEND occurring at the gate number shown on the abscissa.

Peak recognition for Americans, 25%, falls at the same point as the introduction of the vowel of FRIEND, gate 5. There are two high points of recognition for Catalans, at gates 6 and 7, 17% each, at the offset of FRIEND and the onset of THE, the second of which is where natives reach 50%. Total recognition for Americans stays static at 92%, while Catalan recognition is 58%.

ANOVAs for FRIEND were run at gate 7 ($F(1,22) = 1.478$, $p = 0.237$), after THE is available in the acoustic signal, and across gates ($F(1,22) = 5.518$, $p = 0.028$). Though the ANOVA on the magnitude of recognition at the native 50% point does not reach significance, the comparison of the distribution across gates does reach significance. This is due to non-native recognition starting later and the fact that 5 non-natives never recognize the item. Keep in mind that non-recognition was analyzed as "recognition" after the end of the test sentence, at a hypothetical gate 25. This causes the distribution curve for non-natives to be weighted in the direction of later gates, while the distribution for natives is concentrated at earlier gates.

3.1.3.2 FRIEND: Segment Perception

The confusions for FRIEND for Americans and Catalans are listed in Table VIII. For this item, the total number of American confusions is 29, compared to 43 for Catalans. The principal focus of the analysis for FRIEND was the interpretation of its offset to see if listeners could restore the complete underlying final consonant cluster. Interestingly, when Americans restored a phonological /t or d/ in the coda, lines 7-12, they did not report a nasal; when they did report a nasal, they did not report a final /t or d/, see lines 13-16. Catalans too show a somewhat similar trend, however, when they reported a nasal, they also restored the phonological /d/, lines 41, 43 and 46. For both groups there are many missing [ɹ]s, see lines 8-16 for natives as well as the majority of Catalan confusions, and, strikingly, the perception of a vowel lower than /e/, *e.g.*, lines 4-5, 8-10, 13, 16, 24-25, 28-29, 31, 33-37, 39, 42 and 45, often with no accompanying nasal (N), lines 4-5, 8-10, 24, 28-29, 31, 33-37, 39, 42, and 45, was persistent.

Table VIII. Americans' & Catalans' confusions for FRIEND, analyzed for interpretation of [n̪].

AM total confusions = 29									
line#	gate#	confusion	label	# of subjs	line#	gate#	confusion	label	# of subjs
1	3--4	f	inc	8	9	5--11	(iji)fat	t	1
2	4	(ga)f	inc	1	10	6	fat	t	2
3	4--5	fe	inc	2	11	6	feth	θ	1
4	4--5	fa	inc	4	12	6	(e)ffect	kt	1
5	5	(ja)fa	inc	1	13	7--8	fen(a/o/oi)	n	2
6	5	fr	inc	1	14	7--8	fin(al)	n	1
7	5--6	fret	t	1	15	7--24	(i)f I kn(ow)	n	1
8	5--6	fact	kt	1	16	9--21	fan	n	1
CAT total confusions = 43									
line#	gate#	confusion	label	# of subjs	line#	gate#	confusion	label	# of subjs
17	3	(Egy)b	inc	1	33	5--6	fath	θ/ð	3
18	3	(yu)v	inc	1	34	5--23	(o)f at	t	1
19	3--4	f	inc	3	35	5--24	fat	t	5
20	3--4	(o)f	inc	1	36	6	efac	k	1
21	4	(Egy)f	inc	1	37	6	fad	d	1
22	4	(gi)f	inc	1	38	6	fred	d	1
23	4	(je)f	inc	1	39	6	father	θ/ð	1
24	4	(e)fa	inc	1	40	6--24	fed	d	1
25	4	fam	m	1	41	7	fend(up)	nd	1
26	4	(e)v	inc	1	42	7--23	(ju)v had	d	1
27	4	(you')ve	inc	1	43	7--24	find	nd	1
28	4--5	fa	inc	4	44	8--9	fen	n	1
29	5	(e)fat	t	1	45	19--23	flat	t	1
30	5	(gi)fet	t	1	46	24	fond	nd	1
31	5	(you')ve fath	θ/ð	1	47	24	feared	d	1
32	5	fre	inc	2					

The identification of a low vowel in this context is evidence of the perceptual effect of nasalization on vowel quality. Nasalization is known to introduce a nasal formant around 500 Hz, which may affect the perception of vowel height. Beddor, Krakow & Goldstein (1986) found that in contexts where nasalization was insufficient or excessive or when a conditioning environment was absent (creating a phonologically illegal context in English, *i.e.*, where a nasal consonant is not immediately adjacent to a vowel, American speakers identified nasalized high vowels as lower vowels. Thus, nasalization affects the perception of vowel height in certain contexts that are inconsistent with the listener's perception of the conditioning environment, triggering perceptual misidentification. As nasalization does not occur in Catalan to the degree that it does in English, many Catalans were not able to compensate for the unfamiliar extensive nasalization in the vowel. They were unable to identify the true source and instead attributed the consequences to [ẽ] and identified it as a lower vowel, which likely inhibited a higher total percentage of recognition for FRIEND.

Parsing was also a problem for both Americans and Catalans as seen by the numerous responses marked with parentheses. This is curious because FRIEND was stressed. According to the Metrical Segmentation Strategy put forth by Cutler & Norris, (1988), strong syllables, or syllables that receive greater prominence, should be privileged points for hypothesizing word boundaries and initiating lexical searches. Data on processing English have shown clear effects of metrical stress patterns (Cutler & Norris, 1988; Cutler & Butterfield, 1992), as have data on Dutch (Vroomen & de Gelder, 1997). It is interesting then that Americans were not immediately taking into account the fact that stressed [ˈf], introduced in gate 3, is the onset to a stressed syllable. Speakers of other languages such as French, Catalan, and Spanish, however, have been shown to display greater sensitivity to the syllable, though stress remains an important parameter for Catalan and Spanish speakers (Sebastián-Gallés, Dupoux, Seguí, & Mehler, 1992). It is true that non-natives show a good deal of misparsing, lines 17-18, 20-24, 26-27, 29-31, 34, 41 and 42, but so did natives who took longer to identify the lexical item, lines 9 and 12-15.

3.1.4 RECOGNITION OF "THE"

3.1.4.1 THE: Word Recognition

Recognition for THE, which was affected by the same processes as the offset of FRIEND, /ndð/ > [n̺], is plotted in Figure 13. The peak point of American recognition, 33%, occurs at gate 7, when THE has been fully introduced in the acoustic signal. The peak point of Catalan recognition, 17%, falls at gate 9, with the offset of ONE. Though American total recognition remains stable at 92%, Catalan recognition drops drastically to 25%.

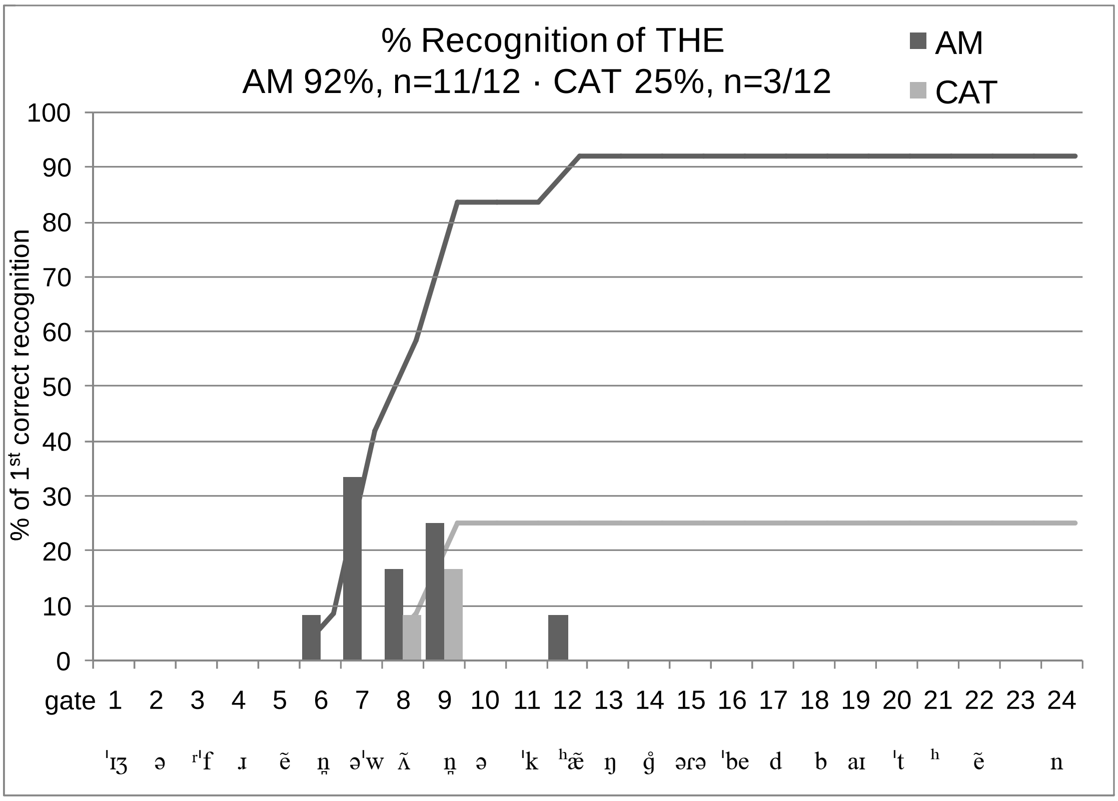


Figure 13. Percentage of Americans' & Catalans' first correct recognition of THE occurring at the gate number shown on the abscissa.

Weak and late recognition by non-natives led to statistical differences between natives and non-natives. At the point of 50% native recognition, gate 8, concurrent with the vowel of the following lexical item in the signal (F(1,22) = 8.609, p = 0.008), and across gates (F(1,22) = 19.322, p = 0.000) differences in recognition are statistically significant.

3.1.4.2 THE: Segment Perception

Despite the reduction of THE in the acoustic signal, American confusions only total 9, while Catalan confusions total 23, as seen in Table IX. THE was analyzed for the interpretation of its onset. The most frequent confusion was /n/, indicating a face value reading of the signal. The most common response across the board was "no" or similar, which once identified by many Catalan listeners was retained through gate 24.

Table IX. Americans' & Catalans' confusions for THE, analyzed for interpretation of [n̥].

AM total confusions = 9										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	7	no	n	1		5	7--11	no(na)	n	1
2	7	(fen)a	n	1		6	7--24	(kn)ow	n	2
3	7	(fen)o	n	1		7	8	th	ð	1
4	7--8	(fin)al	n	1		8	8	(fen)oi	n	1
CAT total confusions = 23										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
9	7	n	n	1		16	8	none	n	1
10	7	an	n	1		17	8--13	know	n	1
11	7	nel	n	1		18	21--23	a	V	1
12	7	ol	V	1		19	24	not	n	1
13	7	(fend)up	V	1		20	24	that no	ð	1
14	7--20	nou	n	2		21	24	he	h	1
15	7--24	no	n	10						

3.1.5 RECOGNITION OF "ONE"

3.1.5.1 ONE: Word Recognition

American and Catalan recognition of ONE is shown in Figure 14. ONE THAT was affected by the same processes that were seen to affect FRIEND THE, /nð/ > [n̪]. Americans show an early peak point of recognition, 50%, at gate 8, which is coincident with the vowel of ONE. The Catalan peak, 42%, falls one gate later, at gate 9, with the offset of ONE. Total recognition for Americans remains at 92%, while Catalan recognition springs to 75%.

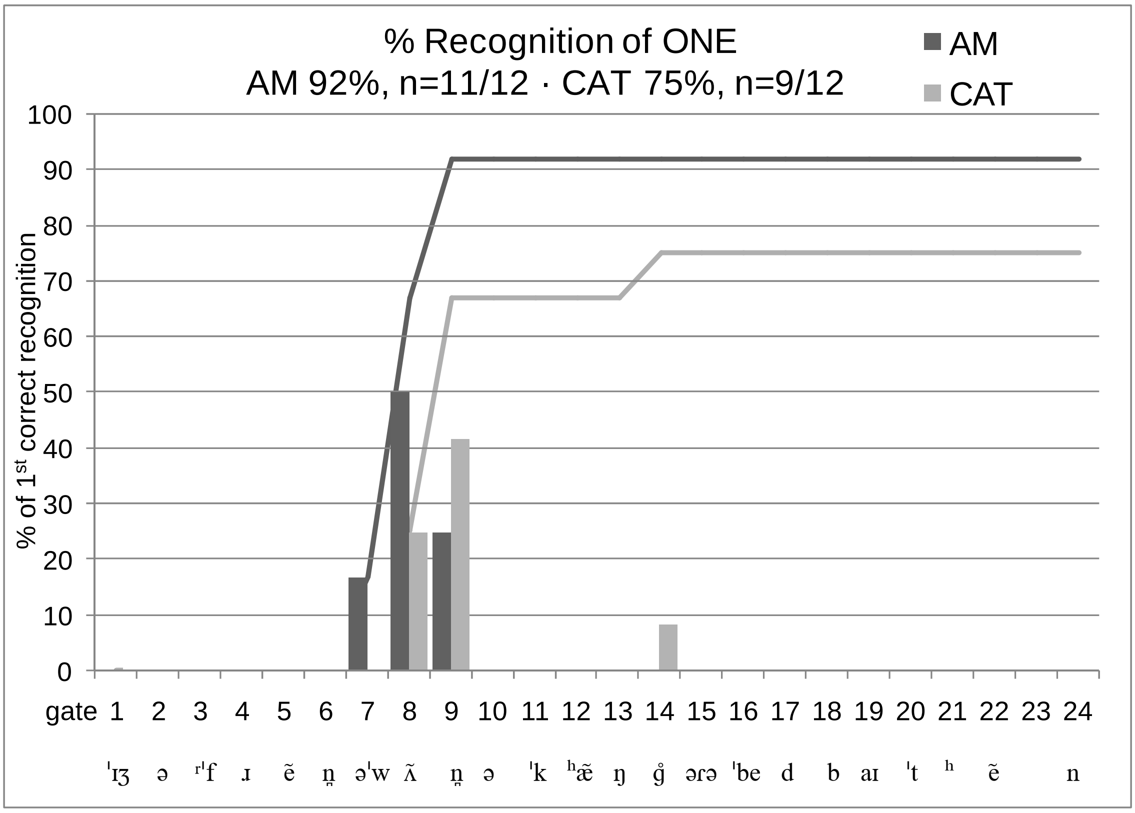


Figure 14. Percentage of Americans' & Catalans' first correct recognition of ONE occurring at the gate number shown on the abscissa.

The distributions of recognition for both groups are similar, however, the majority of Catalan recognition began later, causing the ANOVA run at gate 8 ($F(1,22)$

= 4.661, p = 0.042) to yield significant differences. Non-native recognition recovered quickly enough however for the ANOVA conducted on the distribution across gates (F(1,22) = 2.031, p = 0.168) to show non-significant differences.

3.1.5.2 ONE: Segment Perception

The number of total confusions, listed in Table X, for both Americans and Catalans is low, 3 and 14 respectively. ONE was analyzed for interpretation of its offset. As regards the Catalan confusions, about one half shows recognition of the nasal. Many show the lack of the approximant, /w/, which may have been misparsed somehow as the offset of the common misinterpretation "know" or "nou," [noʊ]. It may also be observed that ONE was stressed, though this is not working as an aid to locating the onset for many, particularly Catalan, listeners as reflected by these confusions.

Table X. Americans' & Catalans' confusions for ONE, analyzed for interpretation of [n̪].

AM total confusions = 3										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	8	I	inc	1		3	10--24	when	n	1
2	9	Im	m	1						
CAT total confusions = 14										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
4	8	I	inc	2		8	9--20	and	n/nd	2
5	8	wa	inc	1		9	10--12	an(a/k)	n	1
6	8,12--24	a	inc	3		10	10--23	an(e/c)	n	1
7	9--11,13	an	n	4						

3.1.6 RECOGNITION OF "THAT"

3.1.6.1 THAT: Word Recognition

Figure 15 represents American and Catalan recognition for THAT, which in addition to the reductions induced by preceding ONE, also shows a reduced vowel, /æ/ > [ə], and reduction at the offset, where /t/ was either dropped or assimilated to the following [k] and reduced in time, /t/ > [k˺k] > [k]. Americans demonstrate a notably high peak, 83%, right when the vowel for THAT is introduced, at gate 10.

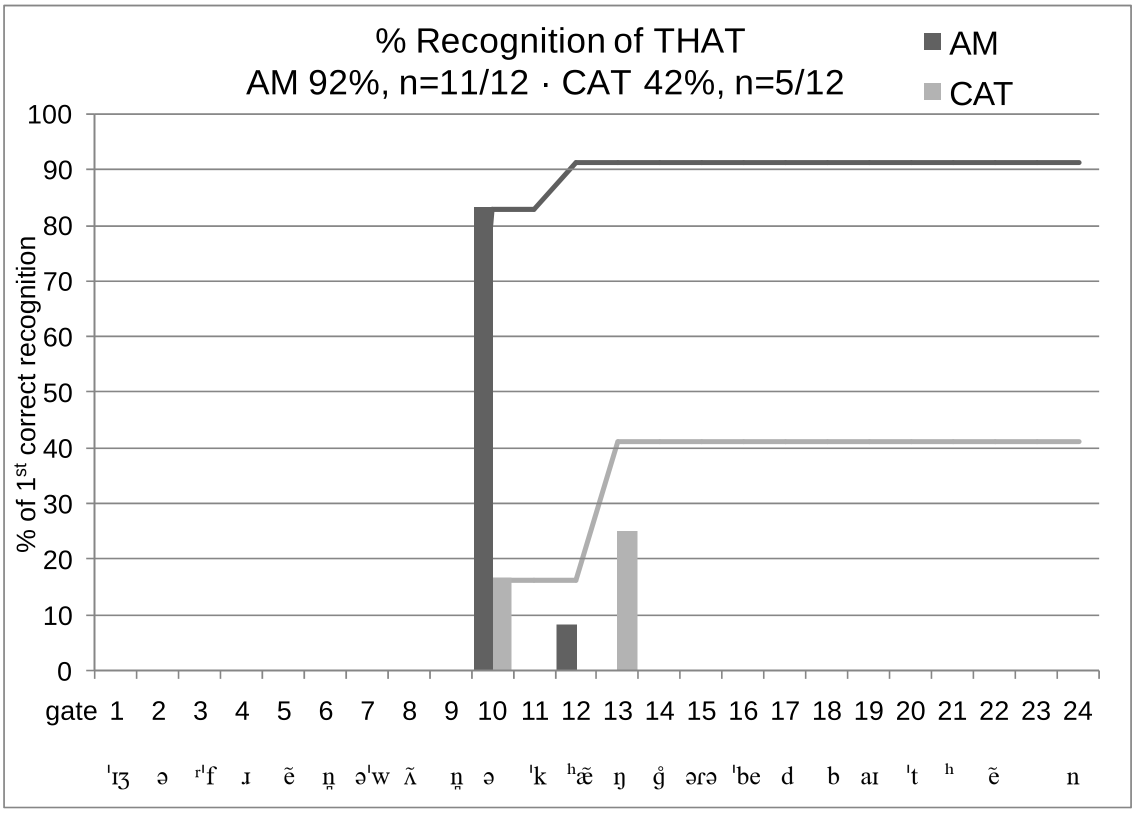


Figure 15. Percentage of Americans' & Catalans' first correct recognition of THAT occurring at the gate number shown on the abscissa.

Given the severe reduction of THAT in the acoustic signal, such quick and high recognition indicates THAT was highly predictable. The much lower Catalan peak, 25%, occurs somewhat later at gate 13, at the offset of CAN'T. American total recognition is static at 92%. Catalan recognition for THAT, 42%, is higher than the total for THE, again supporting the suggestion that THAT was somewhat predictable.

The first ANOVA for THAT was conducted at gate 10 ($F(1,22) = 17.6$, $p = 0.000$). Though Catalans show some degree of recognition at this point, the difference between the two groups is clearly large enough to reach significance. The second ANOVA ($F(1,22) = 11.730$, $p = 0.002$) also shows significant results. As THAT was so highly reduced in the acoustic signal, listeners could not rely solely on the acoustic signal to identify the lexical item. Though this was not a problem for most Americans, many Catalan non-recognizers may not have recognized enough of the previous input to employ top-down strategies relating to higher-level grammatical/syntactic knowledge in order to recognize THAT.

3.1.6.2 THAT: Segment Perception

As Table XI shows, the number of total American confusions is slight, 2. Catalans in turn yield a total of 23 confusions. THAT was analyzed for its onset, which most often was interpreted as involving /n/ or a vowel. This reflects a problem of extracting THAT from preceding and following lexical items. For example, "necka," line 13, most likely reflects the perception of the nasal of ONE, the vowel of THAT, and the velar of CAN'T.

Table XI. Americans' & Catalans' confusions for THAT.

AM total confusions = 2										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	10--11	e(e)	V	1		2	10--24	I	V	1
CAT total confusions = 23										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
3	10	(an)a	V	1		12	11--12	naik	n	2
4	10	ne	n	1		13	11--12	neck(a)	n	1
5	10	neck	n	1		14	11--12	(an)ak	V	1
6	10	ec	V	1		15	12	ac(e)	V	1
7	10--11	ac	V	1		16	12--13	e(ke)	V	1
8	10--11	(an)ec	V	1		17	12--23	(an)e	V	1
9	10--11	egg	V	2		18	12--23	naked	n	1
10	10--18	at(k)	V	1		19	13--24	I	V	3
11	10--24	like	l	2		20	24	naked/nak	n	1

3.1.7 RECOGNITION OF "CAN'T"

3.1.7.1 CAN'T: Word Recognition

Recognition for CAN'T by Americans and Catalans is shown in Figure 16. The articulation of CAN'T may be described as involving consonant deletion and regressive place assimilation, or it may be described as a blending of the gestures /n/ and /g/ due to overlap, causing /t/ to become completely hidden and the nasal to become velar, /ntg/ > [ŋg]. American peak recognition, 42%, occurs when TO is introduced in the signal, at gate 15. Catalan peak recognition, on the other hand, 17%, occurs at the offset of CAN'T, at gate 13. Total recognition for Americans is 83%. Catalan total recognition, 25%, is noticeably lower for this item.

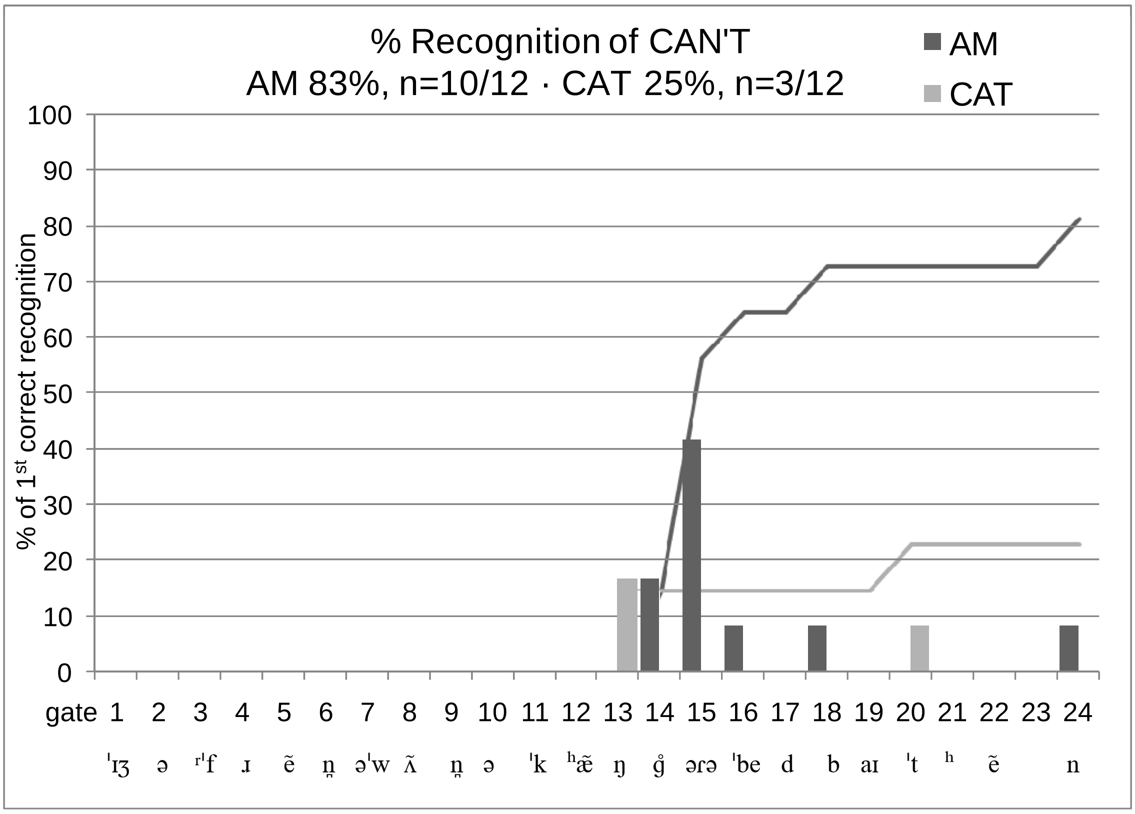


Figure 16. Percentage of Americans' & Catalans' first correct recognition of CAN'T occurring at the gate number shown on the abscissa.

The ANOVA conducted at gate 15 ($F(1,22) = 5.0$, $p = 0.036$), the point of 50% native recognition, yields significant differences, due to low Catalan recognition. The ANOVA across gates ($F(1,22) = 7.350$, $p = 0.013$) also, unsurprisingly, produces significant differences

3.1.7.2 CAN'T: Segment Perception

The total number of confusions for Americans is 22 and the total for Catalans is 28, shown in Table XII. CAN'T was analyzed for its offset. The main obstacle for listeners, as is apparent from the table, was confusion between "can" and CAN'T. All Americans at some point provided "can" as a response, as did 9 Catalans. Why should there be such a strong tendency toward identifying "can" rather than CAN'T?

Table XII. Americans' & Catalans' confusions for CAN'T, analyzed for interpretation of [ŋ].

AM total confusions = 22										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	11	c	inc	1		4	12--24	can	n	12
2	11	ka	inc	1		5	12	came	m	1
3	11--13	ca	inc	6		6	22	could	d	1
CAT total confusions = 28										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
7	11	(ec)a	inc	1		17	12--13	(e)can	n	1
8	11	(at)k	inc	1		18	12--13	(e)ke	inc	1
9	11	c	inc	1		19	13,15--23	an	n	1
10	11--24	can	n	9		20	14	can(k)	n	1
11	12	ca	inc	1		21	14	an(k)	n	1
12	12	ka	inc	1		22	15--18	can(ka)	n	1
13	12	(ak)a	inc	1		23	15--24	an(gue)	n	1
14	12	a	inc	2		24	24	ken	n	1
15	12	(neck)a	inc	1		25	24	Anne	n	1
16	12	(ac)e	inc	1						

A possible answer lies in the suprasegmental treatment of modals in English. In English, a modal is stressed when it is either contrastive, /kæn/, or negative, /kænt/. If the pronunciation of negative CAN'T were to be reduced by dropping the /t/ between consonants, as in the test sentence, both contrastive [kæn] and reduced negative [kæn] would sound identical.

Comparing Table XII and Figure 16 also makes clear that identification of "can," gate 12, actually occurs earlier than recognition of CAN'T, gate 14; thus, it was the first choice for most listeners. Furthermore, the problem of parsing CAN'T from preceding THAT and following GO was critical for Catalans, as may be seen in responses like "necka," "canka," "angue," etc. No Americans however show misparses.

3.1.8 RECOGNITION OF "GO"

3.1.8.1 GO: Word Recognition

Recognition of GO is shown in Figure 17. GO was highly reduced due to diminished voicing at onset as well as the reduction of the vowel, [g̊ə], because of lack of stress. Though American recognition for this item is lower, 67%, than for other items, Catalans show no recognition for GO. Americans show a peak at gate 17, 33%, coincident with the offset of BED. The point of 50% native first recognition is not reached until gate 22, however, and there is even some first recognition in later gates (gate 23, 8%, and gate 24, 8%).

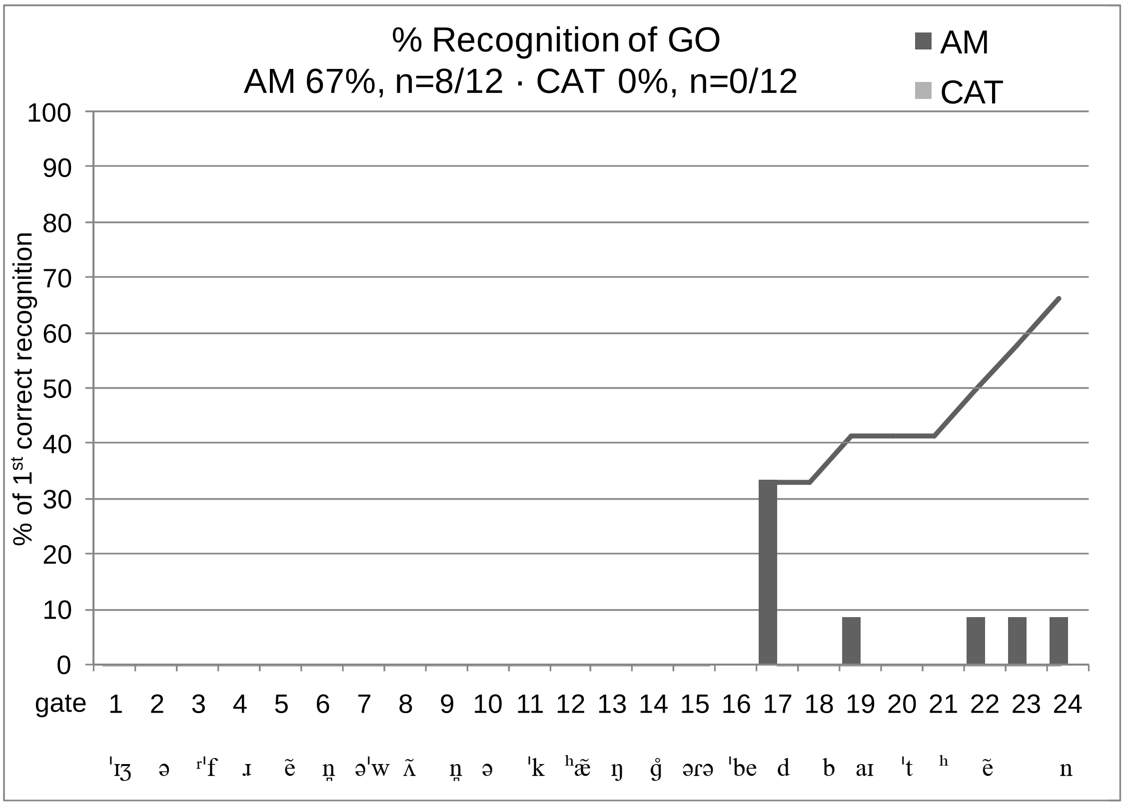


Figure 17. Percentage of Americans' & Catalans' first correct recognition of GO occurring at the gate number shown on the abscissa.

The ANOVAs run at gate 22 ($F(1,22) = 11.0$, $p = 0.003$) and across gates ($F(1,22) = 13.073$, $p = 0.002$) show significant differences.

3.1.8.2 GO: Segment Perception

Confusions for GO for Americans and Catalans are listed in Table XIII. The American total number of confusions for this item is 25, while the Catalan total is only slightly higher, 30. GO was analyzed for interpretation of its devoiced onset. As the table shows, correct interpretation of GO with an initial /g/ was a roadblock for both groups. [k] is a much more frequent interpretation particularly for non-natives. Of the 30 Catalan confusions, 25 cases report [k] and half of the American confusions show [k].

Table XIII. Americans' & Catalans' confusions for GO, analyzed for interpretation of [g̊].

AM total confusions = 25										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	14	g	g	1		8	15	co	k	1
2	14	c	k	3		9	15	co(duk)	k	1
3	14	ge	g	1		10	15--16	ca(d)	k	1
4	14	on	V	1		11	16	ca(du)	k	1
5	14	coo	k	1		12	16--17	could	k	1
6	14--24	ge(t)	g	10		13	18--20	cu(t)	k	1
7	15	c(d)	k/s	1		14	21	could	k	1
CAT total confusions = 30										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
15	13	(can)c	k	1		25	15--17	cu(t)	k	1
16	14	g	g	2		26	15--18	(can)ka(r/o)	k	1
17	14	k	k	2		27	15--20	kind	k	1
18	14	com	k	1		28	15--23	ce(re)	k	1
19	14	(can)k	k	1		29	15--24	coul(d)	k	5
20	14	(an)k	k	1		30	15--24	kin(d o)	k	3
21	14	c	k	1		31	15--24	ca(re)	k	2
22	14--15	cu	k	2		32	15--24	(an)gue(ro)	g	1
23	14--24	ge(t)	g	2		33	19--22	coul(dn't)	k	1
24	15	ku	k	1						

Additionally, as Table XIII suggests in line 6 and Table XIV makes abundantly clear, "get (a)" proved to be a strong competitor for GO (TO), particularly for Americans. "Get a" is a viable interpretation of an ambiguous acoustic signal, given the unexpected reduction of the stressed vowel in GO (TO), /ˈgoʊtə/ > [g̊əɾə]. Here stress and the corresponding full vowel that it would reinforce could not be used as tools to deciphering the signal; so, "get a" was identified by most informants before GO (TO), gate 14 versus gate 17, likely because it is the more obvious choice given the input.

3.1.9 RECOGNITION OF "TO"

3.1.9.1 TO: Word Recognition

First recognition for TO by Americans and Catalans is shown in Figure 18. TO showed a flapped /t/, as well as the reduced vowel [ə]. Interestingly, recognition for TO mirrors that of recognition for GO, reaffirming that recognition of GO was dependent on TO and vice versa. Americans show 67% total recognition for this item, with a peak of 33% at gate 17, the offset of BED, and recognition occurring through gate 24. Catalans show no recognition for this item.

The ANOVA results are identical to those for GO. Results at gate 22 ($F(1,22) = 11.0$, $p = 0.003$) and gate 24 ($F(1,22) = 13.073$, $p = 0.002$) are significant.

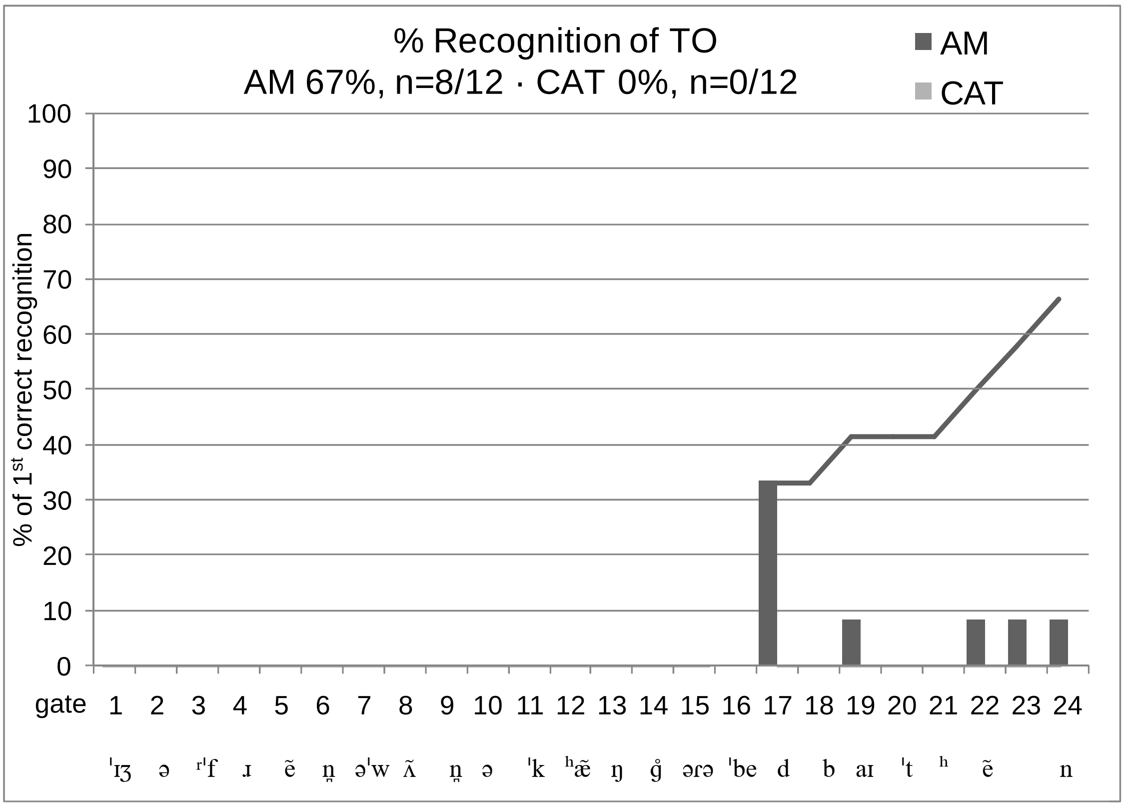


Figure 18. Percentage of Americans' & Catalans' first correct recognition of TO occurring at the gate number shown on the abscissa.

3.1.9.2 TO: Segment Perception

Confusions for TO for Americans, 22, and Catalans, 25, may be seen below in Table XIV. TO was analyzed for its initial consonant. As mentioned for GO, the interpretation and parsing of [g̊ərə] as "get a" was extremely frequent, as was the interpretation of [g̊] as /k/. These misidentifications for GO clearly affect the recognition of TO.

Another recurring misidentification that deserves comment was the interpretation of the flap. It was often interpreted as /d/, as in reported "could," lines 9-10, and a number of Catalan confusions show an interpretation of the flap as /r/, according to Catalan phonology, see lines 16, 20-21, 27, and 29. None of the Americans however provide interpretations of [ɾ] as /r/.

Table XIV. Americans' & Catalans' confusions for TO, analyzed for interpretation of [ɾ].

AM total confusions = 22										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	14--16	(ge)t	t	5		7	16	(ca)du	d	1
2	15	(ca)d	d	1		8	16	(ca)da	d	1
3	15	(co)duk	d	1		9	16	(coul)d	d	1
4	15	(c)d	d	1		10	17,21	(coul)d a	d	2
5	15	(ge)t ove	t	1		11	18--20	(cu)t a	t	1
6	15--24	(ge)t a	t	7						
CAT total confusions = 25										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
12	14	(ge)t of	t	1		22	16	(coul)d	d	1
13	15	(ge)t	t	1		23	16	(re)v b	b	1
14	15	(re)v	b	1		24	16--17	(cu)t up o(f)	t	1
15	15	(cu)t up	t	1		25	16--24	(coul)d ha(ve)	d	3
16	15--18	(ka)ro	r	1		26	16--24	(coul)d a	d	2
17	15--20	g	g	1		27	18	(ca)ra(bet)	r	1
18	15--24	(kin)d o(f)	d	3		28	19--22	(coul)dn't	d	1
19	15--24	(ge)t a	t	2		29	19--24	(ca)re o(f)	r	1
20	15--24	(gue)ro	r	1		30	24	a(bout)	V	1
21	15--24	(ca)re up	r	1						

3.1.10 RECOGNITION OF "BED"

3.1.10.1 BED: Word Recognition

Americans' and Catalans' recognition of BED, which involved no articulatory reduction, is shown in Figure 19. Despite the fact that BED was an unreduced item, Catalan total recognition for this item was extremely low, 17%, vis-à-vis 100% American total recognition. The peaks for the two groups, however, do occur at the same point, gate 17, with the offset of the item itself. The American peak is 67%; the Catalan peak is 17%—the only recognition for this item gate.

ANOVAs for this item run at gate 17 ($F(1,22) = 7.615$, $p = 0.011$) and across gates ($F(1,22) = 37.343$, $p = 0.000$) produce, again, unsurprisingly significant differences between native speakers' and non-natives' recognition.

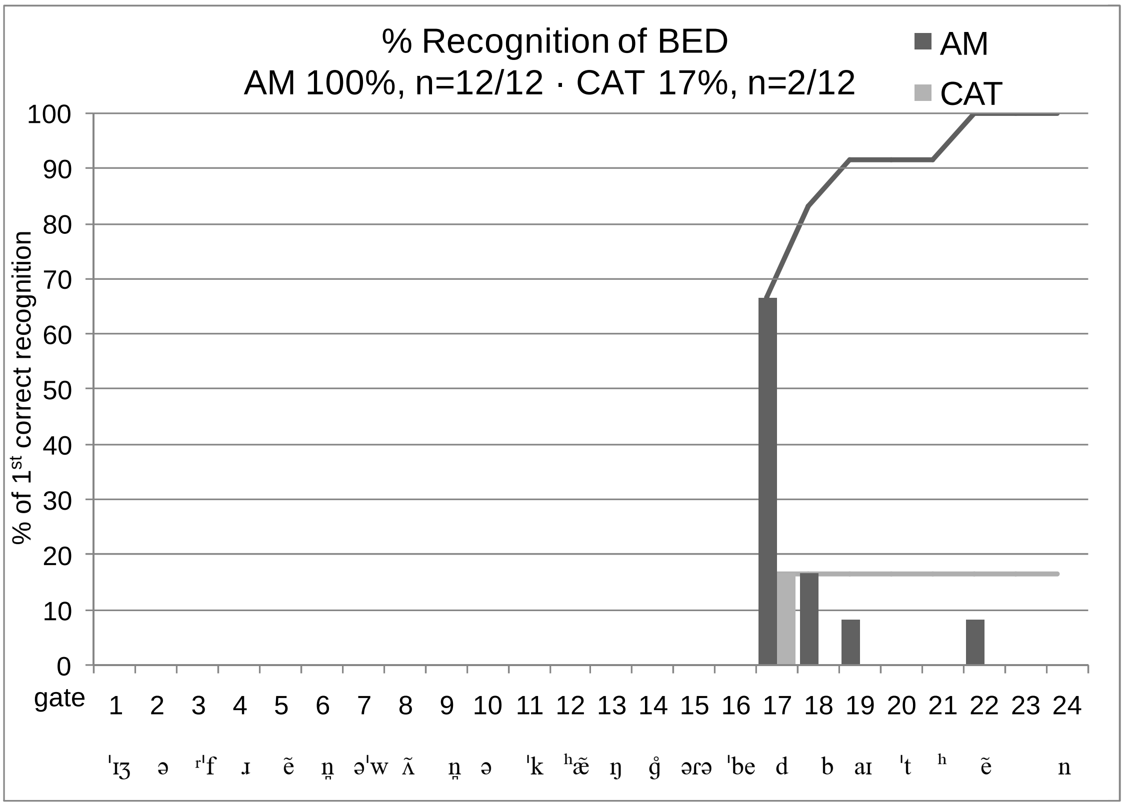


Figure 19. Percentage of Americans' & Catalans' first correct recognition of BED occurring at the gate number shown on the abscissa.

3.1.10.2 BED: Segment Perception

American total confusions, 12, and Catalan total confusions, 25, are shown below in Table XV. BED was analyzed for the interpretation of voicing of its final obstruent. Americans show two early misinterpretations, lines 5 and 6, involving voicelessness rather than voicing; however, in general they do not have problems in identifying BED. Catalans yield a slightly wider variety of confusions, most of which, 19, show voiceless interpretations of the final obstruent, even though voicing is clearly maintained throughout the gesture, see the spectrogram of *Is your friend…* in Figure 6. This is a clear influence of L1 phonology on the perception of L2.

As explained, unlike English, Catalan phonology features two voicing rules which are constantly at work in spoken Catalan: final obstruent devoicing (FOD) and regressive voicing assimilation (RVA). The phonological inventory of Catalan includes a number of obstruents that display voicing contrasts in (absolute) word initial and medial position; but, this contrast is seen to neutralize in word final position due to a final obstruent devoicing rule. When there is a following consonant, regressive voicing assimilation allows the glottal state of C_2 to spread to C_1, resulting effectively in a single glottal gesture. Thus, if C_2 is voiced, C_1 will be voiced even if it is phonologically voiceless, as in CAP DELS (CA[b] DELS), "none of them," and if C_2 is voiceless C_1, will be voiceless, as in CAP CARTA (CA[p] CARTA), "no letter," (Cebrian, 2000). This is of course not the case in English, where the voicing state for a consonant does not usually spread to neighboring consonants and, if it does, it is usually voicelessness that spreads. Instead, contrast of the final obstruent in a case like BET/BED is indicated by the preceding vowel. Therefore, it may be that Catalans are applying an L1 interpretation to the signal, causing them to judge the [d] of BED in the acoustic signal to be the result of a lexical /t/ which has become voiced due to regressive voicing assimilation to the onset of BY. An alternative interpretation is that Catalans do not pay attention to the cues to indicate the contrast between syllable-final voiced and voiceless obstruents in English, that is, vowel length, simply because Catalans do not have any contrast in this position.

Table XV: Americans' & Catalans' confusions for BED, analyzed for interpretation of voicing at offset.

AM total confusions = 12										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	16	b	inc	4		6	17	bet	vless	1
2	16	(da)b	inc	1		7	17--18	be	inc	1
3	16	g	inc	1		8	19--20	bud	vcd	1
4	16	(du)bu	inc	1		9	21	bug	vcd	1
5	16	bit	vless	1						
CAT total confusions = 25										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
10	15--16	f	inc	1		21	17--24	f bit	vless	1
11	15--16	b	inc	1		22	18	(ra)bet	vless	1
12	15--24	but	vless	3		23	19--21	(care)d up	vless	1
13	16	(or)b	inc	1		24	19--22	get	vless	1
14	16	(ha)ve b	inc	1		25	19--24	(ha)ve bet	vless	1
15	16--17	(o)f it	vless	1		26	20--24	(o)f but	vless	1
16	16--24	bit	vless	2		27	21--23	(o)f vet	vless	1
17	17--19	but(a)	vless	1		28	22--24	up	vless	1
18	17--20	that	vless	1		29	23--24	(o)f in(vite)	vcd	1
19	17--18,24	(ha)ve had	vcd	1		30	24	(a)bout	vless	1
20	17--23	(ha)ve bit	vless	2						

3.1.11 RECOGNITION OF "BY"

3.1.11.1 BY: Word Recognition

First correct recognition for BY for Americans and Catalans is plotted in Figure 20. Peak recognition, 92%, occurs at gate 19 with the offset of BY. The remainder of recognition happens with the vowel in TEN, at gates 22, Catalan, and 23, American. Total recognition for both groups is 100%.

As the degree of recognition as well as the timecourse of recognition is almost identical for both groups, ANOVAs conducted at gate 19 ($F(1,22) = 0.0$, $p = 1$) and across time ($F(1,22) = 0.040$, $p = 0.843$) do not show significant differences.

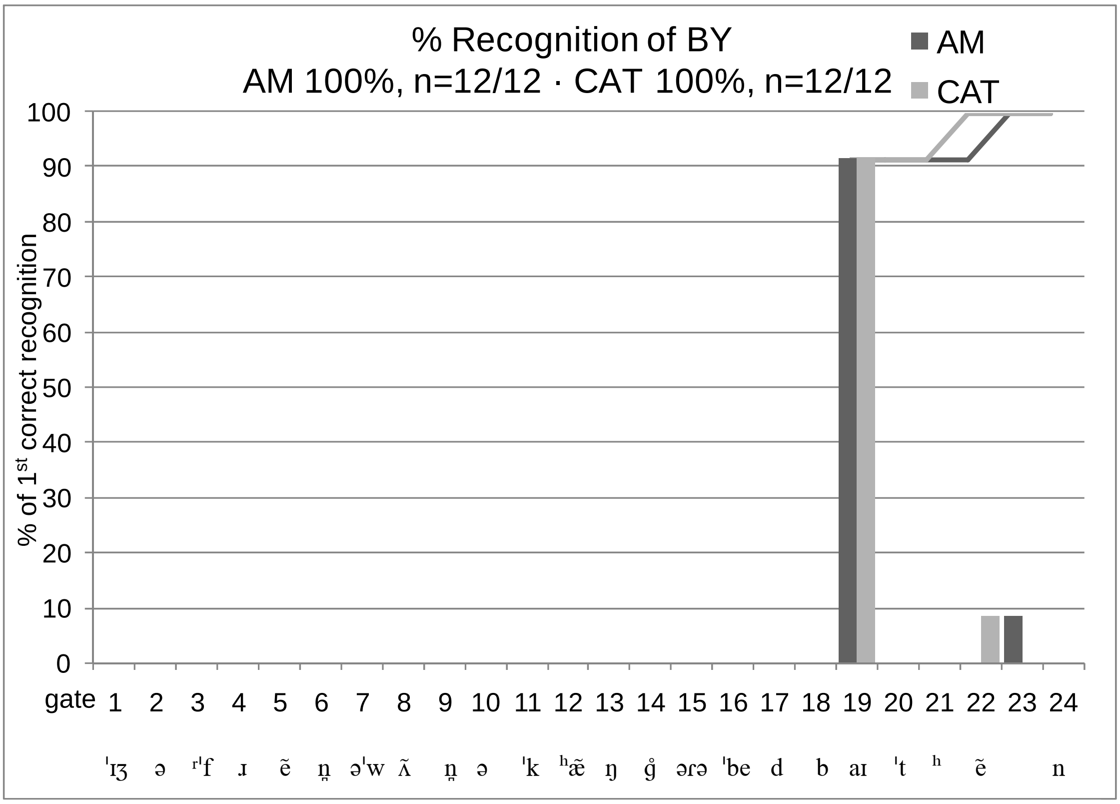


Figure 20. Percentage of Americans' & Catalans' first correct recognition of BY occurring at the gate number shown on the abscissa.

3.1.11.2 BY: Segment Perception

Table XVI shows American and Catalan confusions for BY, which were minimal, 1 and 2 respectively. It appears the only obstacle to identifying BY for some was parsing it from the onset of TEN, “bite.”

Table XVI. Americans’ & Catalans’ confusions for BY.

AM total confusions = 1										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	19--22	bi(te)	parse	1						
CAT total confusions = 2										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
2	18	bu	u	1		3	19--21	bi(te)	parse	1

3.1.12 RECOGNITION OF "TEN"

3.1.12.1 TEN: Word Recognition

American and Catalan recognition for the last item in the test sentence, TEN, an unreduced item, is shown in Figure 21. As with BY, TEN shows very high total recognition for both groups, 100% for Americans and 92% for Catalans. The peaks however for the two groups are different. Americans show two high peaks, 33% each, at gates 21 and 22, concurrent with the aspiration of /t/ and the vowel of TEN. The Catalan peak, 50%, however does not occur until the offset of TEN at gate 24.

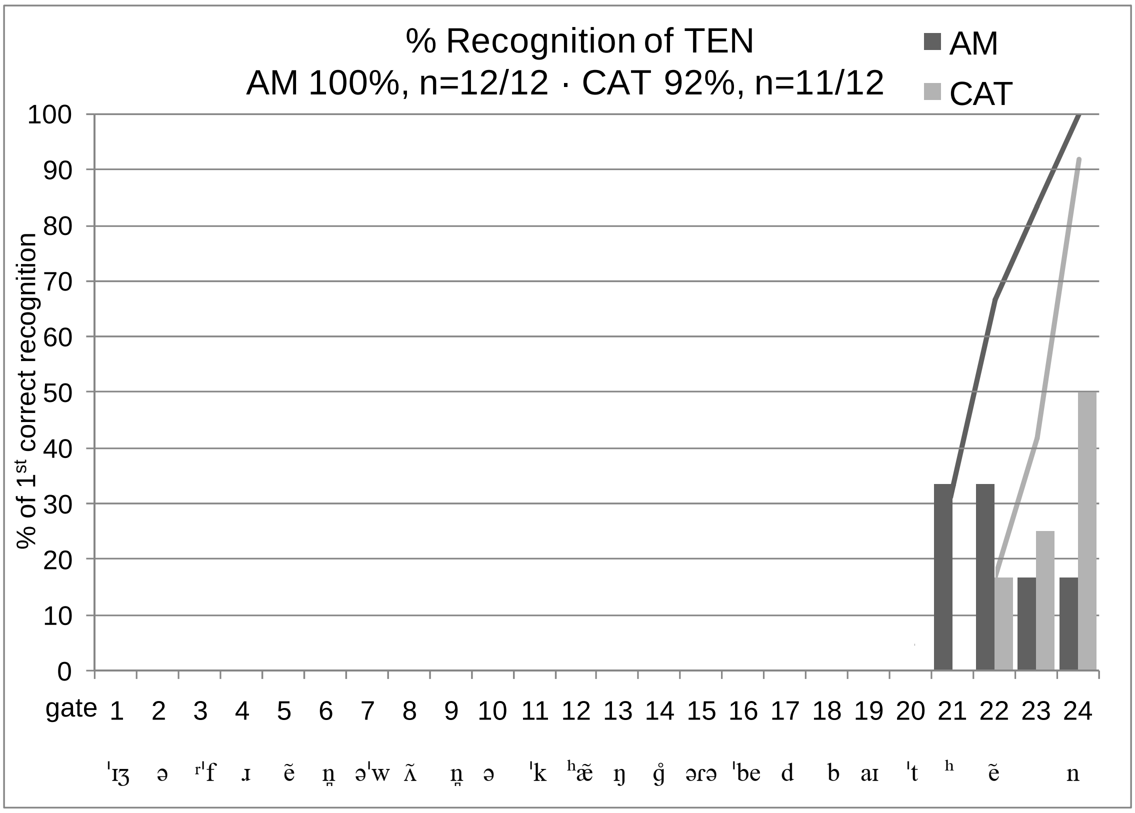


Figure 21. Percentage of Americans' & Catalans' first correct recognition of TEN occurring at the gate number shown on the abscissa.

Though Catalans are able to nearly match native recognition by the end of the presentation of the test sentence, the results for the ANOVA run at gate 22 ($F(1,22) = 7.615$, $p = 0.011$) are significant due to the fact that Catalan recognition begins later than American recognition. It begins late enough for the two distributions to be significantly different ($F(1,22) = 9.605$, $p = 0.005$).

3.1.12.2 TEN: Segment Perception

Table XVII lists the confusions for Americans, 13, and for Catalans, 29, for TEN. TEN was analyzed for its offset. Despite the anticipatory nasalization of the vowel in TEN, two Americans show a misinterpretation of the final nasal (N), lines 4-5. The Catalan confusions are more varied. There is considerable misinterpretation of the vowel as lower than /e/, again due to the heavy nasalization and its known consequences on spectral characteristics and perceived vowel height that Catalans do not have experience with in their native language. Additionally, there are a number of misinterpretations due to misparsing.

Table XVII. Americans' & Catalans' confusions for TEN.

AM total confusions = 13										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	19--22	(bi)te	inc	5		4	22	tel	l	1
2	20,22--23	te	inc	3		5	23	tet	t	1
3	21	t	inc	3						
CAT total confusions = 29										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
6	19--21	(bi)te	inc	6		13	22--23	te	inc	5
7	21	t	inc	4		14	23	tie	inc	1
8	21	ti	inc	2		15	23	tear	r	1
9	21	(bi)ty	inc	1		16	23	tack	k	1
10	22	ta	inc	3		17	23	tax	ks	1
11	22	tel	l	1		18	23	(invi)te /her?	r	1
12	22	(bi)ter	r	1		19	24	(invi)te /him?	m	1

3.2 English Results Summary

3.2.1 English Percent Recognition & ANOVA Results Summary

This section provides a summary of the results for native and non-natives' processing of the English test sentence. Figures 22 and 23 plot Americans' and Catalans' percentage of recognition at the American 50% cross-over point for each item and each groups' total percentage of recognition for each item. Below the graph, the gate where the American 50% cross-over point occurred is listed. Next the results of the ANOVAs conducted on the groups' percentages at the 50% point and on the groups' distribution of recognition across time are given. *P* values lower than 0.05 are considered to indicate significant differences and are denoted by a single asterisk (*). *P* values greater than 0.05 are viewed as not significant and are labeled as such (n.s.).

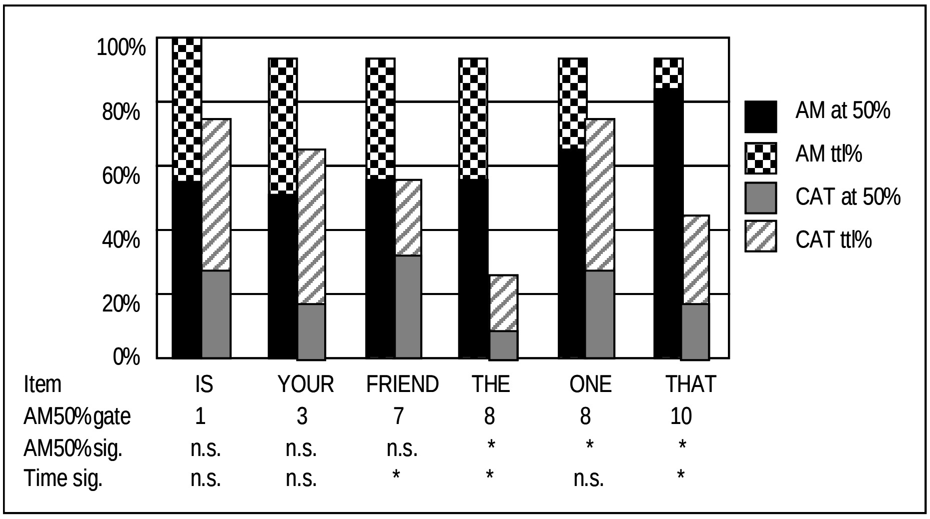


Figure 22. Native & Non-native % recognition at the AM 50% gate & at gate 24 for the first 6 lexical items in the test sentence. Along the abscissa are listed: the item, the gate #s at which the AM50% gate occurred, as well as the level of significance of the ANOVAs conducted at that gate & on the timecourse of recognition, $p < 0.05$ = *, $p > 0.05$ = n.s.

Figure 22 shows the results for the first 6 lexical items (IS-THAT) and Figure 23 presents the results for the last 6 lexical items (CAN'T-TEN). For each figure, the cumulative percentages for each group at the native 50% gate are shown by solid black (AM) and grey (CAT) bars, and the final total percentages at gate 24 are shown by checkered (AM) and striped (CAT) bars.

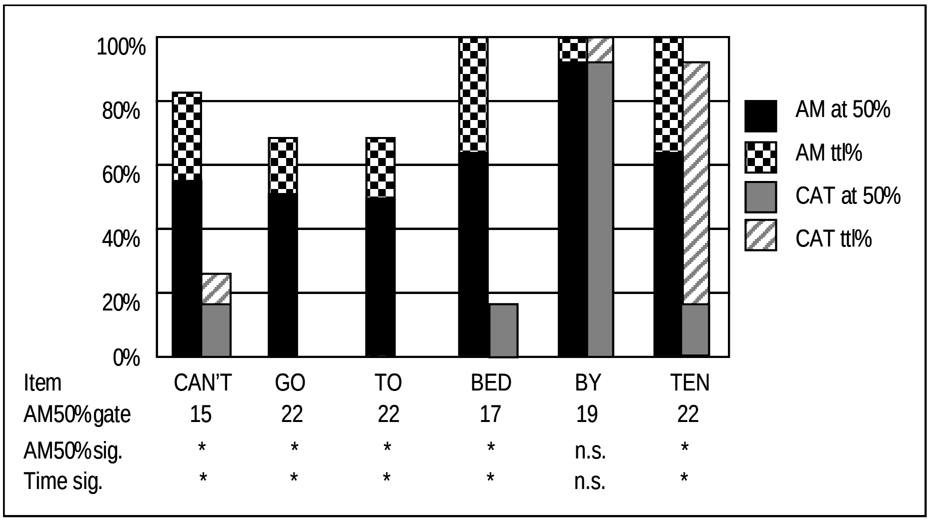


Figure 23. Native & Non-native % recognition at the AM 50% gate & at gate 24 for the last 6 lexical items in the test sentence. Along the abscissa are listed: the item, the gate #s at which the AM50% gate occurred, as well as the level of significance of the ANOVAs conducted at that gate & on the timecourse of recognition, $p < 0.05$ = *, $p > 0.05$ = n.s.

Figures 22 and 23 show that non-natives exhibit lower cumulative recognition at the American 50% gate and at gate 24 in 11 of 12 cases. In the case of BY, non-natives and natives show the same amount of recognition at both the native 50% point and at gate 24. In terms of the results of the ANOVAs that were conducted, for 8 of 12 lexical items there is a significant difference between natives and non-natives at the gate at which natives achieve 50% recognition. For 8 of the 12 items in the test sentence, there is a significant difference involving the timecourse of recognition between the two groups. There are only two cases where a lexical item showed significant differences between the two groups at one point of measurement and not the other. Identification of FRIEND by natives and non-natives was not significant at the native 50% point, while it was across time. This was due to the fact that whereas native speakers increased in identification of this item at later gates, non-natives did not; thus making the differences between the two groups larger. For ONE the opposite tendency is shown, non-native recognition was significantly lower than native recognition at the 50% gate but it increased at later gates so that the difference between the two groups across time is bridged.

3.2.2 English Native *vs.* Non-Native Peak & Total Percentages Comparison & Summary

In this section we now consider the magnitude of recognition, or peak percentage, for each group for each item. The peak is considered important because it indicates that there was some cue made available in the signal at that precise point which led to a peak number of subjects' first correct recognition. Tables XVIII and XIX provide summaries of the native and non-native, that is American and Catalan, peak percentage and gate for each item. In the first column of the tables, the lexical items are listed. In Table XVIII, the American peak percentage follows for each item, as well as the gate at which the peak occurred and the phonetic information available at that gate. Next, it is noted whether or not the beginning of the next word was available in the acoustic signal at the peak point of recognition ('yes' or 'no'). A plus symbol (+) indicates that the onset of the following word occurred within the same gate as the peak percentage. The group total is again provided for quick comparison with the peak.

Table XVIII. Summary of magnitude and gate of the American peak, whether or not the beginning of the next word was available in the test sentence at the peak gate, and total percentages.

Item	AM peak	Gate	Beg.Nxt.Wrd	Group Ttl
IS	58%	1 [ˈɪʒ]	no	100%
YOUR	33%	2 [ʒər]	no	92%
FRIEND	25%	5 [ˈfɹẽ]	no	92%
THE	33%	7 [n̪ə(ˈw)]	yes+	92%
ONE	50%	8 [ˈwʌ̃]	no	92%
THAT	83%	10 [n̪ə]	no	92%
CAN'T	42%	15 [ˈkʰæ̃ŋgərə]	yes	83%
GO	33%	17 [gərəˈbe]	yes	67%
TO	33%	17 [ɾəˈbe]	yes	67%
BED	67%	17 [ˈbe]	no	100%
BY	92%	19 [baɪˈt]	yes+	100%
TEN?	33%-33%	21-22 [ˈtʰẽ]	no next word	100%

Table XVIII presents the data for native speakers only. As column 2 indicates, any given peak represents recognition by at least one quarter of the group, 25%. American peaks were highest for BY, 92%, THAT, 83%, and BED, 67%. American recognition peaks were lowest for FRIEND, 25%, YOUR, THE, GO, TO, and for TEN, 33% each. Peaks were low for TEN only because TEN showed two high points of recognition of 33% each. In general, at the highest point of group recognition for each item, natives did not need to hear the onset of the next word in the signal in order to recognize an item (column 4), indicating that native recognition in this case is likely not sequential, of the type exemplified by Altmann, *The ram roamed around*, (1997). Items where this is not the case can be accounted for. For the series CAN'T GO TO, the peaks occurred relatively late, when the next word or words are made available, see column 3, as this proved to be a challenging and rather ambiguous sequence. For THE and BY, the peaks were found at the same gate as the onset of the following word. This could be due in part to the length of each gate, which was somewhat long, 80ms, and not due to the fact that natives needed to hear the onset of ONE and TEN in order to recognize these items. Lastly, final percentages for Americans range from 67%-100%. Totals were highest for IS and BED-TEN, 100% each; totals were lowest for GO and TO, 67%.

Table XIX now presents the data for Catalans. In Table XIX extra columns provide comparisons between the Catalan and American results. Following the Catalan peak percentage, column 2, the next column indicates whether or not the non-native peak was lower than the native peak ('yes' or 'no') or if it was the same as the native peak ('='). An asterisk in this column denotes a significant difference. Following the gate at which the Catalan peak occurred, column 4, it is noted whether or not the Catalan peak occurred later than the American peak ('yes,' 'no,' or '='), that is, whether or not non-natives took longer to make a peak percent of identification. Finally in the last column, whether or not the non-native total is lower than the native total percentage (‘yes’ or ‘no’) is indicated.

Table XIX. Summary of magnitude and gate of the Catalan peak, whether or not the beginning of the next word was available in the test sentence at the peak gate, and total percentages.

Item	CAT peak	NNS pk < NS pk	Gate	CATpk later than AMpk	Beg.Nxt. Wrd	Group Ttl	NNS ttl < NS ttl
IS	25%	yes	1 [ˈɪʒ]	=	no	75%	yes
YOUR	25%	yes	4 [ʒəɾˈfɹ]	yes	yes	67%	yes
FRIEND	17%-17%	yes	6/7 [ˈfɹẽn̪n̪ə(ˈw)]	yes	yes	58%	yes
THE	17%	yes	9 [n̪əˈwʌ̃n̪n̪]	yes	yes	25%	yes
ONE	42%	yes	9 [ˈwʌ̃n̪n̪]	yes	yes+	75%	yes
THAT	25%	yes*	13 [n̪əkˈˈkʰæ̃ŋ]	yes	yes	42%	yes
CAN'T	17%	yes	13 [ˈkʰæ̃ŋ]	no	no	25%	yes
GO	0%	yes*	--	yes	yes	0%	yes
TO	0%	yes*	--	yes	yes	0%	yes
BED	17%	yes*	17 [ˈbe]	=	no	17%	yes
BY	92%	=	19 [baɪˈt]	=	yes+	100%	no
TEN?	50%	no	24 [ˈtʰẽn]	yes	no next word	92%	yes

Table XIX indicates that Catalans peaks are, in general, not as high as native peaks. Catalan peaks were highest for BY, 92%, and TEN, 50%, two unreduced items. Catalan peaks were lowest for GO and TO, which showed 0% recognition, as well as FRIEND, which yielded two peak gates of 17% each, in addition to THE, CAN’T and BED, which showed 17%. The non-native peak percentage was lower than the native peak percentage in 10 of 12 cases, four of these were significant (THAT, GO, TO, and BED). For BY, the peaks were equal, 92%, and for TEN the Catalan peak was actually higher, as Americans showed two high peaks for this item, 33% each.

In terms of the location of the peak percentage, Catalan peaks occurred at a later gate than the American peak for 8 of 12 lexical items. For IS, and then later with BED and BY, the peaks for both groups occurred at the same gates. For CAN’T, the Catalan group’s peak (totaling one speaker only) actually took place two gates earlier.

As regards whether the onset of the following word had been introduced in the acoustic signal at the time of the Catalan peak, comparison of Tables XVIII (column 4) and XIX (column 6) shows that the beginning of the next word was available in more cases for Catalans than for Americans. For natives, the peak falls after the onset of the succeeding item in only 3 of 12 cases; for non-natives, this is true in 6 of 12 cases (not including cases where the peaks were found at the same gate as the introduction of the onset of the following word). From this data we can not conclude that Catalan recognition was decisively sequential; however, it was more sequential than American recognition in this case.

Finally, concerning the total percentages for each lexical item, Table XIX shows that the Catalan totals show a much wider range, 0%-100%, than do American totals. Catalan totals were highest for BY and TEN, 100% and 92% respectively; totals were lowest for GO and TO, 0%—the same two items which prompted the lowest totals for natives as well. In comparison to the native group, non-natives showed a lower total for 11 of 12 lexical items, as mentioned. For BY, the cumulative totals for the two groups were equal.

To summarize, we have seen support from the data in this section that non-native recognition takes longer than native recognition. The non-native peak occurred later than the native peak for two-thirds of the items, and, for most items, the non-native peak was lower than the native peak. Concurrent with taking longer, non-natives need to hear the onset of the following word to make a lexical identification in twice as many cases as natives do. Lastly, non-native percent totals were lower than native percent totals for almost all test items.

3.3 English Final Lexical Selection/Integration

Tables XX and XXI present the final interpretations of the test sentence, *Is your friend the one that can't go to bed by ten?*, for Catalans and Americans. Each informant's response to gate 24 has been provided with each error highlighted.

Table XX lists the native, American, responses. Quick inspection shows that all American interpretations were syntactically correct, though only four of the twelve American participants arrived at the intended interpretation of the sentence by gate 24. Seven listeners gave interpretations that included items that were identified correctly phonetically, but which held a different phonological form: "can" rather than CAN'T, two occurrences, and "get a," [ɡ̊əɾ#ə], rather than GO TO, [ɡ̊ə#ɾə], cases. Such confusions reveal the unintentional ambiguity related to the test signal and the difficulty it prompted in determining juncture in the latter case.

Table XX. Americans' final responses to the English test sentence, gate 24.

AMERICANS												
subject 1	Is	your	friend	the	one	that	can't	get	a	bed	by	ten?
subject 2	Is	your	friend	the	one	that	can't	go	to	bed	by	ten.
subject 3	Is	your	friend	the	one	that	can't	get	to	bed	by	10
subject 4	Is	your	friend	the	one	that	can	go	to	bed	by	ten.
subject 5	Is	your	friend	the	one	that	can't	go	to	bed	by	ten
subject 6	Is	your	friend	the	one	that	can't	go	to	bed	by	ten
subject 7	Is	your	friend	the	one	that	can	go	to	bed	by	ten?
subject 8	is	your	friend	the	one	that	can't	get	a	bed	by	ten?
subject 9	As		i f / I / kn	ow	when	I	can't	go	to	bed	by	ten.
subject 10	Is	your	friend	the	one	that	can't	get	a	bed	by	ten?
subject 11	Is	your	friend	the	one	that	can't	get	a	bed	by	ten
subject 12	Is	your	friend	the	one	that	can't	go	to	bed	by	ten

Participant 9 stands out from the other Americans for having misinterpreted the entire first half of the test sentence, *Is your friend the one that*, [ˈɪʒəʳˈfɹẽn̪əˈwʌ̃n̪ə], as AS

IF I KNOW WHEN I. Though (s)he did not recognize the utterance as intended, it may be observed that a considerable amount of correct phonetic information appears in the confusions: the [z] of IS, the [f] and the [n] of FRIEND, as well as the [w] and [n] of ONE. This listener therefore appears to have interpreted the phonetic information at face value, *i.e.*, bottom-up—with a minimum of phonological processing, behavior that seems more non-native than native-like. For example, for the item FRIEND THE, [ˈfɹẽn̪ə], this listener was not able to backtrack [n̪] and restore the hidden /d/ to account for the blending involved; consequently, (s)he identified the signal as simply /n/ ("As if I know"). ONE THAT, [ˈwʌ̃n̪ə], was consequently identified at face value as "when I." Speech perception involves a series of decisions which in effect lead us down a path of perception. Once we deviate from the intended path, due to improper analysis of cues in the speech signal, we may become fully committed to the erroneous interpretation. In the case of participant 9, since there was enough of a match between "As if I know when I" and the phonetic signal given and enough of a syntactic match between "As if I know when I" and *can't go to bed by ten*, there was no good reason to doubt that a misinterpretation has occurred.

Participant 9's misinterpreting the test sentence and still arriving at a grammatical final interpretation able to account for most of the acoustic information offered by the signal contrasts with the results of Shockey (1997, 1998, 2003). She found that the three (out of sixteen) native speakers who participated in her study that did not correctly interpret the test sentence, *The screen play didn't resemble the book at all*, tended to prioritize low-level phonetic information over higher-level syntactic/semantic information, even though it led to ungrammatical responses. In the present study, phonetic information was faithfully retained, but **not** at the cost of syntax or semantics.

Catalan informants' final responses at gate 24 are shown in Table XXI. None of the Catalan subjects were able to arrive at the intended interpretation of the test sentence and the majority was unable to arrive at a wholly grammatical final sentence. Only two responses--participant 9 and 6's response, if "ken" is meant to be a proper name, though this was not indicated with capital letters--may be interpreted as grammatical, though some others are close (informant 2, 4, 7 and 8). Interestingly, participant 9's, "Joe feared that no one could have come by ten," deviated almost entirely from what was intended. Though as with American participant 9, there is a good deal of the phonetic signal apparent in the final response [ˈɪʒəʳˈ**fɹẽn̺ə**ˈ**wʌ̃n̺**əˈkʰæ̃ŋ**g̊əɾə**ˈbed**baɪ**ˈ**tʰẽn**]. As for the many ungrammatical interpretations, these results are more coincident with those of Shockey (1997, 1998, 2003), where there may be a trade-off between the acoustic signal and syntax and semantics. Though most informants compromised grammaticality for phonetic information, participant 9 may have (deliberately) overlooked the acoustic signal in an effort to form words or create a coherent final response.

Table XXI. Catalans' final responses to the English test sentence, gate 24.

CATALANS												
subject 1	Is	your	friend						a	bout		ten
subject 2	Is	your	friend	no	one	that	can	kind	of	bit	by	ten
subject 3	Is	you	fond			he	can	get	a	bit	by	ten
subject 4	If	you	find	no	one	I	can	ca	re of	but	by	ten
subject 5	If	I	fed	not	a	naked/nak	an	gue	ro	but	by	ten
subject 6	Is	your	friend	the	one	that	ken	could	have	had	by	ten?
subject 7	Is	your	friend			like	Anne	could	have	bet	by	ten?
subject 8	Is	your	friend	the	one	that		could	have	bed	by	ten?
subject 9	Joe		feared	that no	one			could	have	come	by	ten.
subject 10	Is	your	friend	no	one	I	can't	kind	of	in	vite	him?
subject 11	Is	your	friend	no	one	that	can't	'could'	a	bit	by	ten?
subject 12	Is	your		no	one		can	ca	re	up	by	ten?

Confusions were found for all lexical items for Catalans. Though, for the most part, across speakers, confusions reflected fine phonetic detail. For instance, the result of reduction in FRIEND THE [ˈfɹẽn̪ə] was interpreted at face value, as /n/, somewhat consistently (7/12 Catalans versus 1/12 Americans), showing evidence of a lack of correction for the English reduction at hand. Further evidence of bottom-up processing is seen in the fact that in their final interpretation nine of twelve Catalan informants still retained the interpretation of the initial devoiced /g/ of GO as [k], *e.g.*, "kind," "care," and "could," while those American listeners who had initially shown this confusion had revised their interpretation by this point. There was also general misinterpretation of the flap in GO TO, as mainly /d/ (seven out of twelve informants) and sometimes /r/ (three out of twelve), in addition to misparsing of GO TO, as "could have," "care of," "kind of," etc. Though no Americans misinterpreted the flap, several showed misparsing due to the phonological ambiguity of the signal. CAN'T was misparsed by two Catalan participants, as "naked/nak anguero" and "like Anne," and rarely interpreted as a negative. In fact, only two Catalan subjects provided CAN'T in comparison to ten American subjects. Finally the interpretation of the final obstruent in BED was typically labeled as voiceless by Catalans, seven out of twelve listeners, in contrast to zero out of twelve for Americans.

4 RESULTS FOR CATALAN

4.1 Catalan Online Acoustic Processing

The following section considers the results for online processing of the Catalan test sentence. The results for this second language are a complement to those for American English, providing an opportunity to see how connected speech processes similar to those found in the English sentence are decoded by natives and non-natives. The results for *Em sap greu que cap dels dos xicots no em pugui donar un cop de mà.* have been analyzed for individual word recognition and are presented in histograms in Figures 24-39. For each figure, the percentage of subjects (n = 12) per language group reporting **first** correct recognition of the test item is plotted along the ordinate. The gate number where this occurred is shown along the abscissa, underneath which is displayed the acoustic/phonetic information available at that time. The percentage of recognition at the final gate for each language group is presented at the top of the histogram. For each histogram, the time course of recognition is commented. The point of each group's peak recognition, that is, the gate at which the greatest magnitude of recognition took place, is noted. Then the results of the ANOVAs conducted at the gate where native recognition reached 50% and across all gates are presented and commented.

Misinterpretations or "confusions" up to the point of first correct recognition for each lexical item have also been analyzed and are presented in Tables XXII-XXVII. As for the English test sentence, each confusion has been labeled according to the phonetic composition, indicated by the spelling, in regard to the reduction affecting the item.

The tables are arranged so that each confusion is listed by the first gate at which it appeared as a response. Successive gates where it was still given as a response are also reported, as are the total number of participants who listed it. Remember that not all of the informants counted may have given the confusion at all the gates listed, at least one subject however had to provide it as a response at a particular gate for that gate to be mentioned. Material in parentheses refers to acoustic information actually pertaining to a previous or following lexical item that was not parsed from the item under analysis. Slashes separate various adjoined material. Totals are calculated by summing the total number of participants, so that the idea of the relative weighting for each confusion is clearer. Line numbers are included for reference in the text. For all responses per subject see Appendix B.

4.1.1 RECOGNITION OF "EM"

4.1.1.1 EM: Word Recognition

Figure 24 represents Catalans' and Americans' first correct identification of EM, an unreduced item. Peak recognition, 58%, for both Catalans and Americans falls at gate 1, with the offset of [əm]. Recognition for both groups is high and occurs early. Total group recognition for Catalans is 100%, 12 out of 12 listeners. American recognition is slightly lower, 83%, 10 out of 12 listeners.

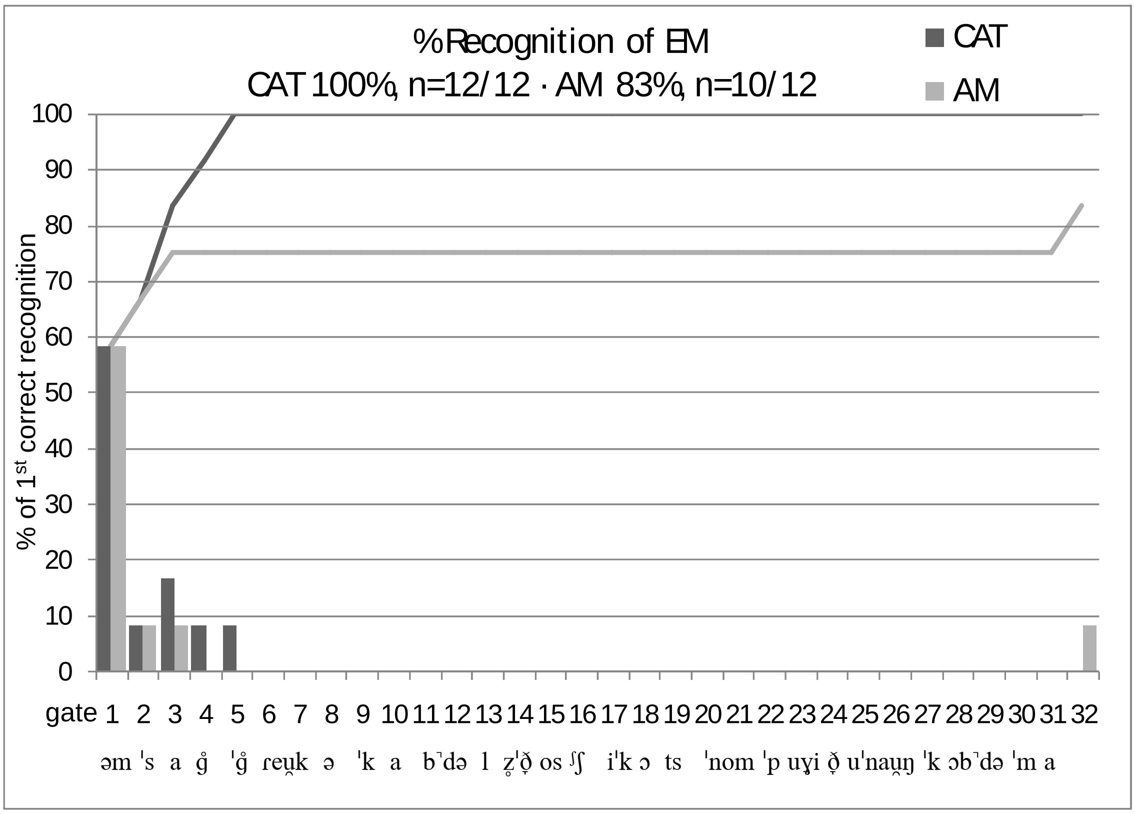


Figure 24. Percentage of Catalans' & Americans' first correct recognition of EM occurring at the gate number shown on the abscissa.

Results for the ANOVA at the native 50 % point, gate 1 ($F(1,22) = 0.0$, $p = 1$), are not significant for this item, due to very early recognition for both groups, the majority of which is concentrated through gate 3, that is, the vowel of SAP. Results for the ANOVA run for recognition across gates ($F(1,22) = 3.035$, $p = 0.095$) is also not significant. EM was easily and quickly recognized by almost all informants.

4.1.1.2 EM: Segment Perception

Table XXII shows the confusions that occurred during the recognition of EM by Catalans and Americans. Catalan confusions total 7, while American confusions total 8. EM was analyzed for the interpretation of its final nasal. Early confusions for this item demonstrate the difficulty in identifying [əm] without greater context, due to the fact that "em," "amb" ('with,' before a consonant), and "en," (article for masculine names, *i.e.*, 'the;' clitic pronoun, and preposition, *i.e.*, 'on,' before a labial consonant) would all be pronounced [əm]. Therefore, confusions such as "en" suggest the undoing of regressive place assimilation in a context where [m] was a lexical /m/ rather than the result of post-lexical assimilation. Catalan subjects discard the "en" interpretation by the offset of the following word, that is, when they recognize SAP (gate 5), an item which does not provide the appropriate context for post-lexical assimilation /n/ > [m]. Thus, they are able to revise and change their identification. Some American informants, on the other hand, retain the erroneous "en"/"amb" interpretations until the last gate.

Table XXII. Catalans' & Americans' confusions for EM, analyzed for interpretation of [m].

CAT total confusions = 7										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	1--4	En	n	3		3	1	N	n	1
2	1--2	m	m	2		4	2	ens	n	1
AM total confusions = 8										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
5	1--32	Am	m	3		7	1--2	Amb	m	2
6	1--31	En	n	3						

4.1.2 RECOGNITION OF "SAP"

4.1.2.1 SAP: Word Recognition

Catalans' and Americans' first correct recognition of SAP is shown in Figure 25. SAP was articulated such that there was place and voicing assimilation to the onset of GREU, /pg/ > [g̊g̊]. Again, the Catalan and American peaks both fall at the same gate, 5, when the initial consonant of GREU is made available to the listener; though, the American peak is much lower than the Catalan peak, 25% versus 75% respectively. Total group recognition for Catalans is 100% and American recognition is 83%

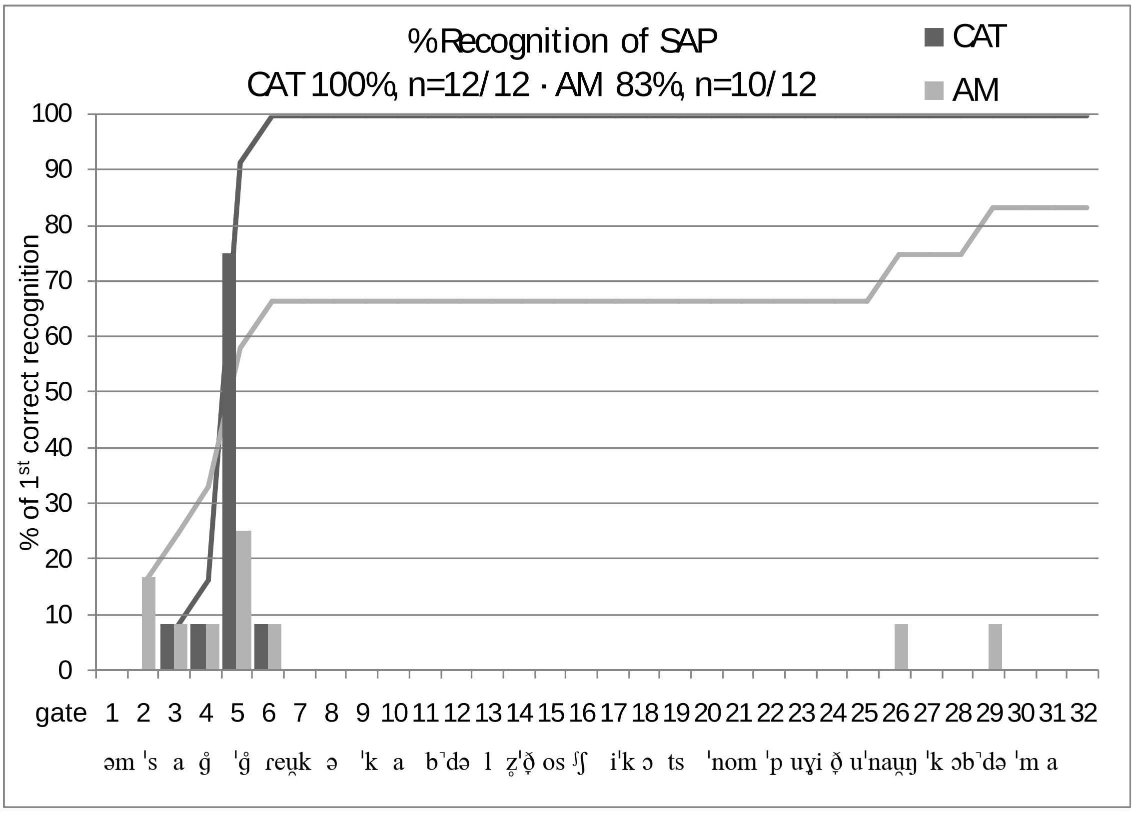


Figure 25. Percentage of Catalans' & Americans' first correct recognition of SAP occurring at the gate number shown on the abscissa.

The ANOVA conducted at gate 5 ($F(1,22) = 3.826$, $p = 0.063$), at the onset of the following lexical item, shows that the differences at this point are not significant. It is worth noting the very early recognition of SAP for Americans, as early as gate 2, where only the initial /s/ was available, and gate 3 for Catalans, when the vowel was input, points to the predictability of this item. Though recognition for this item for non-natives was relatively high, there are 2 non-native outliers and 2 non-natives with no recognition, causing the distributions of the two groups to be different enough across gates that the ANOVA on the timecourse of recognition ($F(1,22) = 4.368$, $p = 0.048$) is significant.

4.1.2.2 SAP: Segment Perception

Table XXIII details the confusions for SAP for Catalans, 25, and Americans, 30. SAP was considered for the interpretation of its offset which proved to be a recurring obstacle for identification. A face-value reading of its offset as /k/ was frequent for both groups; however, notably, Catalans stop reporting /k/ around gate 5, see line 9, when the conditioning environment, that is, the trigger for the assimilation of /pg/ > [g̊g] has been made available in the signal. However, there are American reports of /k/ as late as gates 24 and 25, see line 20, and another subject misidentified the context as including an underlying /t/, line 19, suggesting that some Americans needed more than just the conditioning context to identify SAP. They needed more time and/or more syntactic/semantic context.

In addition to face-value readings of the offset of SAP, a second recurring confusion was the misidentification of the vowel, which was heard as a closer vowel, *i.e.*, [e], as opposed to intended [a], see lines 2-7, 12, 14-15, 18-19. However, it is unclear based on spelling exactly which vowel is intended: orthographic ‘e’ may correspond to [e, ɛ, ə] and orthographic ‘a’ to [a, ə]. It is probable that the vowel did not quite reach its full, open target and was heard as a central [ə], or alternatively, that the falling F2 transitions from an alveolar fricative to an open vowel with a mid-F2 frequency may have cued a vowel with a higher F2, *i.e.*, a closer vowel, thus causing confusion for at least two-thirds of the listeners.

Table XXIII. Catalans’ & Americans’ confusions for SAP, analyzed for interpretation of assimilated [g̊].

CAT total confusions = 25										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	1--2	s	inc	7		6	3	sem	m	1
2	2--4	se	inc	7		7	4	semb	m	1
3	2	si	inc	1		8	4	sac	k	1
4	3--4	sec	k	5		9	5	s'a(cr)	k	1
5	3--4	seg	g	1						
AM total confusions = 30										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
10	2	(Em)s	inc	1		16	5	s(creu)	k	1
11	2--3	s	inc	5		17	5	sac-	k	1
12	2--4,6--32	se	inc	8		18	5--6	sec(cri/r)	k	1
13	3--4,7--28,32	sa	inc	5		19	6--23	set	t	1
14	3--5	sec	k	5		20	24--25	s'(creu)	k	1
15	3--31	sep	p	1						

The two responses “sem” and “semb,” lines 6 and 7, illustrate *garden path* responses. In this case, “em semb” suggests the development of “em sembla” ‘it seems to me,’ and is representative of either a semantic/syntactic garden path response, given that there is no previous semantic/syntactic information to contradict such a response, or most likely a frequency-inspired garden path response—“em sembla” and “em sap greu” are both high-frequency close-knit units in Catalan.

4.1.3 RECOGNITION OF "GREU"

4.1.3.1 GREU: Word Recognition

First correct recognition for GREU for Catalans and Americans is plotted in Figure 26. For this lexical item, the Catalan peak is distributed across two gates, showing 42% each: gate 5, when only the initial consonant of GREU has been introduced, and gate 6, after the first portion of the diphthong, that is, the [e], has been fully introduced. The same gates show the American peak, 33% at gate 5, and a further 25%, at gate 6. Catalan total group recognition reaches 100%, while American recognition is 75%.

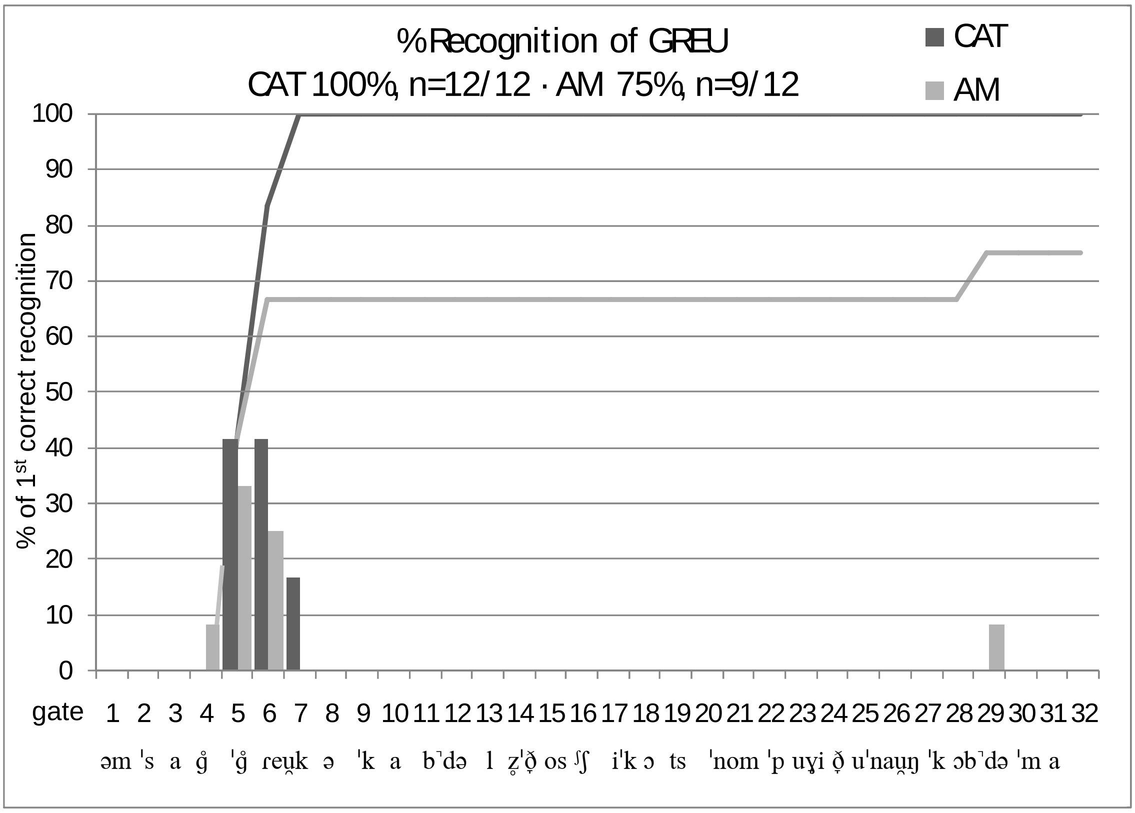


Figure 26. Percentage of Catalans' & Americans' first correct recognition of GREU occurring at the gate number shown on the abscissa.

The ANOVA conducted at gate 6 ($F(1,22) = 0.846$, $p = 0.368$), with the introduction of the /r/ and the first portion of the diphthong of GREU, confirms that differences at this point are not significant. Such early recognition for both groups, when only the first consonant in the word is available, is most likely related to predictability of the afore-mentioned, close-knit unit EM SAP GREU (cf. "I'm sorry" in English). As with SAP though, GREU has an outlier as well and three non-natives were not able to recognize the item. This led to a non-native distribution across time that showed another concentration at later gates, while the native distribution showed a concentration only at earlier gates, prompting significant differences ($F(1,22) = 4.846$, $p = 0.038$).

4.1.3.2 GREU: Segment Perception

Catalan and American confusions for GREU are listed in Table XXIV. Catalans show very few confusions, 9 total, while Americans show more, 15. GREU was analyzed for its devoiced onset. Catalans mainly show incomplete responses, with one parsing problem, line 3, that led to a /k/ response, that is resolved in gate 6. For Americans, on the other hand, more than half of the confusions show an interpretation of the [g̊] as /k/, lines 10-15. Most of these interpretations are also linked to parsing problems, lines 10-13; however, the interpretation of an unaspirated, voiceless stop in stressed position (GREU is stressed) as [k], lines 14-15, is evidence that several of the American listeners have learned to not rely on aspiration as a cue for /k/ versus /g/ in this position, while in English it is known to be the primary cue. The fact that they show considerably more misidentification as [k] than natives suggests that they still have not figured out the range of VOT values associated with voiced and voiceless stops in Catalan.

Table XXIV. Catalans' & Americans' confusions for GREU, analyzed for interpretation of [g̊].

CAT total confusions = 9										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	4--5	g	g	3		3	5	(s'a)cr	k	1
2	5	gr	g	2		4	5--6	gre	g	3
AM total confusions = 15										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
5	3--5	g	g	3		11	5	(sac)r	k	1
6	4	e	V	1		12	5--32	(s)creu	k	1
7	4	la	l	1		13	6	(sec)crir	k	1
8	5	gr	g	1		14	6--31	cre	k	1
9	5	gre	g	1		15	6--32	creu	k	3
10	5	(sec)cri	k	1						

4.1.4 RECOGNITION OF "QUE"

4.1.4.1 QUE: Word Recognition

Figure 27 represents Catalan and American recognition for QUE, an unreduced item. For this item, the Catalan peak falls at gate 8, 50%, when QUE has been fully introduced in the signal, with the remaining 50% of Catalan recognition occurring through gate 12. Total American recognition, 50%, is distributed across gates 8 and 9, the latter coinciding with the consonant onset of CAP, each 25%. Total recognition for Catalans remains 100%; American recognition, as stated previously, is only 50%.

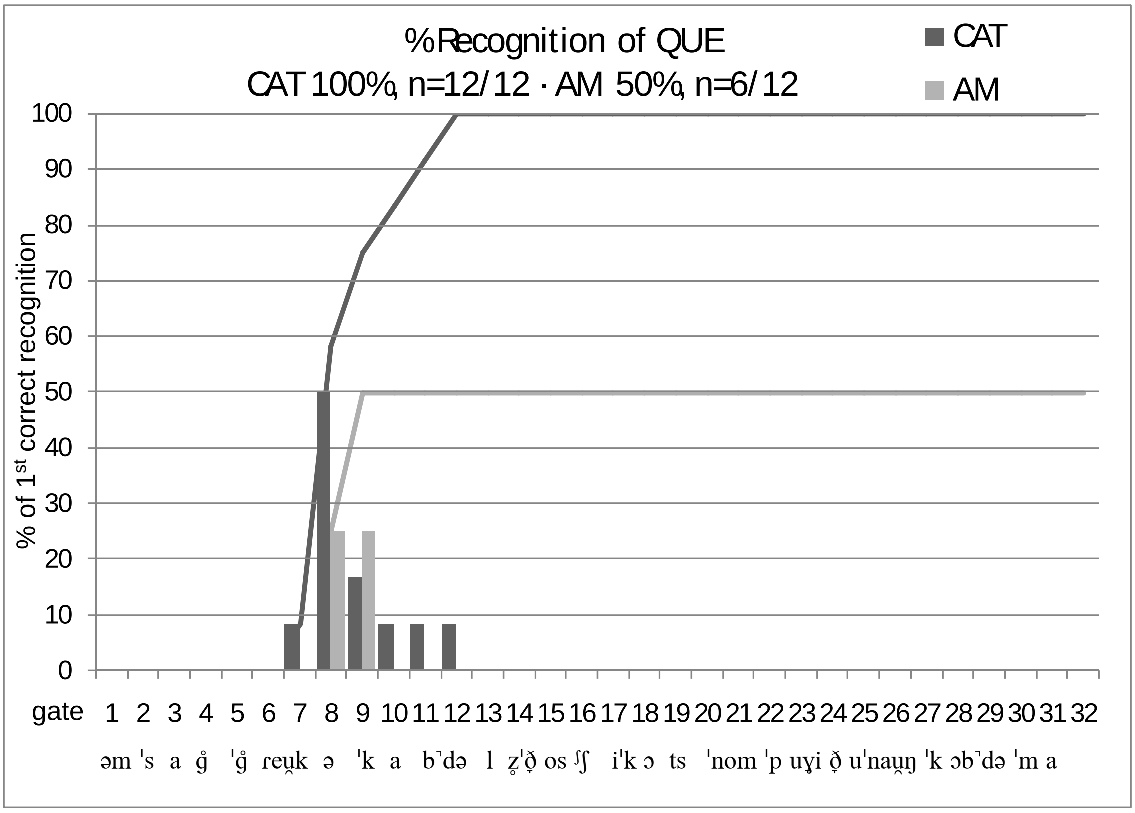


Figure 27. Percentage of Catalans' & Americans' first correct recognition of QUE occurring at the gate number shown on the abscissa.

Results for the ANOVA conducted at gate 8 ($F(1,22) = 2.839$, $p = 0.106$), concurrent with the vowel of QUE, are not significant; however the differences across time (F(1,22) = 10.273, p = 0.004) are statistically significant. Though some non-natives were able to recognize QUE quickly and easily, half of the non-native informants were unable to identify this item. Such low overall recognition led to significantly different results after the native 50% point.

4.1.4.2 QUE: Segment Perception

Table XXV presents the confusions for Catalans and Americans for QUE. The Catalan total number of confusions for this item is 8; Americans show 13. QUE was analyzed for its onset, which was frequently misinterpreted by both groups as /p/. Presumably it is the preservation of rounding from the /u/ of GREU through the onset of QUE that is at the source of this confusion. Analysis of the spectrogram, see Figure 7, reveals a compact and non-intense burst as well as the pulling of formant F2 and F3 to values looking more like those of a labial than a velar. An alternate explanation would be the imposition of a top-down interpretation on the acoustic signal; given the preceding sentential context "em sap greu," following "que" ("em sap greu que") and following "per" ("em sap greu per") would be equally likely.

Table XXV: Catalans' & Americans' confusions for QUE, analyzed for interpretation of [k].

CAT total confusions = 8										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	7--9	q	k	3		4	8--10	pe(c/ca/car)	p	2
2	8	qu	k	1		5	11	pe(cap)	p	1
3	8--9	per	p	1						
AM total confusions = 13										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
6	7	q	k	2		10	9--28	pa	p	1
7	8--32	per	p	5		11	25--32	però a	p	1
8	8,10--16	par	p	1		12	29--32	p'	p	1
9	8	cua	k	1		13	32	perquè	p	1

4.1.5 RECOGNITION OF "CAP"

4.1.5.1 CAP: Word Recognition

First correct identification of CAP for Catalans and Americans is represented in Figure 28. According to Catalan phonology, CAP was pronounced with a final voiced [b], due to the assimilation to the voicing of the following obstruent in DE, /pd/ > [b˺d]. Again, the peaks for both language groups fall at the same gate, 11, after CAP has been fully introduced in the acoustic signal, but before DE has been input, though traces of the following [d] may have been picked up at gate 11. For this item, curiously, the non-native, American peak, 75%, is actually slightly higher than the native peak, 58%. Both groups show 100% total recognition.

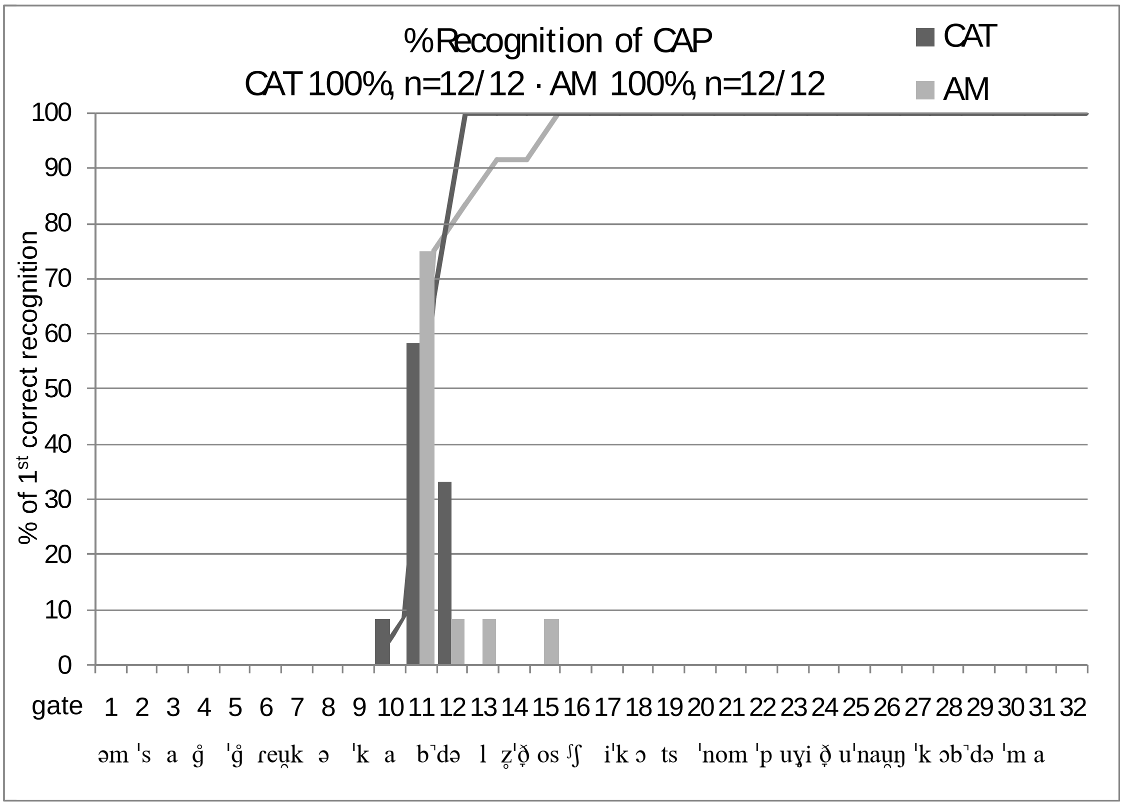


Figure 28. Percentage of Catalans' & Americans' first correct recognition of CAP occurring at the gate number shown on the abscissa.

Significant differences are not found in the ANOVA results conducted at gate 11 ($F(1,22) = 0.186$, $p = 0.670$) nor across gates ($F(1,22) = 0.693$, $p = 0.414$), unsurprisingly. Though some Americans take slightly longer to recognize CAP, all participants were able to recognize this item by gate 15.

4.1.5.2 CAP: Segment Perception

Table XXVI provides the confusions for CAP for Catalans, 22, and Americans, 15. CAP was analyzed for the interpretation of the regressive voicing assimilation affecting its offset. The main problem, however, for both groups was parsing, see lines 8-15 or 16 and 21-22. The voiced [b] in CAP did not facilitate its parsing as a word-final consonant, since voiced stops do not occur word-finally in Catalan. Analysis of responses such as “acab,” “acabi,” etc. is evidence of the difficulty in parsing this item from surrounding information. The acoustic signal through the offset of CAP provided listeners with [kəˈkab]. [kəˈkab] is exactly what listeners would hear if they were listening to the onset of “que acab(i)” ‘that something might end/finish’ in fast speech (careful speech: [kəəˈkab]), a common misinterpretation for both Catalans and Americans. Once listeners are given the context at gate 12, that is, the /d/, there are no more [b] interpretations. Only one American problem of parsing remains, line 24, which is resolved in gate 15.

Table XXVI. Catalans' & Americans' confusions for CAP, analyzed for interpretation of [b̚].

CAT total confusions = 22										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	9	ac	inc	2		9	10	acab	b	3
2	9	aq	inc	2		10	10	(pe)ca	inc	1
3	9	(pe)c	inc	1		11	10	(pe)car	r	1
4	9	c	inc	1		12	10	cab	b	1
5	9	q	inc	1		13	10--11	acabi	b	2
6	9	pe	inc	1		14	11	(pe)cap	p	1
7	9--10	ca	inc	2		15	11	acasa	z	1
8	10	aca	inc	2						
AM total confusions = 15										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
16	9	(per)què	GP	2		21	10--11	acabi	b	1
17	9--10	a	inc	6		22	10--11	acaba	b	1
18	9--10	ca	inc	1		23	10--12	que	GP	1
19	10	(qu'a)cab	b	1		24	12--14	acap	p	1
20	10	q	inc	1						

4.1.6 RECOGNITION OF "DELS"

4.1.6.1 DELS: Word Recognition

Catalans' and Americans' recognition of DELS, an unreduced item, is shown in Figure 29. For both groups total recognition for DELS starts at gate 12. Such early recognition of DELS shows it is highly predictable from the previous sentential context, which is why it is recognized with as little acoustic information as the initial consonant and vowel. The peaks for both Catalans and Americans fall at gate 14, the offset of DELS. Catalans show a peak of 67% while Americans show a slightly lower peak of 50%. Recognition for both groups is complete at this gate. Catalans total 100%; Americans total 83%.

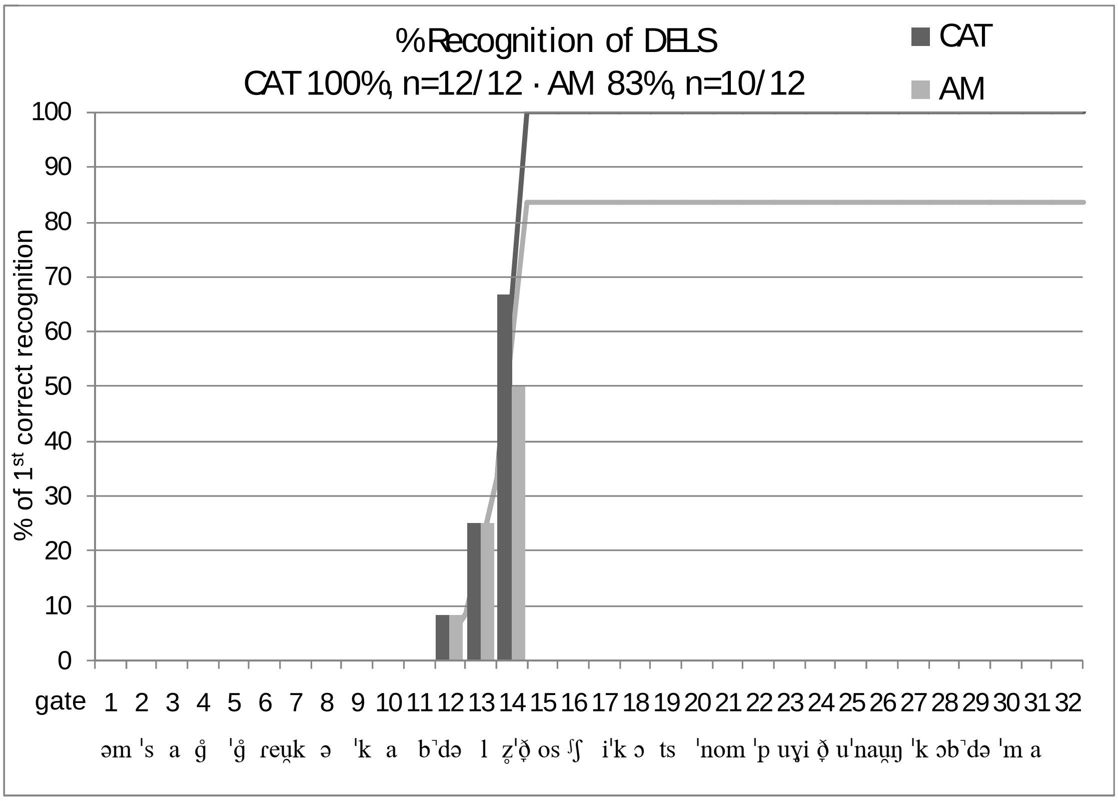


Figure 29. Percentage of Catalans' & Americans' first correct recognition of DELS occurring at the gate number shown on the abscissa.

Results of the ANOVA at gate 14 ($F(1,22) = 2.2$, $p = 0.152$), as well as across time ($F(1,22) = 2.060$, $p = 0.165$) show non-significant differences, due to the fact that natives and non-natives show the same distribution of recognition, though American recognition is slightly lower at gate 14.

4.1.6.2 DELS: Segment Perception

Catalan and American confusions for DELS are provided in Table XXVII. For this item the total numbers of confusions are 14 and 16 respectively. For both groups, most of the confusions can be chalked up to incomplete responses and one problem of parsing for Americans, line 9. Catalans also show one case of the onset of DELS, [də], being interpreted as the onset of “d’aqui” ‘from here’ line 2, which would have an equivalent onset consonant-vowel sequence. This interpretation naturally ends when /l/ has been introduced.

Table XXVII. Catalans’ & Americans’ confusions for DELS.

CAT total confusions = 14									
line#	gate#	confusion	label	# of subjs	line#	gate#	confusion	label	# of subjs
1	12	d	inc	2	4	12--13	de	inc	4
2	12	d'aq	GP	1	5	12--13	de l	inc	1
3	12--13	del	inc	6					
AM total confusions = 16									
line#	gate#	confusion	label	# of subjs	line#	gate#	confusion	label	# of subjs
6	12	d	inc	1	9	13--18	del s(us/o)	parse	1
7	12,32	de	inc	4	10	15--31	desl	inversion	1
8	12--13,19--31	del	inc	9					

4.1.7 RECOGNITION OF "DOS"

4.1.7.1 DOS: Word Recognition

Recognition for DOS for Catalans and Americans is plotted in Figure 30. In the spectrogram in Figure 7, DOS appeared to show some degree of coarticulatory overlap, [sʃʃ], rather than complete palatalization, *i.e.*, [ʃʃ]. Peaks for natives and non-natives, 75% for Catalans and 58% for Americans, fall at gate 15, at the very onset of [sʃ] of DOS. Though about a third of Americans required more time to identify DOS correctly—recognition is seen at gates 19, 21, and 32, as more phonetic and semantic/syntactic information is available—both groups achieve 100% final recognition.

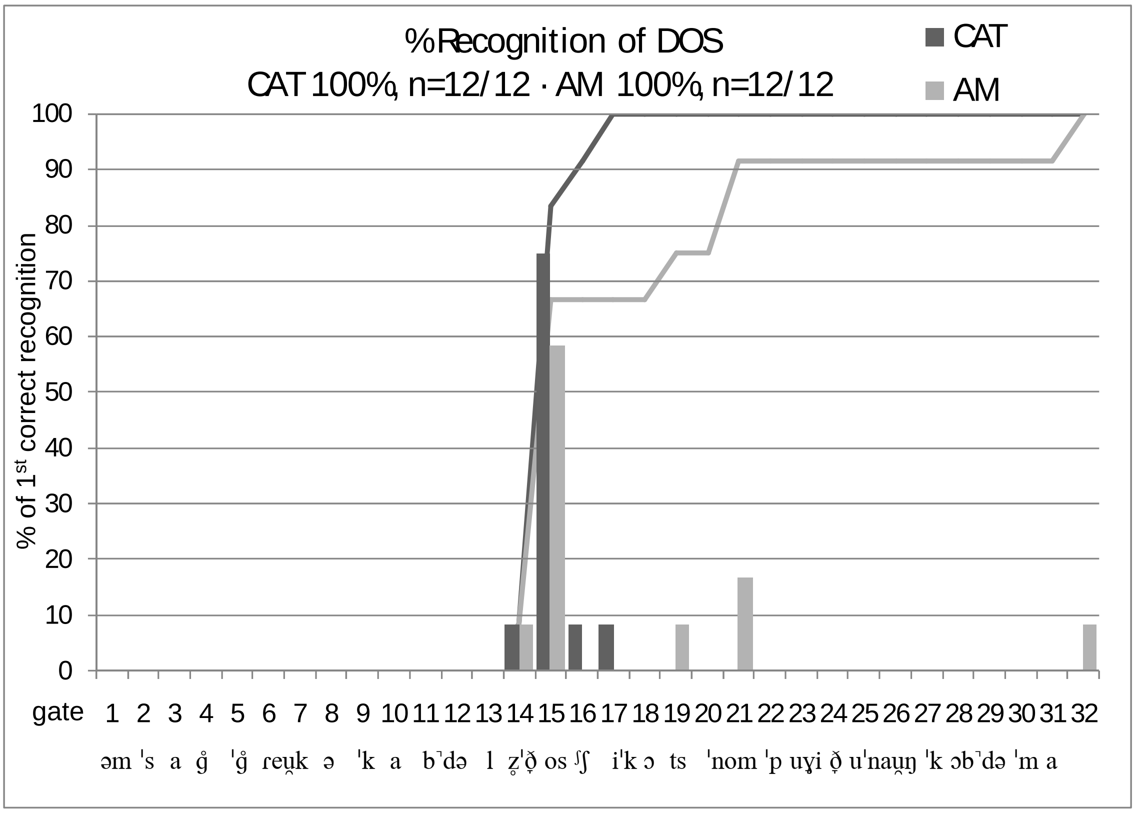


Figure 30. Percentage of Catalans' & Americans' first correct recognition of DOS occurring at the gate number shown on the abscissa.

Results for the ANOVA at the point where 50% of natives had accomplished first correct recognition of the item, gate 15, ($F(1,22) = 0.846$, $p = 0.368$) when the vowel of DOS is introduced, do not reveal significant differences. DOS prompted quick recognition for both groups. Recognition at gate 32 was ceiling for both groups and comparison of the distribution across gates ($F(1,22) = 2.991$, $p = 0.098$) does not lead to significant differences either.

4.1.7.2 DOS: Segment Perception

Catalan and American confusion totals for DOS are 3 and 7 respectively and are listed below in Table XXVIII. DOS was examined for interpretation of its offset. The analysis of the confusions suggests that there is certainly not as much palatalization in Catalan as there is in English, as predicted. In contrast to the English sentence, where both natives and non-natives provided early confusions of IS YOUR, /zj/ > [ʒ], as "ij" or "ish" or similar, suggesting that they reconstructed a lexical palatal segment, there is not a single confusion for DOS which may be interpreted as [doʃ] or [doʒ]. Thus the data suggests that palatalization here is only coarticulatory and not a complete case of assimilation or blending.

In terms of other confusions, in two cases, lines 4 and 7, an approximant [d̞] in DELS <u>D</u>OS was not identified by a non-native as /d/, but rather as part of a prolonged [z̥], giving rise to cases of misparsing "dels sus" and "del so." This reduction process, or the lingering of the sibilant onto the next segment, would be similar to the English context "What's the time," normally pronounced [wɒtssətaɪm] rather than [wɒtsð̥ətaɪm], [tsð̥] > [tss] (Brown, 1975).

Table XXVIII. Catalans' & Americans' confusions for DOS, analyzed for interpretation of [$s^{ʕ}$].

CAT total confusions = 3										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	13--15	d	inc	2		2	15--16	es	s	1

AM total confusions = 7										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
3	14--15	d	inc	2		6	16--31	lo	GP	1
4	15--16	(del s)us	s	1		7	17--18	(del s)o	s	1
5	16--18	doç	s	1		8	19--20	do	inc	1

4.1.8 RECOGNITION OF "XICOTS"

4.1.8.1 XICOTS: Word Recognition

As occurred with DELS, both Catalan and American recognition for XICOTS, another unreduced item, is nearly identical. Figure 31 shows that both groups have a peak of group recognition of 50% at gate 18, consistent with [ʃiˈkɔ]. Both groups also show 33% at gate 19, the [ts] of XICOTS, and then 8% more at gate 20, the onset of NO. Total group recognition is only slightly higher for Catalans, 100%, than for Americans, 92%.

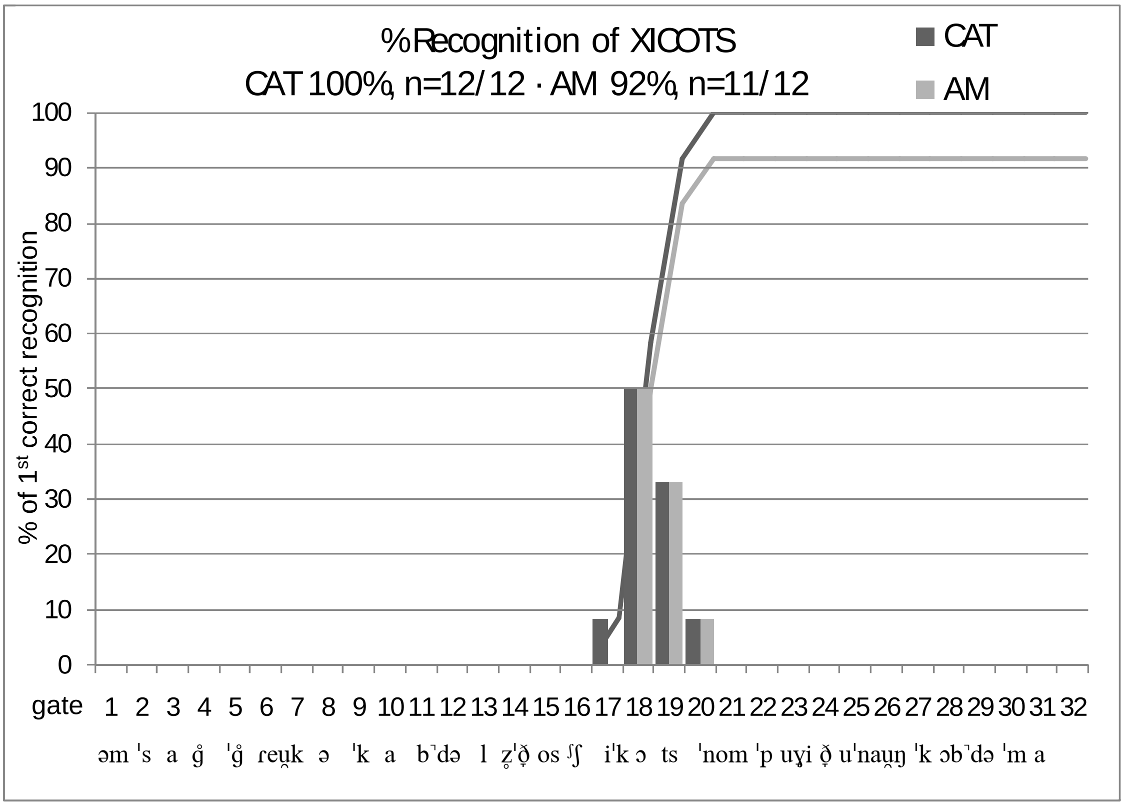


Figure 31. Percentage of Catalans' & Americans' first correct recognition of XICOTS occurring at the gate number shown on the abscissa.

Results for the ANOVA conducted at gate 18 ($F(1,22) = 0.155$, $p = 0.698$), at the introduction of the second vowel of XICOTS in the acoustic signal, are not significant, as are those for the ANOVA across gates ($F(1,22) = 1.154$, $p = 0.294$). The distributions for both groups are nearly identical.

4.1.8.2 XICOTS: Segment Perception

Table XXIX represents the confusions for XICOTS for Catalans and Americans. The Catalan total for this item is 21, while the total for Americans is 25. XICOTS was analyzed for interpretation of its onset. Most of the confusions show an incomplete response to the item, with the intended reading of [ʃ]. There are however a handful of interpretations of [ʃ] as /s/, mainly for Catalans. Interestingly, Americans list a number of ‘j’ interpretations, which have been given the labels /dʒ/, /ʒ/, and /j/, *e.g.*, see line 19, since it is unclear whether this participant is trying to use English or Catalan spelling conventions. /j/ has been included as an interpretation to indicate a possible falling back on English phonology, interpreting s → ʃ/_ ʃ as a context for s → ʃ/_ j palatalization.

Table XXIX. Catalans’ & Americans’ confusions for XICOTS, analyzed for interpretation of [ʃ].

CAT total confusions = 21										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	16	x	ʃ	1		6	17	xic	ʃ	1
2	16	s	s	1		7	17	xiu	ʃ	1
3	16	su	s	1		8	17	sh	ʃ	1
4	16--17	xi	ʃ	7		9	18	xico	ʃ	5
5	17	si	s	2		10	19	xicot	ʃ	1

AM total confusions = 25										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
11	15	po	p	1		20	17	schi	ʃ	1
12	16	x	ʃ	3		21	17--18	i	V	1
13	16	(dou)x	ʃ	1		22	17--18	ju	dʒ/ʒ/j	1
14	16	chi	ʃ/tʃ	1		23	18	xico	ʃ	1
15	16--19	xi	ʃ	6		24	18	(o)cico	s	1
16	17	chi	ʃ/tʃ	1		25	19	juci	dʒ/ʒ/j	1
17	17	chico	ʃ/tʃ	1		26	20	juco	dʒ/ʒ/j	1
18	17	(o)ci	s	1		27	21	juco i	dʒ/ʒ/j	1
19	17	j	dʒ/ʒ/j	1		28	32	se cos(mo)	s	1

4.1.9 RECOGNITION OF "NO"

4.1.9.1 NO: Word Recognition

Figure 32 plots Catalans' and Americans' recognition for NO. NO is another item which shows early correct recognition for both groups as well as peaks of recognition at the same gate, 21, [ˈnom], 58% for Catalans and 75% for Americans. Catalan total recognition is 100%; while American recognition falls just short of this total, 92%.

Results of the ANOVA at gate 21 ($F(1,22) = 0.355$, $p = 0.557$), with the introduction of EM, are not significant, just as the results on the comparison across gates ($F(1,22) = 1.485$, $p = 0.236$) are also not significant. Both natives and non-natives are recognizing the signal essentially as it is input.

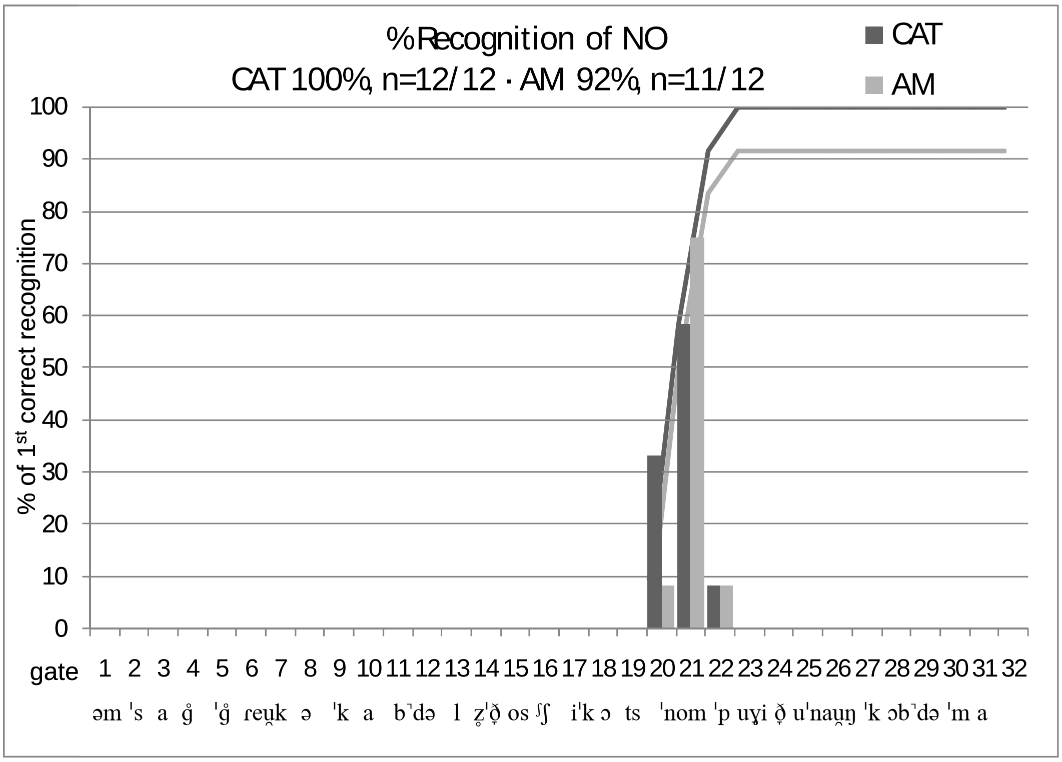


Figure 32. Percentage of Catalans' & Americans' first correct recognition of NO occurring at the gate number shown on the abscissa.

4.1.9.2 NO: Segment Perception

Confusions for Catalans' and Americans' interpretation of NO are listed in Table XXX. The confusions are rather unremarkable, being small in number, 2 for Catalans vis-à-vis 6 for Americans, and mainly involving incomplete responses or parsing problems. Most confusions stop after gate 21, though one American, line 7, had problems in parsing which continued through the end of the sentence. "Cosmopoli," which later builds to "cosmopolitan," is an interesting confusion, because though it is clearly not the intended interpretation, the confusion accounts for a good deal of the acoustic signal, beginning with the second syllable of XICOTS through the /n/ of DONAR, [ʃiˈ**kɔ**t**s**ˈn**om**ˈ**puɣið̞u**ˈ**n**]. This issue will be further elaborated in the discussion section.

Table XXX. Catalans' & Americans' confusions for NO.

CAT total confusions = 2										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	20	n	inc	1		2	21	no(m)	parse	1
AM total confusions = 6										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
3	19--20	g	g	1		6	22-31	mos	GP	1
4	20	n	inc	2		7	32	(cos)mo(poli)	GP	1
5	20	No(rt)	GP	1						

4.1.10 RECOGNITION OF "EM"

4.1.10.1 EM: Word Recognition

Figure 33 represents Catalans' and Americans' first correct recognition of the second occurrence of the item EM. This time EM was reduced in that the vowel of EM was elided or reduced in magnitude. This appears to have inhibited recognition, particularly for the American group. While the American peak, 25%, still occurs at the same gate, 22 (the onset of PUGUI), as the Catalan peak, 50%, total American group recognition only reaches 50% versus 92% for the Catalan group. That is, American recognition is 33% lower than the total for the first occurrence of EM in the sentence, which showed no reduction other than a weak vowel and also no previous context.

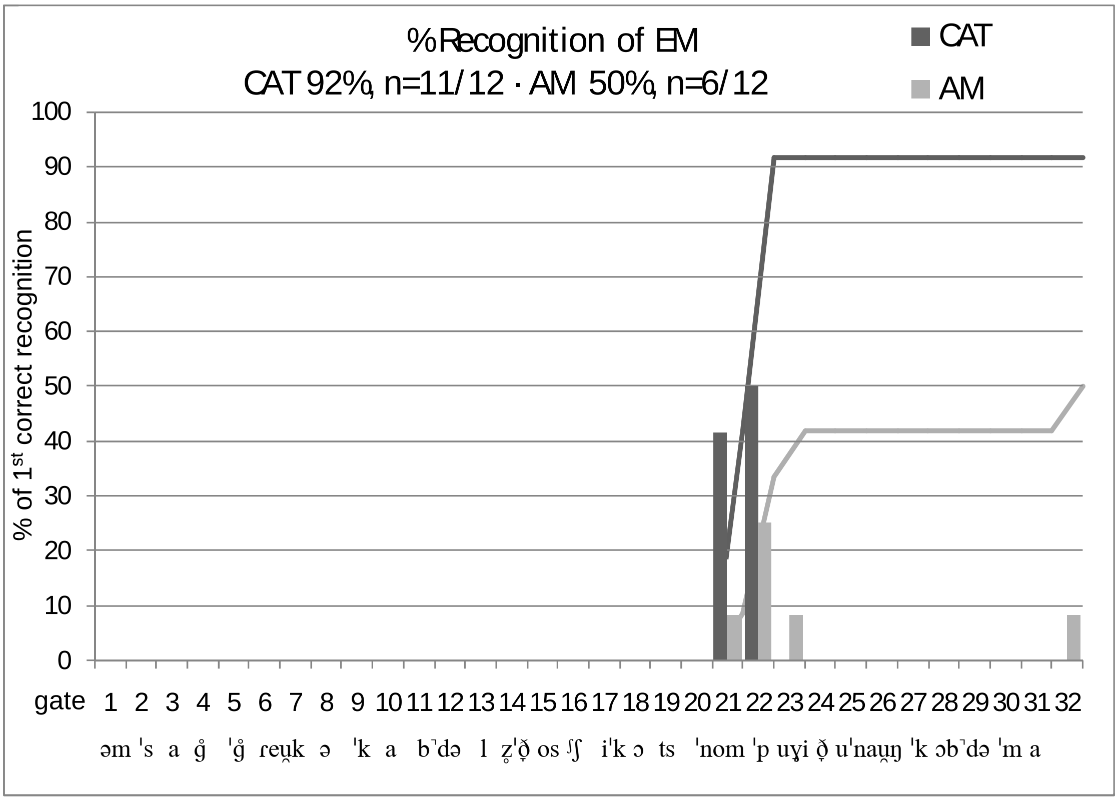


Figure 33. Percentage of Catalans' & Americans' first correct recognition of EM occurring at the gate number shown on the abscissa.

Such low recognition for Americans leads to significant differences for the two groups seen in the ANOVA run at gate 22 ($F(1,22) = 12.535$, $p = 0.002$), the 50% mark for Catalans, as well as in comparison of the groups across gates ($F(1,22) = 9.534$, $p = 0.005$). This is opposite the case for the first occurrence of EM in the test sentence, where comparison of the groups did not lead to significance at either the 50% gate or across time. It is interesting that Americans should have more problems in identifying this second occurrence than the first, given the amount of context that they had received up to this point.

4.1.10.2 EM: Segment Perception

Table XXXI lists the confusions for Catalans, 2, and Americans, 10, for the second occurrence of EM in the sentence, which was again analyzed for its offset. As occurred with EM at the beginning of the sentence, some Americans began to report /n/ around gates 22 and 23, after the onset of PUGUI, see for example lines 7 and 8, most likely they are undoing what they think is the effect of overlap, “en” + PUGUI. This is a case of overcorrection (in the sense of Ohala, 1981, 1993).

Table XXXI. Catalans’ & Americans’ confusions for EM, analyzed for interpretation of [m].

CAT total confusions = 2										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	21	(no)m	m	1		2	23--32	amb	m	1
AM total confusions = 10										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
3	20	(No)rt	GP	1		8	23--30	han	n	1
4	21	mes	m	1		9	22-31	mos	m	1
5	22	(no)n	n	1		10	32	m'en	m/n	1
6	22	(no)m	m	1		11	32	(cos)mo(poli)	m	1
7	22,32	en	n	2						

4.1.11 RECOGNITION OF "PUGUI"

4.1.11.1 PUGUI: Word Recognition

Catalan and American recognition of PUGUI is plotted in Figure 34. As with many other items, the peaks for both groups occur at the same gate, 23, [ˈpuɣ̞i], however the American peak is 50% lower than the Catalan peak, 17% vis-à-vis 67%. Low non-native recognition continues through gate 32: American total recognition is lower for PUGUI than for any other lexical item, 42%, while Catalan recognition is 83%.

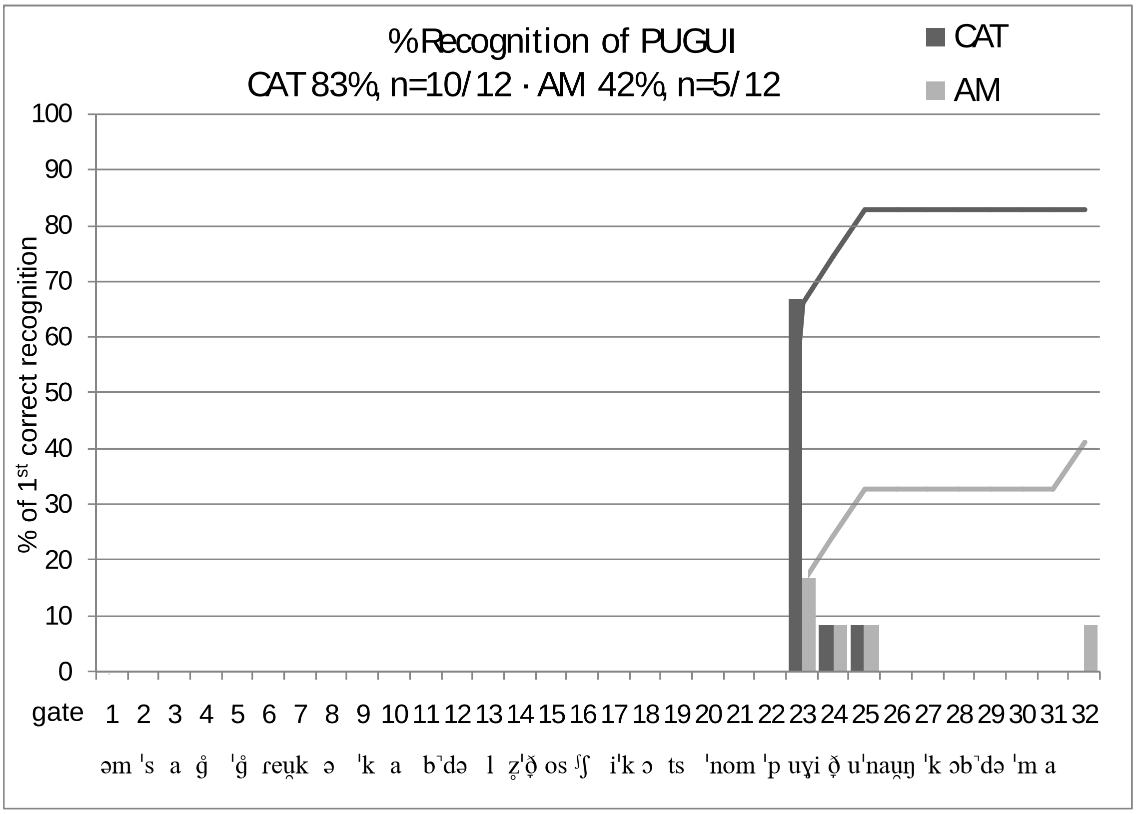


Figure 34. Percentage of Catalans' & Americans' first correct recognition of PUGUI occurring at the gate number shown on the abscissa.

The two ANOVAs conducted at gate 23 ($F(1,22) = 1.478$, $p = 0.237$) and across time ($F(1,22) = 8.222$, $p = 0.009$) show different results. Though differences in the cumulative percentages for the two groups are not significant at the native 50% mark, the one American outlier combined with the 7 Americans who never identified PUGUI, produce significant variance between the two groups across time.

4.1.11.2 PUGUI: Segment Perception

Confusions for PUGUI for Catalans and Americans are given in Table XXXII. While the total number of confusions for Catalans is 8, the total number for Americans is more than triple that amount, 27. Because it appeared to be a point of difficulty for Americans, the medial [ɣ], was analyzed for its interpretation. Catalans of course have no problems in analyzing [ɣ] correctly. The only notable confusion for Catalans is one case of interpretation of the verb in 3rd person plural, “puguin,” through the last gate instead of 3rd person singular, see line 4. This is syntactically correct (agreeing with XICOTS rather than CAP); but, it is not consistent with the phonetic signal. Had “puguin” been what was actually articulated, the vowel would have been nasalized and the following obstruent would have been a stop [d] while it is instead a [ð]. This indicates top-down information dominating low-level information.

Americans on the other hand show great difficulty in interpreting [ɣ]. Though about a third of the confusions correctly interpret it as /g/ and are merely incomplete, the most common recurring error was the misperception of a /g/ as /d/. Those cases where an interpretation with /d/ is provided before gate 24, that is, before the next word in the signal, DONAR, is introduced, may reveal cases of a top-down interpretation of the verb PODER, “pod” and “pud,” see lines 5 and 10, on a misinterpreted segment. Those cases which show a /d/ after gate 24, for example, “pugui(d),” “pui(d/di/don),” lines 16 and 17, see also lines 22 and 25, are due to the effect of the [ð̞] in DONAR and failing to provide an interpretation of the approximant [ɣ̞] as /g/.

Table XXXII. Catalans' & Americans' confusions for PUGUI, analyzed for interpretation of [ɣ̞].

CAT total confusions = 8										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	22--23	pu	inc	2		3	23	pug	g	1
2	22,24	p	inc	3		4	23--32	puguin	g/3r plural	2
AM total confusions = 27										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
5	22	pod	d	1		17	24--27	pui(d/di/don)	d	1
6	22	pu	inc	1		18	24--31	pol i(tan)	l	1
7	22--23	p	inc	3		19	24--32	pogut	g	2
8	23--32	puguin	g/3r plural	2		20	24,32	poguer	g	1
9	23	pog	g	1		21	25	pugio(d)	g	1
10	23	pud	d	1		22	25--28	puden	d	1
11	23	pol	l	1		23	26--31	pugi	g/spelling	1
12	23	purgi	rg	1		24	28--32	pui	inc	1
13	23	puguim	g/1st plural	1		25	29--32	pueden	d	1
14	23,25--31	pogue	g	1		26	31	puc	k	1
15	24	pude	d	1		27	32	(mo)poli(tan)	l	1
16	24	pugi(d)	g	1						

4.1.12 RECOGNITION OF "DONAR"

4.1.12.1 DONAR: Word Recognition

Percent recognition for DONAR for Catalans and Americans is shown in Figure 35. Again, the peaks for Catalans and Americans may both be found at the same gate, 25, [ð̞uˈna], though the American peak is again 50% lower than the Catalan peak, 33% versus 83%. While all of the 100% total Catalan recognition occurs between gates 25 and 26, [ð̞uˈnau̯ŋ], Americans show some later recognition at 27, with the onset of COP, and 31, the offset of MÀ, 17%. At gate 32, Catalan recognition, as stated, is 100%; American recognition only totals 67%.

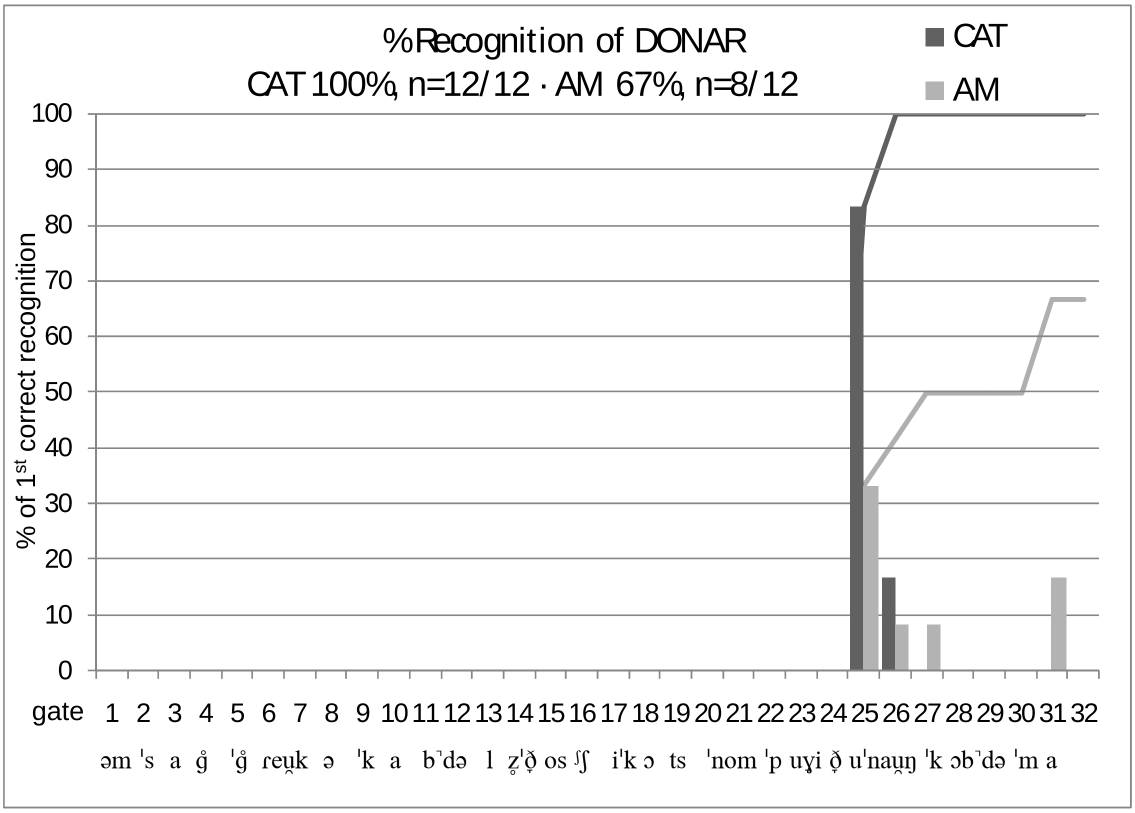


Figure 35. Percentage of Catalans' & Americans' first correct recognition of DONAR occurring at the gate number shown on the abscissa.

The differences between the two groups at gate 25 ($F(1,22) = 7.615$, $p = 0.011$) are great enough to be significant, as non-native performance is also low enough for differences in the distributions across time ($F(1,22) = 12.236$, $p = 0.002$) to also be significant.

4.1.12.2 DONAR: Segment Perception

Table XXXIII lists the confusions for DONAR for Catalans and Americans, 9 and 14 respectively. DONAR was analyzed for interpretation of its onset. In contrast to the Catalan confusions, which mainly show incomplete responses, Americans' main problem is one of parsing. One possibility for this is due to the fact that the second syllable of DONAR, rather than the first, is stressed. As mentioned earlier the Metrical Segmentation Strategy posits that stress serves as a cue for word onset and for commencing English lexical searches (Cutler & Norris, 1988). The use of this strategy on the part of Americans, but not Catalans, could explain the problems we see in parsing DONAR from previous input.

Table XXXIII. Catalans' & Americans' confusions for DONAR.

CAT total confusions = 9										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	24	do	inc	4		4	24	tr	tr	1
2	24	du	inc	1		5	24	v	β	1
3	24	don	inc	1		6	25	dona	inc	1
AM total confusions = 14										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
7	24	(pugi)d	inc	2		13	25--30	(pogut) anar	V	1
8	24,26	do	inc	2		14	26--30	d'en(on)	inc	1
9	24--32	(poli)tan	t	1		15	27	(pugi)don	inc	1
10	25	d	inc	1		16	28--32	d(on/en)	inc	1
11	25	(pugio)d	inc	1		17	31	d'	inc	1
12	25--26	(pugi)do	inc	1		18	32	don	inc	1

4.1.13 RECOGNITION OF "UN"

4.1.13.1 UN: Word Recognition

Recognition of UN for both groups is represented in Figure 36. UN showed assimilation between the nasal and the initial consonant of COP, /nk/ > [ŋk]. For this item, Catalans show an impressive early peak, 92%, at gate 26, [u̯ŋ]. Americans on the other hand show a much later and much smaller peak, 25%, at gate 30, with the onset of MÀ. American recognition is much more dispersed than Catalan recognition.

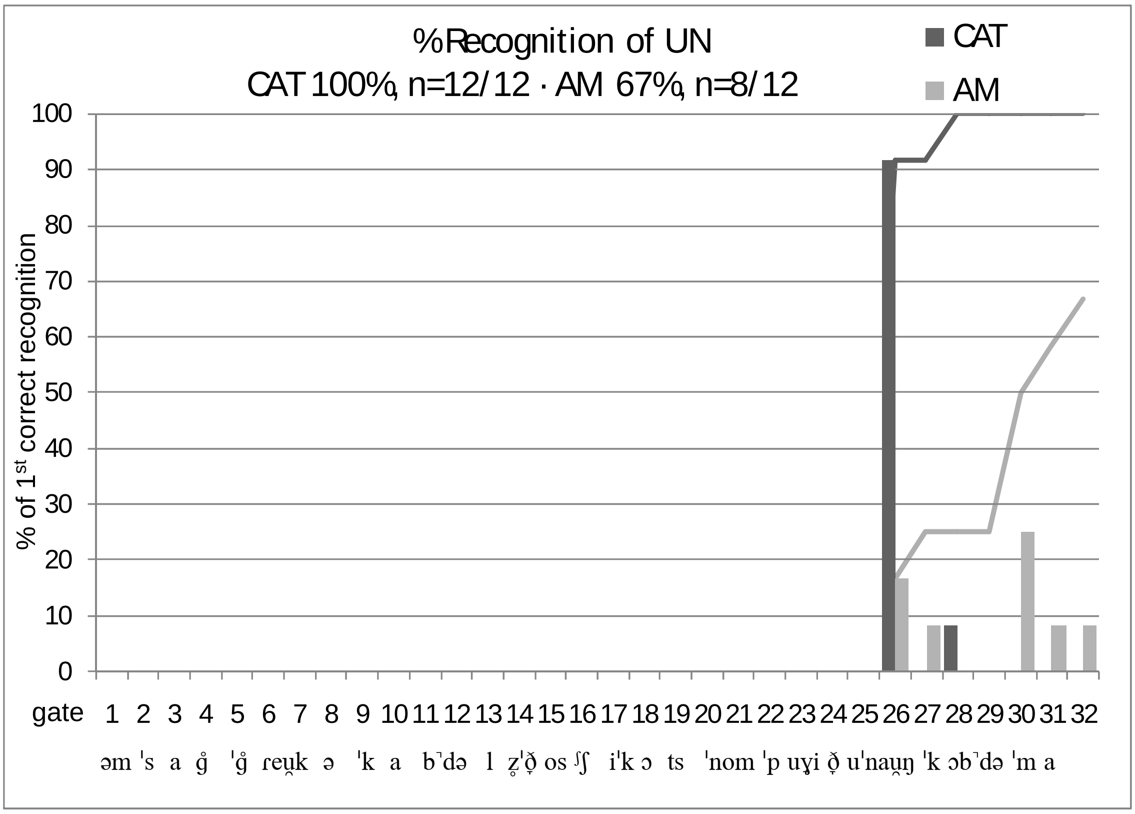


Figure 36. Percentage of Catalans' & Americans' first correct recognition of UN occurring at the gate number shown on the abscissa.

Though there is some early recognition for Americans, 25%, at gates 26 and 27, [u͜ŋ/ˈk], most of this group's recognition occurs in the last three gates, beginning with the onset of MÀ. Total group recognition for Americans continues to be considerably lower than Catalan group recognition, 67% versus 100% respectively.

The ANOVA conducted at gate 26 ($F(1,22) = 28.742$, $p = 0.000$) shows unsurprisingly significant differences between the two groups, as does the ANOVA across time ($F(1,22) = 26.703$, $p = 0.000$).

4.1.13.2 UN: Segment Perception

Confusions for Catalans and Americans for UN are shown in Table XXXIV. UN was analyzed for its offset. Confusions for Catalans are extremely low in number, 3, and all end by gate 27, with the onset of COP. Confusions for Americans are much higher in number, 19, and last longer, some through gate 32. The main problem for Americans in this case is not identifying the nasal correctly, but parsing UN from surrounding items—sometimes preceding, but typically following items. Though the spectrogram reflects a clear velar nasal at the offset of UN, no participants show an obvious face value interpretation as [ŋ], which would likely be represented by an 'ng' spelling; thus sentential context and top-down knowledge must be helping to over-ride face value interpretations of the phonetic signal, but it is slow to assist in helping to extract UN from its immediate neighbors.

Table XXXIV. Catalans' & Americans' confusions for UN, analyzed for interpretation of [ŋ].

CAT total confusions = 3										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	25--26	u	inc	2		2	27	un(c)	n	1

AM total confusions = 19										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
3	26	e	inc	1		11	28--30	en(co/comp)	n	1
4	26,29	a	inc	2		12	28--29,31--32	en	n	3
5	26--27	amb	m	1		13	29	pa	V	1
6	27	en(c)	n	2		14	29--32	(d)en(cor)	n	1
7	28	an(c)	n	1		15	30	an	n	1
8	28	an(co)	n	1		16	30--31	on	n	1
9	28	(d)on(cor)	n	1		17	32	al	l	1
10	28--29	(d'en)on(c/cop)	n	1						

Interestingly, there are several American confusions that fail to report a nasal for [ṳŋ], only reporting a vowel, see lines 3, 4 and 13. This may reflect the fact that in Catalan oral vowels are slightly nasalized, and much heavier nasalization on the vowel preceding the nasal is required in American English (Solé, 1995). Additionally, there seems to have been a good deal of confusion concerning the vowel of UN. According to Catalan orthography, ‘o’ may represent either [o], [ɔ] or [u], thus it may be assumed that the confusions written with ‘o’ are perceiving the vowel [u] as intended. However, many confusions are written with ‘a’ or ‘e,’ see lines 3-8, 11-15, and 17, suggesting the perception of a lower and more open or mid-vowel than /u/.

4.1.14 RECOGNITION OF "COP"

4.1.14.1 COP: Word Recognition

Catalan and American recognition for COP is shown in Figure 37. Like CAP DELS, COP DE also shows assimilation, /pd/ > [b̚d]. For this item, the Catalan peak, 42%, falls at gate 29, when the /d/ from the following word triggering the voicing assimilation is made available in the signal. This is after 50% of Catalan recognition has already occurred with as little signal as [u̯ŋk]. The American peak, 33%, falls one gate later, at gate 30, the onset of MÀ, with some recognition occurring earlier than the peak, 25%, beginning with the [k] of COP, and some later, 17%, through MÀ.

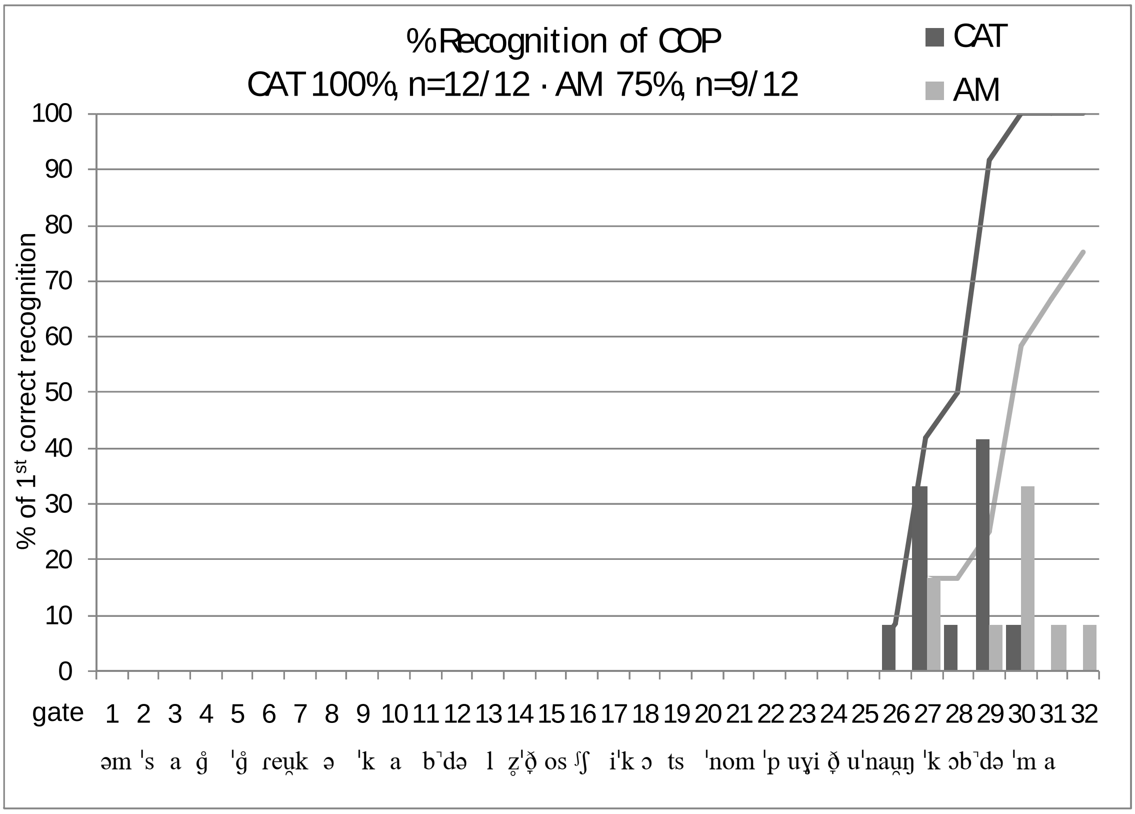


Figure 37. Percentage of Catalans' & Americans' first correct recognition of COP occurring at the gate number shown on the abscissa.

Though total recognition is higher for this item for Americans, 75%, than for some previous items, it is still lower than Catalan total group recognition which reaches 100%.

Results for the ANOVA conducted at gate 28 ($F(1,22) = 3.143$, $p = 0.090$) show non-significant differences for the two groups. Differences in the two groups are however significant across time ($F(1,22) = 10.883$, $p = 0.003$), as shown by the ANOVA results. The 2 outliers and the 4 non-natives who never identified COP create a non-native distribution more concentrated to the right, while the native curve is concentrated on the left.

4.1.14.2 COP: Segment Perception

Catalan and American confusions for COP are represented in Table XXXV. Catalans total 14 confusions and the American total is 17. COP was analyzed for the effect of regressive voicing assimilation affecting its offset. What is telling is that, compared to CAP, which yielded a number of face value interpretations involving ‘b,’ there are no confusions for COP involving ‘b,’ even though both lexical items underwent the same type of assimilation, /pd/ > [b˺d].

Table XXXV. Catalans’ & Americans’ confusions for COP, analyzed for interpretation of [b˺].

CAT total confusions = 14										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	27	c	inc	6		3	28	co	inc	6
2	27	(un)c	inc	1		4	29	cop(d)	p	1

AM total confusions = 17										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
5	27	(en)c	inc	2		13	28--32	(on/en)cor	r	1
6	27	c	inc	1		14	29	(on)cop	p	1
7	27--28	(d'en/on)c	inc	1		15	29	com	m	1
8	28	co	inc	1		16	29--30	(en)comp	m	1
9	28	(en)co	inc	1		17	30--31	cap	p	1
10	28	(an)c	inc	1		18	31	co(de)	no C	1
11	28	(an)co	inc	1		19	32	can	n	1
12	28--31	comp(te)	m	2						

Figure 37 suggests 83% of Americans clearly haven't figured out the phrase UN COP (DE) at gate 28, the offset of COP, while 50% of Catalans likely had. Though there is no top-down knowledge to assist them, because they haven't identified the phrase yet, they are still not reporting a 'b'. This suggests that the gate fell at different places in the two phrases, CAP DELS and COP DE, with more information available in the latter. Alternatively, informants may have learned from exposure to the speaker, i.e., previous /pd/ > [b˺d], and this may be guiding their judgments in the second occurrence of the same sequence. This would be compatible with an exemplar model of representation where listeners keep track of auditory memories, including speaker characteristics.

COP however does receive responses including a nasal, *e.g.*, "compte," line 12, see also lines 15, 16 and 19. This could be linked to nasalization in UN COP perceptually lingering onto the following vowel or, more likely, the buildup of a garden path response. Additionally, there were a number of parsing errors. Here COP is clearly stressed in the signal and in Table XXXV, as well as XXXIV, we see Americans still having problems in extracting this item as a separate word, contrary to the predictions of the Metrical Segmentation Strategy.

4.1.15 RECOGNITION OF "DE"

4.1.15.1 DE: Word Recognition

Recognition of DE, an unreduced item, for Catalans and Americans is seen in Figure 38. Though for both groups the peak percentage, 33%, is the same, the Catalan peak falls much earlier than the American peak: gate 28 for Catalans versus gate 31 for Americans. The Catalan peak occurs before DE actually appears in the signal, underscoring the predictability of this item for natives due to both sentential context and cues in the acoustic signal—COP's coda was realized with a voiced segment due to regressive voicing assimilation rules. Catalans achieve 50% recognition one gate later,

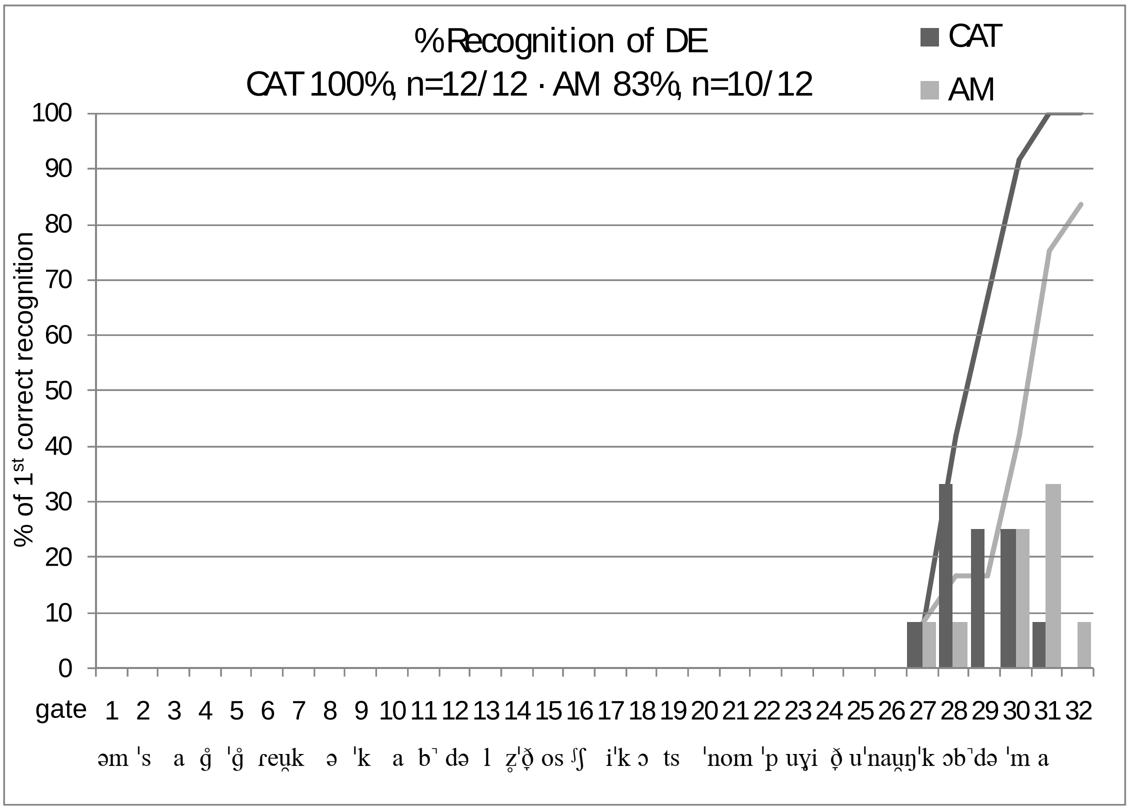


Figure 38. Percentage of Catalans' & Americans' first correct recognition of DE occurring at the gate number shown on the abscissa.

gate 29, while Americans still show a low cumulative total. American recognition instead rises steeply when the stressed onset of the following word, MÀ, is made available at gate 30. This reflects the use of top-down, higher-level cognitive strategies by natives versus bottom-up, low-level phonetic strategies by non-natives to identify the signal. Total recognition for this item in the end is high, 100% for Catalans and 83% for American.

Results of the ANOVA at gate 28 ($F(1,22) = 7.615$, $p = 0.011$) yield significant differences, as the majority of non-native recognition does not begin until gate 30. This is likely also the reason why the ANOVA run across time ($F(1,22) = 7.380$, $p = 0.013$) also shows significant differences, even though non-natives are more or less able to catch up by the end of the test sentence.

4.1.15.2 DE: Segment Perception

Confusions for DE for the two groups are shown in Table XXXVI. The totals for each group are extremely low, 2 for Catalans and 5 for Americans. Misparsing persists in creating confusions. We see Americans providing responses such as “compte,” English ‘account,’ and misspellings of “demà” ‘tomorrow,’ which are congruent with the phonetic signal, but which have different word boundaries.

Table XXXVI. Catalans’ & Americans’ confusions for DE.

CAT total confusions = 2										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	29	(cop)d	inc	1		2	30	d	inc	1
AM total confusions = 5										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
3	28--31	(comp)te	GP	2		5	30--32	de(man)	GP	1
4	30	de(ma)	GP	1		6	31	(co)de	GP	1

4.1.16 RECOGNITION OF “MÀ”

4.1.16.1 MÀ: Word Recognition

Finally, Catalan and American percent recognition of MÀ is shown in Figure 39. The peak for Catalans, 67%, falls at gate 30, [ˈm], one gate earlier than for Americans, 42%, whose peak falls at gate 31, [ˈma]. Early recognition of this word, as early as gate 28 and 29, when only COP was available highlights that COP DE MÀ is a close-knit unit, most likely stored as a single lexical item. Thus, the whole unit COP DE MÀ was probably activated and selected particularly by Catalan listeners when only COP is present, though the strict interpretation of the task instructions (“listen to each sound and write down what you hear…”), likely discouraged some from listing the whole unit early on. Total recognition for Catalans remains at 100% while the total for Americans only reaches 75%.

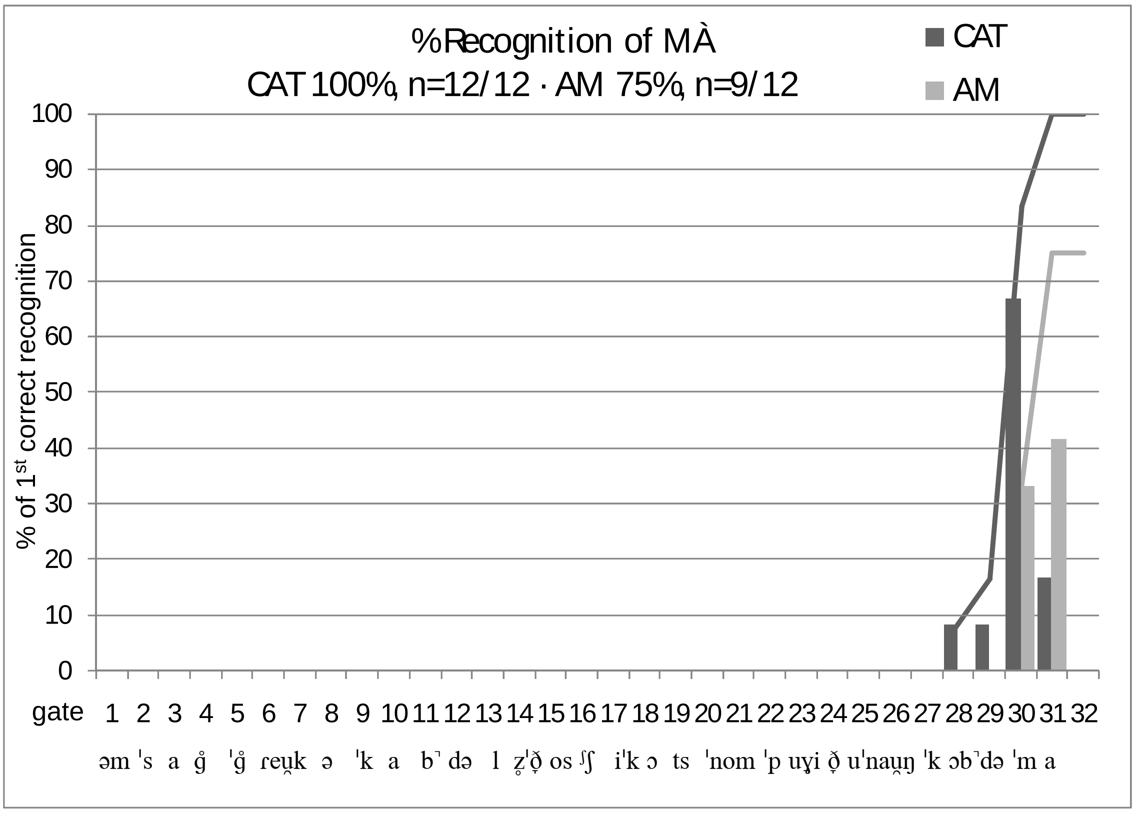


Figure 39: Percentage of Catalans’ & Americans’ first correct recognition of MÀ occurring at the gate number shown on the abscissa.

The ANOVA conducted at gate 30 ($F(1,22) = 7.615$, $p = 0.011$), the onset of MÀ, yields significant differences, mainly because American recognition begins when 50% of Catalan recognition has already occurred. Again, late recognition affected the results of the ANOVA on the distributions across time ($F(1,22) = 8.979$, $p = 0.007$), which also show significant differences.

4.1.16.2 MÀ: Segment Perception

The confusions for the final item in the acoustic stream, MÀ, are presented in Table XXXVII. Catalans show 1 incomplete response, while Americans show 7 different confusions, involving incomplete responses, parsing problems and two confusions which are real Catalan words, "mal" 'bad,' and "mar" 'sea,' lines 5 and 6, incongruent with the phonetic signal. The last two interpretations in particular reflect that Americans are influenced by English phonology and orthography. The utterance-final vowel lengthening present in [ma] is interpreted by English speakers as a possible realization of "mar" and "mal" precisely because final /r/ may be missing in some dialects of English before a long vowel such as /ɑː/ and /l/ may be vocalized syllable-finally, thus the primary articulatory constriction would not be present in those cases.

Table XXXVII. Catalans' & Americans' confusions for MÀ.

CAT total confusions = 1										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
1	29--30	m	inc	1						
AM total confusions = 7										
line#	gate#	confusion	label	# of subjs		line#	gate#	confusion	label	# of subjs
2	30	m	inc	2		5	31	mal	l	1
3	30,32	(de)mà	GP	2		6	32	mar	r	1
4	30--32	(de)man	GP	1						

4.2 Catalan Results Summary

4.2.1 Catalan Percent Recognition & ANOVA Results Summary

The following section provides a summary of the results for native and non-native speakers' processing of the Catalan test sentence. Figures 40 and 41 show Catalans' and Americans' percentage of recognition at the Catalan 50% cross-over point for each item and each groups' total percentage of recognition for each item. Below the graph, the gate where the Catalan 50% cross-over point occurred is listed. Next the results of the ANOVAs conducted on the groups' percentages at the 50% point and on the groups' distribution of recognition across time are given. *P* values lower than 0.05 are considered significant differences and are indicated by a single asterisk (*). *P* values greater than 0.05 are viewed as not significant and are labeled as such (n.s.).

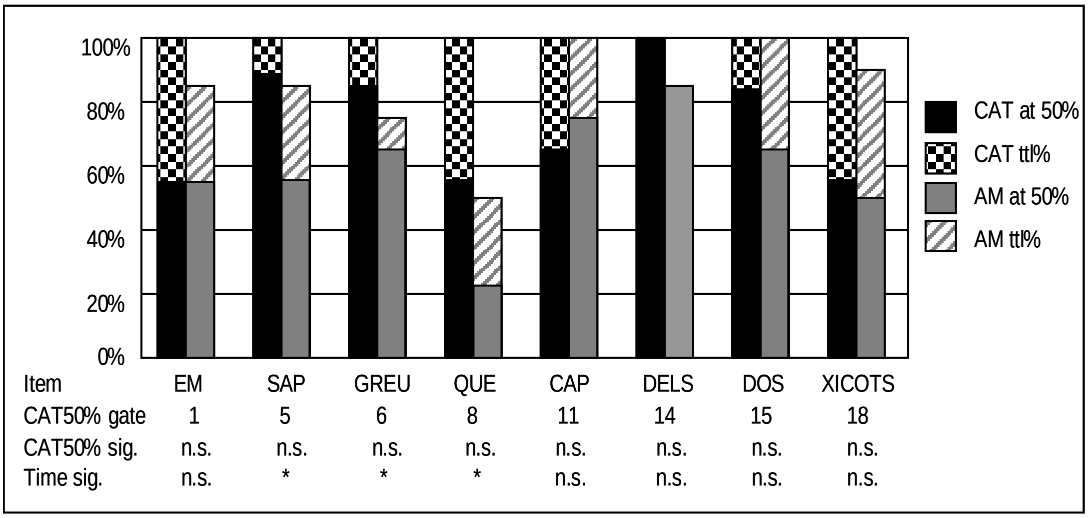


Figure 40. Native & Non-native % recognition at the CAT 50% gate & at gate 32 for the first 8 lexical items in the test sentence. Along the abscissa are listed: the item, the gate #s at which the CAT50% gate occurred, as well as the level of significance of the ANOVAs conducted at that gate & on the timecourse of recognition, $p < 0.05$ = *, $p > 0.05$ = n.s.

Figure 40 gives results for the first 8 lexical items (EM-XICOTS) and Figure 41 presents the results for the last 8 lexical items (NO-MÀ). For each figure, the cumulative percentages for each group at the native 50% gate are shown in solid black (CAT) and grey (AM) bars and the final percentage totals at gate 32 are shown by checkered (CAT) and striped (AM) bars.

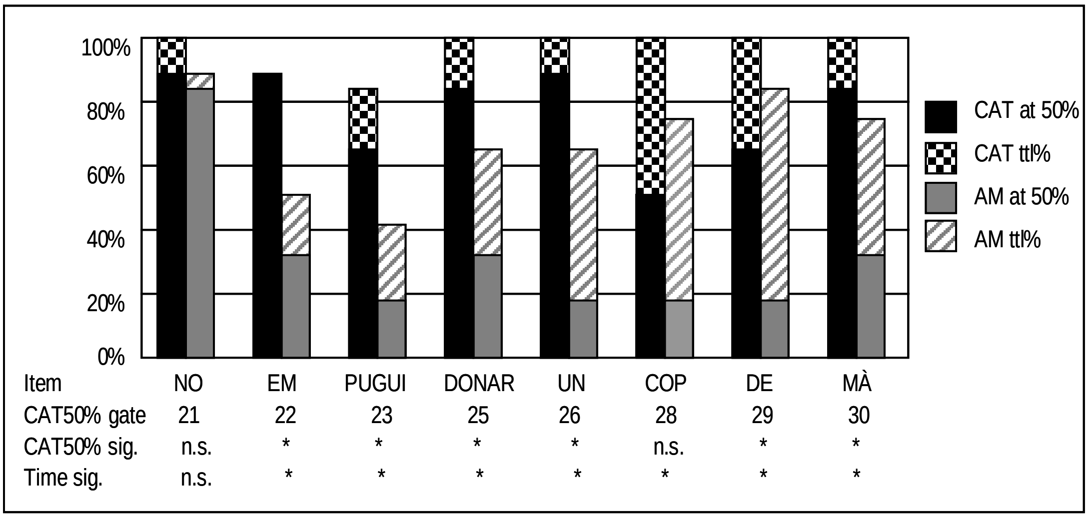


Figure 41. Native & Non-native % recognition at the CAT 50% gate & at gate 32 for the last 8 lexical items in the test sentence. Along the abscissa are listed: the item, the gate #s at which the CAT50% gate occurred, as well as the level of significance of the ANOVAs conducted at that gate & on the timecourse of recognition, $p < 0.05$ = *, $p > 0.05$ = n.s.

Figures 40 and 41 show that non-natives exhibit lower cumulative recognition at the Catalan 50% gate in 14 of 16 cases and a lower final percentage at gate 32 also in 14 of 16 cases. At the native 50% point, non-natives and natives show the same amount of recognition (58%) for the first instance of EM. For CAP, non-natives actually show slightly higher recognition (75% *vs*. 67%). At the final gate, both groups show 100% total recognition for CAP and DOS. Regarding the ANOVAs that were conducted, for 6 of 16 lexical items (all concentrated in the second half of the test sentence) there is a significant difference between the two groups at the gate at which natives reach 50% recognition. For 10 of the 16 items (mainly concentrated in the second half of the test sentence), there is a significant difference concerning the distribution of recognition across time. All of the items that showed significant differences at the 50% point showed significantly differences across time.

4.2.2 Catalan Native *vs.* Non-Native Peak & Total Percentages Comparison & Summary

This section examines the gate showing greatest magnitude in recognition, or peak, for each group per item. Again, the peak is viewed as insightful because it indicates that there was a cue available in the signal at that particular point which contributed to a peak number of subjects' first correct recognition. Tables XXXVIII and XXXIX offer summaries of the native and non-native, that is, Catalan and American, peak percentage and gate for each item. As with the English tables, in the first column of the tables, the lexical items are listed. In Table XXXVIII, the Catalan

Table XXXVIII. Summary of magnitude and gate of the Catalan peak, whether or not the beginning of the next word was available in the test sentence at the peak gate, and total percentages.

Item	CAT peak	Gate	Beg.Nxt.Wrd	Group Ttl
EM	58%	1 [əm]	no	100%
SAP	75%	5 [ˈɡ̥ɾ]	yes	100%
GREU	42%-42%	5/6 [ˈɡ̥ɾ/eu̯]	no	100%
QUE	50%	8 [kə]	no	100%
CAP	58%	11 [ˈkab]	no	100%
DELS	67%	14 [dəɫz̥]	no	100%
DOS	75%	15 [ˈð̞os]	no	100%
XICOTS	50%	18 [ʃiˈkɔ]	no	100%
NO	58%	21 [ˈnom]	yes+	100%
EM	50%	22 [mˈp]	yes	92%
PUGUI	67%	23 [ˈpuɣ̞i]	no	83%
DONAR	83%	25 [ð̞uˈna]	no	100%
UN	92%	26 [u̯ŋ]	no	100%
COP	42%	29 [ˈkɔbd]	yes	100%
DE	33%	28 [ˈkɔb]	no	100%
MÀ	67%	30 [ˈm]	no next word	100%

peak percentage is provided next for each item, as well as the gate at which the peak was seen to occur. Following this, it is noted whether or not the onset of the next word was available in the acoustic signal at the peak point of recognition ('yes' or 'no'). A plus symbol (+) indicates that the beginning of the following word occurred within the same gate as the peak percentage. The group total is again provided for quick comparison with the peak.

Table XXXVIII gives the data for native speakers only. As column 2 shows, any given peak represents recognition by at least one third of the group, 33%. Catalan peaks were highest for UN, 92%, DONAR, 83%, SAP and DOS, 75%. Catalan recognition peaks were lowest for DE, 33%, GREU and COP, 42% each. Peaks were low for GREU only because this item showed two high points of recognition of 42% each. In general, at the highest point of group recognition for each lexical item, natives did not need to hear the beginning of the following word in the signal in order to make an identification (column 4), indicating that native recognition in this case is not likely sequential. Items where this is not the case, such as SAP and COP, can be accounted for in terms of listeners needing to hear the triggering context, a following voiced consonant, in order to backtrack the regressive voicing assimilation and make an identification. However this was not the case for other assimilated forms, e.g., CAP and UN. The second case of EM could have been a similar case of regressive place assimilation, though it was not. Listeners likely needed more acoustic information to confirm this. The peak for NO occurred at the same gate as the onset of the next word. This could again be due to the length of each gate (80ms) and not to the fact that natives needed to hear the onset of EM to make an identification. Lastly, final percentages for Catalans range from 83%-100%. Totals were 100% for all items except for EM2, 92%, and PUGUI, 83%.

Table XXXIX now presents the data for Americans. In this table, extra columns provide comparisons between the American and Catalan results. After the American peak percentage, listed in column 2, the next column shows whether the non-native peak was lower than the native peak ('yes' or 'no') or if it was the same percentage as the native peak ('='). An asterisk in this column denotes a significant difference. Following the gate at which the American peak occurred, column 4, it is noted whether or not the American peak was later than the Catalan peak ('yes,' 'no,' or '='), that is, if non-natives took longer to achieve a peak percent of identification. In the last column, it is indicated whether or not the non-native total is lower than the native total percentage ('yes' or 'no').

Table XXXIX. Summary of American peak & total percentages, as well as comparison to native percentages.

Item	AM peak	NNS pk < NS pk	Gate	AMpk ltr than CAT pk	Beg.Nxt. Wrd	Group Ttl	NNS ttl < NS ttl
EM	58%	=	1 [əm]	=	no	83%	yes
SAP	25%	yes	5 [ˈg̥ɾ]	=	yes	83%	yes
GREU	33%	yes	5 [ˈg̥ɾ]	no	no	75%	yes
QUE	25%-25%	=	8/9[kə/ˈk(a)]	yes	yes	50%	yes
CAP	75%	no	11 [ˈkab]	=	no	100%	no
DELS	50%	yes	14 [dəɫz̥]	=	no	83%	yes
DOS	58%	yes	15 [ˈð̞os]	=	no	100%	no
XICOTS	50%	=	18 [ʃiˈkɔ]	=	no	92%	yes
NO	75%	no	21 [ˈnom]	=	yes+	92%	yes
EM	25%	yes*	22 [mˈp]	=	yes	50%	yes
PUGUI	17%	yes	23 [ˈpuɣ̞i]	=	no	42%	yes
DONAR	33%	yes*	25 [ð̞uˈna]	=	no	67%	yes
UN	25%	yes*	30 [u̯ŋˈkɔbdəˈm]	yes	yes	67%	yes
COP	33%	yes*	30 [ˈkɔbdəˈm]	yes	yes	75%	yes
DE	33%	=	31 [dəˈma]	yes	yes	83%	yes
MÀ	42%	yes*	31 [ˈma]	yes	no next word	75%	yes

Table XXXIX demonstrates that American peaks, in general, are not as high as native peaks, though they are not as low as the non-native peaks for the English data. American peaks were highest for CAP and NO, 75% each. American peaks were lowest for PUGUI, 17%, SAP, QUE, which showed two peak points, EM2, and UN, which showed a 25% peak each. The non-native peak percentage was lower than the native peak percentage in 10 of 16 cases; five of these cases were significantly different (EM2, DONAR, UN, COP, and MÀ). For EM1, XICOTS, and DE, the peaks were equal for the two groups, 58%, 50%, and 33% respectively, and for CAP and NO the American peaks were actually higher, 75% versus 58% each.

Concerning the peak percentage, American peaks occurred at a later gate than the Catalan peak for 5 of 16 lexical items, a much smaller ratio than for the English data. For 10 items, the peaks for both groups occurred at the same gates, and, for GREU, the single American peak is coincident with the first of the two Catalan peaks for this item.

Regarding whether or not the onset of the next word had been introduced in the acoustic signal at the time of the Catalan peak, comparison of Tables XXXVIII (column 4) and XXXIX (column 6) shows that the onset for the following word was available in more cases for Americans than for Catalans. For natives, the peak falls after the beginning of the next item in only 3 of 16 cases; for non-natives, this is the case in 6 of 16 cases (not including cases where the peaks were found at the same gate as the introduction of the onset of the succeeding item). From this data, as with the English data, we can not conclude that non-native recognition was decisively sequential; however, it was more sequential than native recognition.

Finally, in terms of the total percentages for each lexical item, Table XXXIX shows that the American totals show a wider range, 42%-100%, than do Catalan totals; however, compared to the English data, non-natives in this case do show a considerable degree of recognition for every item presented. In all cases except one, total group recognition for non-natives was equal to or over 50%. American totals were highest for CAP and DOS, 100%, and XICOTS and NO, 92% each; totals were lowest for PUGUI, 42%, which also showed the lowest total for Catalans (83%), and QUE and EM2, 50% each, which showed the second lowest total for Catalans (92%). With respect to the native group, as stated, non-natives showed a lower total for 14 of 16 lexical items. For CAP and DOS, the final totals for the two groups were equal.

In summary, we have seen further support from the data in this section that non-native recognition requires more time than native recognition. The non-native peak occurred later than the native peak for one-third of the items, and, for nearly two-thirds of the items, the non-native peak was lower than the native peak. Coincident with needing more time, non-natives need to hear the onset of the following word in the signal to recognize an item in twice as many cases as natives. Non-native percent totals were lower than those of natives for almost all the test items.

4.3 Catalan Final Lexical Selection/Integration

The final interpretations of the test sentence, *Em sap greu que cap dels dos xicots no em pugui donar un cop de mà*, for each language group are presented in Tables XL and XLI. That is, each response at gate 32, the final gate, are listed by participant. Errors have been highlighted. Responses considered spelling errors have been highlighted and bold boxed.

Table XL provides Catalans' final responses at the final gate. As shown in the table, Catalans made very few errors. There are two cases of agreement with XICOTS, "puguin," rather than agreement with CAP, "pugui." Both are correct in Catalan, though "puguin" in this case reflects the weight of top-down interpretation. Participants 4 and 12 expected to hear a certain syntactic number agreement and they "heard" it in spite of the signal showing otherwise. There is also one case of "amb," which must be considered a spelling error because it is syntactically incorrect in Catalan. As mentioned, "amb" and "em" are homophonous in Catalan (cf. English "there" *vs*. "their").

Table XL. Catalans' final responses to the Catalan test sentence, gate 32.

CATALANS															
subject 1	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
subject 2	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
subject 3	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
subject 4	Em	sap	greu	que	cap	dels	dos	xicots	no	em	puguin	donar	un	cop	de	mà.
subject 5	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
subject 6	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
subject 7	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
subject 8	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
subject 9	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
subject 10	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
subject 11	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
subject 12	Em	sap	greu	que	cap	dels	dos	xicots	no	amb	puguin	donar	un	cop	de	ma

The American responses seen in Table XLI provide much more to comment on. All of the American listeners made at least one error and most more than one. Incorrect responses are again highlighted. Correct responses involving incorrect Catalan spelling conventions are highlighted and bold boxed.

Analysis of the responses shows that at gate 32 only two American informants, 2 and 10, arrived at what may be considered a grammatical sentence. Participant 7 was close, but, due to the choice of "perquè," created a sentence involving anacoluthon, that is, an abrupt change within a sentence to a second construction inconsistent with the first, for example, "I warned her that if she continued drinking, what will become of her?"

In general, we see loyalty to the phonetic signal even when it created a nonsensical sentence, particularly for participants 11 and 12. This supports the findings for non-natives found by Shockey (1997, 1998, 2003) and the data from this study for the English sentence. Non-natives show a tendency to prioritize phonetic information over syntactico-semantic information. Most of the confusions however reflect fine phonetic detail, for example, the devoiced [g̊] at the onset of GREU identified as /k/ (3 of 12 participants), and the conflicting cues for the onset of QUE, that is, the lack of an intense burst as well as values for F2 and F3 more similar to a labial than a velar, which led to many /p/ interpretations (6 of 12 subjects). Participant 11 and, even more so, participant 12 are particularly interesting cases in that, though these two deviated most from the intended sentence grammatically, they still captured a good deal of the low-level phonetic information. Participant 12 interpreted XICOTS NO EM PUGUI DONAR, [ʃiˈkɔtsˈnomˈpuɣiðu̯ˈna], as "se cosmopolitan," correctly capturing most of the phonetic signal: we can identify the initial and final sibilants and the velar of XICOTS, as well as comparable vowels in "se cos"; the vowel of NO and the consonant of EM, which seem to be inverted, “mo;” the onset of PUGUI, “po,” and its final vowel, “i;” as well as the dental and nasal of DONAR, “tan.”

Table XLI. Americans’ final responses to the Catalan test sentence, gate 32.

AMERICANS																	
subject 1	Em	sap	greu	però	a	cap	dels	dos	xicots	no		pugui	donar	un	cop	de	mà
subject 2	Em	sap	greu	que		cap	d'els	dos	chicots	no	m'en	pogut	donar	un	cop	de	main
subject 3	Em	sab	greu	que	al	cap	dels	dos	xicots	no	me	puguin	donar	un	cop	de	mà
subject 4	Am	sap	greu	p'		cap	dels	dos	xicos	no		pueden		an	cop	de	má
subject 5	En	sap	greu	per		cap	dels	dos	chicots	no	en	poguer	donar	un	cop	de	má
subject 6	Em	sap	greu	per		cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà
subject 7	Em	sap	greu	perquè		cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà
subject 8	Em	se	creu	que	al	cap	de	dos	xicos	no		pugui	don	un	cop	de	ma
subject 9	Em	sap	greu	que	a	cap	dels	dos	xicots	no	em	pugui	donar	en	compte	demà	
subject 10	Em	sap	greu	que		cap	dels	dos	xicots	no	han	pogut	donar	un	cop	de	mà
subject 11	Am	sap	creu	per		cap	dels	dos	chicos	no		pui	dencor			deman	
subject 12	Em	sa	creu			cap		dos	se cosmopolitan					al	can	de	mar

Hypercorrection put some Americans at a disadvantage in arriving at the correct final response. In the case of the lexical /m/s of EM, some speakers maintained the incorrect interpretation of a lexical /n/ (“en,” “han”) through gate 32. Participant 5 did so with both the first and second occurrence of EM, while participants 2 and 10 did so with only the second occurrence.

The juncture problem or the location of word boundaries affected subjects’ responses in a number of cases. Misparsing such as participant 12’s “se cosmopolitan” for XICOTS NO EM PUGUI DONAR, participant 11’s “dencor,” and participant 9’s “en compte demà” for UN COP DE MÀ, [u̯ŋˈkɔb˺dəˈma] were setbacks. As with “se cosmopolitan,” “en compte demà” accurately reflects much of the information in this portion of the signal—the phonological /n/ of UN, the onset and the vowel of COP, as well as a face value interpretation of the labial stop in the coda (though in correctly-pronounced Catalan, the labial in "compte" would actually be silent), in addition to DE and MÀ in their entirety.

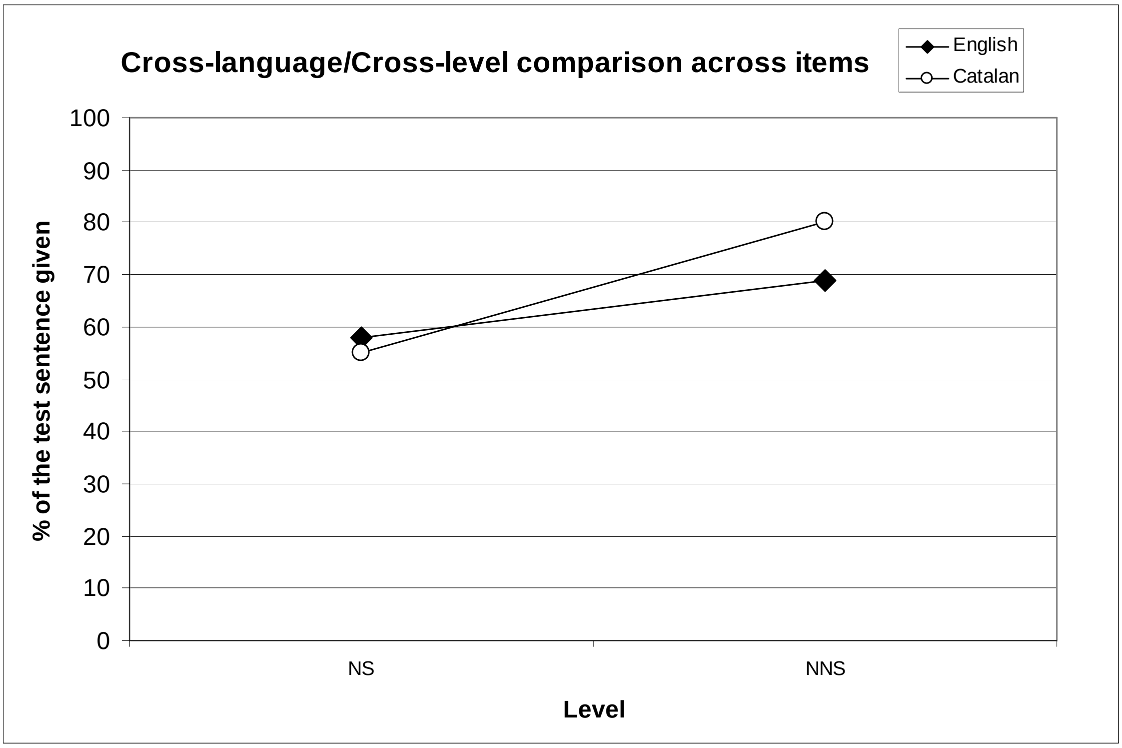
Misspellings were also rampant, particularly concerning XICOTS, which appeared as "chicots," "xicos," and "chicos." SAP was also written "sab" in one instance, which is logical given that SAP is the third person singular form of "saber," 'to know;' however it is convention in Catalan to write words of this type, *i.e.*, words that end in a stressed vowel, with the voiceless counterpart, in this case 'p' rather than 'b,' due to final obstruent devoicing. A dearth of formal training could also be responsible for the 50% misidentification of PUGUI, the third person singular form of the verb "poder," 'to be able to' or 'can,' in the subjunctive. Because the subjunctive is a mood that has the same form as the indicative in English, many learners have difficulty producing it in appropriate contexts and in the correct form, and ultimately may end up dismissing the subjunctive forms for the more convenient, yet incorrect, indicative forms. Formal training can help overcome this problem. In fact, comparing the experiment responses with the questionnaires completed by the informants themselves shows that those subjects who had more experience in using Catalan and/or a greater amount of formal training were actually those that were able to identify PUGUI/"puguin" correctly. Informants with less Catalan experience are seen to try to rely on indicative forms such as the past participle "pogut" (2 cases), a false infinitive form "poguer," and the Spanish third person plural indicative form "pueden" from the comparable Spanish verb "poder."

5 Comparison of Cross-Language Online Word Recognition

In terms of identifying items in reduced, connected speech, in general, native listeners tend to show greater success, while non-natives show varying degrees of success. Figure 42 provides a graphic cross-language, cross-level comparison, showing the central tendencies across items for native English and Catalan listeners (represented by a diamond and circle symbol, respectively) processing L1 (left), and L2 (right).

The results were calculated by finding the convergence of recognition distributions, the central tendency, for each item per group in relation to the percentage of the test sentence which had been given as input. For example, for the English test sentence, each gate corresponds to approximately 4% of the test sentence (100%/24 gates). Though it is simpler to think in gates, percentages were necessarily used for purposes of comparison because there were an unequal number of gates in the English and Catalan sentences. Thus, for example, for native speakers' recognition of IS, all 12 participants identified the item correctly: 7 listeners recognized the item at gate 1, when 4% of the sentence had been made available, 1 listener recognized it at gates 2 (8%), 3 (13%), 4 (17%), and 5 (21%), while one subject did not identify the item until gate 12 (50%). Therefore the average of the results for natives (4 + 4 + 4 + 4 + 4 + 4 + 4 + 8 + 13 + 17 + 21 + 50) is 11% (roughly gate 3). For non-natives, only 9 informants identified the item correctly: 3 at gate 1 (4%), 1 at gate 2 (8%), 2 at gates 3 (13%) and 5 (21%), and 1 at gate 6 (25%). In order to take into account lack of recognition, participants were assumed to have recognized the item after the last gate, thus these were calculated as the last gate plus one (gate 25, 104%, for English, gate 33, 103%, for Catalan). Assuming zero is impossible because it leads to a faster overall result. Therefore the average of the results for non-natives (4 + 4 + 4 + 8 + 13 + 13 + 21 + 21 + 25 + 104 + 104 + 104) is 35% (roughly gate 9). Thus, the same type of calculation was made for each item, for natives and non-natives, for each sentence. These results were then averaged to arrive at a single native and non-native average for each language.

Figure 42: Cross-language/Cross-level comparison showing the central tendencies for each group across all items. English speakers, natives (left) and non-natives (right) are marked with the diamond, while Catalan speakers, natives (left) and non-natives (right) are marked with the circle.



As one can see in the figure, natives do not show much difference in their results: the convergence for English item recognition for Americans is 58% of the way through the test sentence, while the convergence for Catalan item recognition by Catalans is when 56% of the sentence had been input. A chi-square was run to test for significance, though the results are predictably non-significant χ^2 (1, N=200) = 0.082, p = 0.775. Non-native results however differ. The convergence for Catalan item recognition for Americans is at 69%, while the convergence for English item recognition by Catalans is at 80%. A chi-square was run on these data. The results for non-natives however are also not significant χ^2 (1, N=200) = 3.185, p = 0.074. Further tests were run to see how non-natives compared to natives processing the same test material. The results for the English data, Americans' 58% compared to Catalans' 80%, showed a significant difference between the two groups, χ^2 (1, N=200) = 11.314, p = 0.001. By contrast, the results for the Catalan data, Catalans' 56% compared to Americans' 69%, showed a tendency to significance, χ^2 (1, N=200) = 3.605, p = 0.058).

6 DISCUSSION

6.1 Native versus Non-native Casual Speech Processing

This study has evidenced native and non-native casual speech processing from a number of angles. We have examined how listeners process speech online, to identify individual lexical items, and have analyzed what listeners report when they are unable to recognize a lexical item. We have also examined offline recognition, in terms of how listeners integrate online lexical selections to provide a final response. The main results of these different aspects are considered in this section.

In terms of online speech processing and word recognition, we have seen evidence from the English and Catalan data that non-natives generally require significantly more time than natives to recognize words as intended. The results in sections 3.2.1 and 4.2.1 reveal that non-native and native recognition was significantly different regarding cumulative percentage at the gate at which natives had already achieved 50% recognition or more at least one-third of the time (8/12 cases for English and 6/16 cases for Catalan). The timecourse of recognition was also significantly different between the two groups about two-thirds of the time (8/12 cases for English and 10/16 cases for Catalan). The results in sections 3.2.2 and 4.2.2 show that non-native peaks were significantly lower than native peaks more than half of the time (10/12 cases for English and 9/16 cases for Catalan) and non-native peaks occurred later at least one-third of the time (8/12 cases for English and 5/16 cases for Catalan). In addition, non-natives show lower final total percentages at the last gate about nine/tenths of the time (11/12 cases for English and 14/16 cases for Catalan). For most items tested (11/12 cases for English and 14/16 cases for Catalan), at least some number of non-natives was unable to ever identify the item. These results are consistent with the work of Koster (1987) and

Nooteboom & Truin (1980), who were the first to document that in gating experiments non-native listeners tend to require a greater portion of the word than native listeners in order to make an identification. Shockey (1997, 1998, 2003) attributes this “processing lag” for non-natives to an over-dependence on syntactic/semantic information. That is, rather than using phonological knowledge in order to backtrack the reduced acoustic signal to recognize words online, many non-natives may try to impose a syntactic/semantic interpretation on the bits and pieces of the acoustic signal they have picked up. This implies more offline decision-making rather than online perception, which necessarily requires more time.

Analysis of the confusions provides supporting evidence that better and poorer perceivers, generally native and non-native, may not go about processing incoming speech in the same way. We have seen that, in terms of identifying speech as intended, poorer perceivers tend to produce a greater number of face-value interpretations. One explanation for this could be that some listeners, primarily L2 listeners, are unable to undo the reduction processes that take place in certain contexts. Therefore we see interpretations that often reflect fine phonetic detail but with a minimum of (L2) phonological processing.

In terms of final lexical selection and integration of lexical items, sections 3.3 and 4.3, we see that native final responses tend to be correct overall and, even when particular lexical items are not interpreted as intended, the responses tend to be syntactically correct. In those cases where certain lexical items were given a different reading as a result of ambiguity, the interpretations are seen to be correct phonetically, but not phonologically (*e.g.*, “can,” “get a,” “amb”).

Non-native final responses on the other hand tend to show a trade-off between phonetic information and syntax/semantics. This is behavior that is also reported in the work of Shockey (1997, 1998, 2003). Listeners who remain diligently loyal to the acoustic signal often show highly ungrammatical final responses, while listeners who aim for a coherent final response typically deviate greatly from the acoustic signal.

The observations support the idea that, in general, native versus non-native word recognition in casual speech is somehow different. The factors which appear to contribute to how and why they are different are further explored in the following sections.

6.2 Casual Speech Processing & the Perceptual Assimilation Model

Extending the predictions of the Perceptual Assimilation Model (e.g., Best, 1995) to connected speech, we predicted that non-native recognition should be better for processes in the L2 which occur in the L1 in the same or similar contexts (same process, same context), than for those processes which are similar but appear in different contexts, or for those processes that are different in the two languages. Leaving aside factors such as familiarity with the lexical item, frequency and predictability effects which will also be addressed, this would predict the following order of difficulty. The most difficult items to recognize should be those affected by a different process (≠P). Somewhat less difficult should be those involving a similar process in a different context (=P/≠C). Even less difficult to perceive should be those items reduced by a similar process in the same context (=P/=C). And, the least difficult items to perceive should be those items not affected by any process.

In order to determine whether or not the predictions were borne out in the data, the lexical items for each language were first ranked by the cross-linguistic same/different labels according to process and context in the above manner. Those items which were affected by different processes (IS, YOUR, and TO for English and CAP, PUGUI, DONAR, and COP for Catalan) were assigned the ranks of 1, 2, 3 and so on. Items which showed same process, different context were ranked next (THAT and GO), followed by those which were labeled same process, same context (FRIEND, THE, ONE and CAN'T for English and EM1, QUE, DELS, EM2, UN, and DE for Catalan). Items which were not affected by any reduction process were ranked last (BED, BY, and TEN for English and GREU, DOS, XICOTS, NO, and MÀ for Catalan).

Table XLII: Ranking of the English test items by the labels assigned in terms cross-linguistic differences process and context, 1-12.

Process Rank	Item	Process	=/≠
1	IS	Prog. Manner Assim. Palatalization	≠ P = P ≠ C
2	YOUR	Prog. Manner Assim. Vowel Lenition	≠ P = P ≠ C
3	TO	Consonant Lenition: Flapping Vowel Lenition	≠ P = P ≠ C
4	THAT	Onset blended with ONE Vowel Lenition Reg. Pl. Assim.: Velarization	= P = C = P ≠ C = P = C
5	GO	Vowel Lenition	= P ≠ C
6	FRIEND	Consonant Deletion Reg. Pl. Assim.: Dentalization	= P = C = P = C
7	CAN'T	Consonant Deletion Nasal Assimilation	= P = C = P = C
8	THE	Onset blended with offset of FRIEND	= P = C
9	ONE	Reg. Pl. Assim.: Dentalization	= P = C
10	BED	no process (V lengthening as cue to voicing of final obstruent)	---
11	BY	no process	---
12	TEN	no process	---

In cases where items showed the exact same set of labels, like IS, YOUR and TO, (≠P and =P/≠C, see Table XLII), the item appearing first in the test sentence was ranked before items appearing later in the test sentence, under the assumption that items appearing later would benefit from greater semantic/syntactic predictability effects. So, in this case, IS was ranked before YOUR, which was ranked before TO. In cases where an item showed multiple cases of reduction, and the reduction carried the same label as other items, for example FRIEND was reduced by consonant deletion and regressive place assimilation (both =P/=C), while ONE was only reduced by regressive place assimilation (=P/=C), the item which showed more cases of reduction was listed first, so FRIEND was ranked before ONE.

Table XLIII: Ranking of the Catalan test items by the labels assigned in terms cross-linguistic differences process and context, 1-16.

Process Rank	Item	Process	=/≠
1	SAP	Reg. Voicing Assim. Reg. Pl. Assim.	≠ P = P ≠ C
2	DONAR	Spirantization Vowel Lenition	≠ P = P ≠ C
3	CAP	Reg. Voicing Assim.	≠ P
4	PUGUI	Spirantization	≠ P
5	COP	Reg. Voicing Assim.	≠ P
6	EM1	Vowel Lenition	= P = C
7	QUE	Vowel Lenition	= P = C
8	DELS	Vowel Lenition	= P = C
9	EM2	Vowel Smoothing	= P = C
10	UN	Nasality Assim.	= P = C
11	DE	Vowel Lenition	= P = C
12	GREU	no process	---
13	DOS	no process	---
14	XICOTS	no process	---
15	NO	no process	---
16	MÀ	no process	---

Theoretically, items with a process rank closer to 1 show greater cross-linguistic difference in terms of reduction, because they are affected by processes which do not occur in the L1 of the non-native, and items closer to the other extreme of the continuum (12 for English and 16 for Catalan) show little or no difference. According to the predictions, we would expect that an item with a ranking closer to 1 should be more difficult to perceive for non-natives than an item with a process rank closer to 12 or 16. The process rankings are presented in Table XLII for English and Table XLIII for Catalan.[13]

[13] Note that comparisons of vowel reduction were originally assigned same process, same context labels. Re-analyzing these comparisons as same process, different context when the direction of reduction is not the same in the L1, e.g., GO, /o/ to [ə] does not occur in Catalan, or DONAR, /o/ to [u] which does not occur in English, appears to fit the results better. This leads to a change in only one process rank for both the English and Catalan data, that of GO, from 9 to 5.

Next, the statistical results of the ANOVAs were considered. ANOVAs were run on the total percentage of recognition for the native and the non-native groups at the last gate, at the gate where natives achieved a cumulative total recognition percentage of 50% or more, at the gate where each group's peak occurred, at the gate where the native peak occurred, and across the timecourse of recognition for each group. The lexical items for each language were then ranked as to the number of statistically significant differences between the native and the non-native groups.

Table XLIV: Ranking of the English test items, 1-12, according to the number of statistically significant differences between groups found in the ANOVA tests conducted on the final total percentage of recognition for each group (FINAL % TTL), the cumulative recognition percentage for each group at the native 50% gate (AM 50% GATE), the percentage of recognition for each group at their peak (GROUP PEAK %), the percentage for each group at the native peak (AM PEAK % GATE) and on the timecourse of recognition. ** indicates $p < 0.01$ and * indicates $p < 0.05$.

SIGNIFICANCE RANK	ITEM	FINAL % TTL		AM 50% GATE		GROUP PEAK %		AM PEAK % GATE		TIMECOURSE	
1	THAT	F (1,22) = 8.609, p = 0.008	**	F (1,22) = 17.6, p = 0.000	**	F (1,22) = 11.468, p = 0.003	**	F (1,22) = 17.6, p = 0.000	**	F (1,22) = 11.730, p = 0.002	**
2	GO	F (1,22) = 22.0, p = 0.000	**	F (1,22) = 11.0, p = 0.003	**	F (1,22) = 5.5, p = 0.028	*	F (1,22) = 5.5, p = 0.028	*	F (1,22) = 13.073, p = 0.002	**
3	TO	F (1,22) = 22.0, p = 0.000	**	F (1,22) = 11.0, p = 0.003	**	F (1,22) = 5.5, p = 0.028	*	F (1,22) = 5.5, p = 0.028	*	F (1,22) = 13.073, p = 0.002	**
4	BED	F (1,22) = 55.0, p = 0.000	**	F (1,22) = 7.615, p = 0.011	*	F (1,22) = 7.615, p = 0.011	*	F (1,22) = 7.615, p = 0.011	*	F (1,22) = 37.343, p = 0.000	**
5	THE	F (1,22) = 18.526, p = 0.000	**	F (1,22) = 8.609, p = 0.008	**	F (1,22) = 0.846, p = 0.368		F (1,22) = 7.857, p = 0.010	**	F (1,22) = 19.322, p = 0.000	**
6	CAN'T	F (1,22) = 11.468, p = 0.003	**	F (1,22) = 5.0, p = 0.036	*	F (1,22) = 1.8, p = 0.193		F (1,22) = 5.0, p = 0.036	*	F (1,22) = 7.350, p = 0.013	*
7	TEN	F (1,22) = 1.0, p = 0.328		F (1,22) = 7.615, p = 0.011	*	F (1,22) = 0.647, p = 0.430		F (1,22) = 5.5, p = 0.028	*	F (1,22) = 9.605, p = 0.005	**
8	FRIEND	F (1,22) = 3.826, p = 0.063		F (1,22) = 1.478, p = 0.237		F (1,22) = 0.234, p = 0.633		F (1,22) = 5.5, p = 0.028	*	F (1,22) = 5.518, p = 0.028	*
9	ONE	F (1,22) = 1.158, p = 0.294		F (1,22) = 4.661, p = 0.042	*	F (1,22) = 0.155, p = 0.698		F (1,22) = 4.661, p = 0.042	*	F (1,22) = 2.031, p = 0.168	
10	IS	F (1,22) = 3.667, p = 0.069		F (1,22) = 2.839, p = 0.106		F (1,22) = 2.839, p = 0.106		F (1,22) = 2.839, p = 0.106		F (1,22) = 3.557, p = 0.073	
11	YOUR	F (1,22) = 2.302, p = 0.143		F (1,22) = 3.143, p = 0.090		F (1,22) = 0.186, p = 0.670		F (1,22) = 2.302, p = 0.143		F (1,22) = 2.266, p = 0.146	
12	BY	F (1,22) = --, p = --		F (1,22) = 0.0, p = 1		F (1,22) = 0.0, p = 1		F (1,22) = 0.0, p = 1		F (1,22) = 0.040, p = 0.843	

For example, for the English sentence, all five comparisons for THAT were statistically significant, as were those for GO, TO and BED. Those for THAT, however, were all highly significant, $p < 0.01$, while some of those for GO, TO and BED were just significant at the 5% level; so THAT was ranked before the other items. When items showed the same number (and level) of statistically significant differences, the item appearing earlier in the test sentence was listed before those appearing later in the text sentence. The significance rankings are listed in Table XLIV for English and Table XLV for Catalan.

Table XLV: Ranking of the Catalan test items, 1-16, according to the number of statistically significant differences between groups found in the ANOVA tests conducted on the final total percentage of recognition for each group (FINAL % TTL), the cumulative recognition percentage for each group at the native 50% gate (CAT 50% GATE), the percentage of recognition for each group at their peak (GROUP PEAK %), the percentage for each group at the native peak (CAT PEAK % GATE) and on the timecourse of recognition. ** indicates $p < 0.01$ and * indicates $p < 0.05$.

SIGNIFICANCE RANK	ITEM	FINAL % TTL		CAT 50% GATE		GROUP PEAK %		CAT PEAK % GATE		TIMECOURSE	
1	UN	F (1,22) = 5.5, p = 0.028	*	F (1,22) = 28.742, p = 0.000	**	F (1,22) = 18.526, p = 0.000	**	F (1,22) = 28.742, p = 0.000	**	F (1,22) = 26.703, p = 0.000	**
2	DONAR	F (1,22) = 5.5, p = 0.028	*	F (1,22) = 7.615, p = 0.011	*	F (1,22) = 7.615, p = 0.011	*	F (1,22) = 7.615, p = 0.011	*	F (1,22) = 12.236, p = 0.002	**
3	EM2	F (1,22) = 5.851, p = 0.024	*	F (1,22) = 12.535, p = 0.002	**	F (1,22) = 1.571, p = 0.223		F (1,22) = 12.535, p = 0.002	**	F (1,22) = 9.534, p = 0.005	**
4	PUGUI	F (1,22) = 5.0, p = 0.036	*	F (1,22) = 1.478, p = 0.237		F (1,22) = 7.615, p = 0.011	*	F (1,22) = 1.478, p = 0.237		F (1,22) = 8.222, p = 0.009	**
5	MÀ	F (1,22) = 3.667, p = 0.069		F (1,22) = 7.615, p = 0.011	*	F (1,22) = 1.478, p = 0.237		F (1,22) = 7.615, p = 0.011	*	F (1,22) = 8.979, p = 0.007	**
6	QUE	F (1,22) = 11.0, p = 0.003	**	F (1,22) = 2.839, p = 0.106		F (1,22) = 1.571, p = 0.223		F (1,22) = 2.839, p = 0.106		F (1,22) = 10.273, p = 0.004	**
7	COP	F (1,22) = 3.667, p = 0.069		F (1,22) = 3.143, p = 0.090		F (1,22) = 0.164, p = 0.689		F (1,22) = 18.526, p = 0.000	**	F (1,22) = 10.883, p = 0.003	**
8	SAP	F (1,22) = 2.2, p = 0.152		F (1,22) = 3.826, p = 0.063		F (1,22) = 7.333, p = 0.013	*	F (1,22) = 3.826, p = 0.063		F (1,22) = 4.368, p = 0.048	*
9	DE	F (1,22) = 2.2, p = 0.152		F (1,22) = 7.615, p = 0.011	*	F (1,22) = 0.0, p = 1		F (1,22) = 1.8, p = 0.193		F (1,22) = 7.380, p = 0.013	*
10	GREU	F (1,22) = 3.667, p = 0.069		F (1,22) = 0.846, p = 0.368		F (1,22) = 0.164, p = 0.689		F (1,22) = 0.0, p = 1		F (1,22) = 4.846, p = 0.038	*
11	CAP	F (1,22) = --, p = --		F (1,22) = 0.186, p = 0.670		F (1,22) = 0.710, p = 0.409		F (1,22) = 0.186, p = 0.670		F (1,22) = 0.693, p = 0.414	
12	EM1	F (1,22) = 2.2, p = 0.152		F (1,22) = 0.0, p = 1		F (1,22) = 0.0, p = 1		F (1,22) = 0.0, p = 1		F (1,22) = 3.035, p = 0.095	
13	DELS	F (1,22) = 2.2, p = 0.152		F (1,22) = 2.2, p = 0.152		F (1,22) = 0.647, p = 0.430		F (1,22) = 2.2, p = 0.152		F (1,22) = 2.060, p = 0.165	
14	DOS	F (1,22) = --, p = --		F (1,22) = 0.846, p = 0.368		F (1,22) = 0.710, p = 0.409		F (1,22) = 0.846, p = 0.368		F (1,22) = 2.991, p = 0.098	
15	XICOTS	F (1,22) = 1.0, p = 0.328		F (1,22) = 0.155, p = 0.698		F (1,22) = 0.0, p = 1		F (1,22) = 0.155, p = 0.698		F (1,22) = 1.154, p = 0.294	
16	NO	F (1,22) = 1.0, p = 0.328		F (1,22) = 0.355, p = 0.557		F (1,22) = 0.710, p = 0.409		F (1,22) = 0.355, p = 0.557		F (1,22) = 1.485, p = 0.236	

Since, an item with a low process rank (*i.e.*, items ranking at the top of Tables XLII and XLIII) should represent greater L2 perceptual difficulty than one with a high process rank (*i.e.*, items ranking at the bottom of Tables XLII and XLIII), we would expect items with a low process rank to show more statistically significant differences, that is, show a low significance rank (*i.e.*, rank at the top of Tables XLIV and XLV), and items with a high process rank to show fewer statistically significant differences, that is, a high significance rank (*i.e.*, rank at the bottom of Tables XLIV and XLV). These findings are presented in Table XLVI for English and Table XLVII for Catalan. Note that a difference of three or less between the process and significance ranks was taken as support for the predictions.

Table XLVI: Summary of American and Catalan recognition of the English test sentence in terms of "Process Rank" (Proc. Rank), 1-12, "Significance Rank" (Sig. Rank), 1-12, whether or not the predictions were supported by the data ('yes'/'no'), the item, the processes affecting the item, the cross-linguistic difference label (different process, ≠ P; same process, different context, = P ≠ C; same process, same context, = P = C; no process), the cumulative recognition percentage at the last gate for each group, followed by the level of statistical significance for the five ANOVA comparisons, ** = $p < 0.01$ and * = $p < 0.05$: each group's final total recognition percentage (FINAL % TTL), each group's cumulative recognition at the native 50% gate (AM 50% GATE), each group's percentage of recognition at their peak (GRP PEAK %), each group's percentage at the native peak (AM PK % GATE) and comparing each group's timecourse of recognition.

PROC. RANK	SIG. RANK	PRED. BORNE OUT?	ITEM	PROCESS	=/≠	AM FINAL % TTL	CAT FINAL % TTL	FINAL % TTL	AM 50% GATE	GRP PEAK %	AM PK % GATE	TIME COURSE
4	1	**yes**	THAT	Onset blended with ONE Vowel Lenition Reg. Pl. Assim.: Velarization	= P = C = P ≠ C = P = C	92%	42%	**	**	**	**	**
5	2	**yes**	GO	Vowel Lenition	= P ≠ C	67%	0%	**	**	*	*	**
3	3	**yes**	TO	Consonant Lenition: Flapping Vowel Lenition	≠ P = P ≠ C	67%	0%	**	**	*	*	**
10	4	no	BED	no process (V length as cue to voicing of final obstruent)	---	100%	17%	**	*	*	*	**
8	5	**yes**	THE	Onset blended with FRIEND	= P = C	92%	25%	**	**		**	**
7	6	**yes**	CAN'T	Consonant Deletion Nasal Assimilation	= P = C = P = C	83%	25%	**	*		*	*
12	7	no	TEN	no process	---	100%	92%		*		*	**
6	8	**yes**	FRIEND	Consonant Deletion Reg. Pl. Assim: Dentalization	= P = C = P = C	92%	58%				*	*
9	9	**yes**	ONE	Reg. Pl. Assim.: Dentalization	= P = C	92%	75%		*		*	
1	10	no	IS	Prog. Manner Assim. Palatalization	≠ P = P ≠ C	100%	75%					
2	11	no	YOUR	Prog. Manner Assim. Vowel Lenition	≠ P = P ≠ C	92%	67%					
11	12	**yes**	BY	no process	---	100%	100%					

For the English test sentence, we see that the predictions were borne out for eight of twelve items: THAT, GO, TO, THE, CAN'T, FRIEND, ONE and BY. These items' process ranks were similar to their significance ranks, that is, increased recognition difficulty for items involving unfamiliar processes or processes applying in unfamiliar contexts was evidenced by longer response times for non-natives versus natives according to the ANOVA tests. Four items' results were not found to support the predictions: BED, TEN, IS and YOUR. IS and YOUR were predicted to be more difficult to perceive because each was affected by a process which does not occur in Catalan (progressive manner assimilation) and one which does occur but not in the same context (palatalization for IS and vowel lenition for YOUR). Most non-natives were, however, able to identify these items by the final gate and the comparisons between non-natives and natives at the five different test points did not show any significant differences. We would suggest that the reduced difficulty for these items can be accounted for by their high frequency of occurrence as a unit. Sequences such as IS YOUR, HAS YOUR, DOES YOUR, GOT YOU, and DID YOU are extremely common and L2 learners have been exposed to a large number of cases. An alternative interpretation related to the frequency factor is that reduced pronunciations of these sequences are often explicitly taught in the ESL/EFL classroom; therefore, in this case, some participants may have correctly relied on their metalinguistic knowledge.

BED and TEN were items that did not involve a reduction process, so we would have predicted that they would be easier to recognize for non-natives. For BED particularly, however, this was not the case. BED showed a very low final percentage of recognition for non-natives, 17% (compared to 100% for natives), and statistically significant differences between natives and non-natives in all five cases. Examination of the confusions, see Table XV, shows that the majority reflect the interpretation of a voiceless obstruent (/t/) in coda position. This suggests that L1, Catalan, phonology, which features final obstruent devoicing, likely exerted top-down influence which hindered most non-natives' recognition of this item. TEN, on the other hand, showed high non-native recognition at the last gate, 92%; however, non-natives simply took statistically longer than natives to recognize the item, resulting in significant differences at three points: the gate where Americans achieved 50% recognition and where American's reached their peak, in addition to across time. Consideration of the confusions for TEN does not reveal any systematic trends regarding misperception, see Table XVII. There are a number of confusions with other existing English lexical items which do not fit the acoustic signal. Since TEN was the last item in the test sentence to recognize, perhaps several non-natives initially selected items based on predictive top-down interpretations fitting the semantic/syntactic construction of the sentence they had created, rather than relying on acoustic evidence.

Table XLVII: Summary of Catalan and American recognition of the Catalan test sentence in terms of "Process Rank" (Proc. Rank), 1-16, "Significance Rank" (Sig. Rank), 1-16, whether or not the predictions were supported by the data ('yes'/'no'), the item, the processes affecting the item, the cross-linguistic difference label (different process, ≠ P; same process, different context, = P ≠ C; same process, same context, = P = C; no process), the cumulative recognition percentage at the last gate for each group, and the level of statistical significance for the five ANOVA comparisons, ** = $p < 0.01$ and * = $p < 0.05$: each group's final total recognition percentage (FINAL % TTL), each group's cumulative recognition at the native 50% gate (CAT 50% GATE), each group's percentage of recognition at their peak (GRP PEAK %), each group's percentage at the native peak (CAT PK % GATE) and comparing each group's timecourse of recognition.

PROC. RANK	SIG. RANK	PRED. BORNE OUT?	ITEM	PROCESS	=/≠	CAT FINAL % TTL	AM FINAL % TTL	FINAL % TTL	CAT 50% GATE	GRP PEAK %	CAT PK % GATE	TIME COURSE
10	1	no	UN	Nasality Assimilation	= P = C	100%	67%	*	**	**	**	**
2	2	**yes**	DONAR	Spirantization Vowel Lenition	≠ P = P ≠ C	100%	67%	*	*	*	*	**
9	3	no	EM2	Vowel Smoothing	= P = C	92%	50%	*	**		**	**
4	4	**yes**	PUGUI	Spirantization	≠ P	83%	42%	*		*		**
16	5	no	MÀ	no process	---	100%	75%		*		*	**
7	6	**yes**	QUE	Vowel Lenition	= P = C	100%	50%	**				**
5	7	**yes**	COP	Reg. Voicing Assimilation	≠ P	100%	75%				**	**
1	8	no	SAP	Reg. Voicing Assimilation Reg. Place Assimilation	≠ P = P ≠ C	100%	83%			*		*
11	9	**yes**	DE	Vowel Lenition	= P = C	100%	83%		*			*
12	10	**yes**	GREU	no process	---	100%	75%					*
3	11	no	CAP	Reg. Voicing Assimilation	≠ P	100%	100%					
6	12	no	EM1	Vowel Lenition	= P = C	100%	83%					
8	13	no	DELS	Vowel Lenition	= P = C	100%	83%					
13	14	**yes**	DOS	no process	---	100%	100%					
14	15	**yes**	XICOTS	no process	---	100%	92%					
15	16	**yes**	NO	no process	---	100%	92%					

Regarding the Catalan test sentence, see Table XLVII, the predictions were supported by nine of sixteen items: DONAR, PUGUI, QUE, COP, DE, GREU, DOS, XICOTS, and NO. These items' process ranks were similar to their significance ranks (*i.e.*, showed a difference of three or less between the two scales), that is, increased recognition difficulty was reflected in longer response times for non-natives vis-à-vis natives, as shown by the ANOVA tests. Seven items did not support the predictions: UN, EM2, MÀ, SAP, CAP, EM1, and DELS. Of these items, UN and MÀ were predicted to be less difficult to identify for non-natives, but they showed a number of statistically significant differences. Consideration of the final percentage totals shows that most non-natives (67% for UN and 75% for MÀ) were able to recognize these items, they just simply took longer to do so, evidenced by the five significant differences for UN and the three for MÀ. Confusions for UN and MÀ, see Tables XXXIV and XXXVII, reflect parsing problems and misinterpretation as other existing Catalan lexical items, e.g., "en," (article for masculine names, *i.e.*, 'the;' clitic pronoun, and preposition, *i.e.*, 'on,' before a labial consonant) and "on" ('where') for UN and "demà," ('tomorrow') "mal" ('bad') and "mar" ('sea') for MÀ, in addition to early failure to identify a nasal for UN. As both were part of an idiomatic expression, DONAR UN COP DE MÀ, early recognition for each of these items was likely heightened for natives, but not for many non-natives, thus broadening the difference in recognition time between the two groups and leading to greater statistical significance at the points where the ANOVAs were run.

Three items, EM1, EM2 and DELS, were expected to show moderate recognition, each has an intermediate process rank (6, 9 and 8 respectively), but EM2 has a very low significance rank, suggesting it was more difficult to identify, while EM1 and DELS have high process ranks, showing no statistical differences between natives and non-natives. It is curious that the same item, EM, elicited such different results. If we look at the confusions by non-natives, EM1 fluctuated between three possibilities "am" or "amb" and "en," see Table XXII, while the confusions for EM2 were much more varied, eliciting "Nort" (a likely mis-spelling of "nord," 'North'), "mes" ('more'), "non," and "han" for example, see Table XXXI. It may be suggested that the high frequency of EM SAP GREU as a unit likely assisted listeners who were not able to recognize EM1 immediately at the first gate to recognize it with the introduction of the remainder of the string. Indeed, 9 of 12 non-natives identified this item within the first three gates, see Figure 24. On the other hand, EM2, which was not part of a fixed expression in the test sentence, did not have the benefit of being part of a highly frequent string and was more difficult to identify. Regarding DELS, a frequently occurring item in the language, we see that the vowel reduction, /e/ to [ə], which is familiar to Americans (=P/=C) posed no problem for recognition. In fact, examination of Figure 29 supports that non-natives recognized this item much in the way natives did.

Finally, SAP and CAP were predicted to be difficult, showing low process ranks, but in the end they were not so challenging, given their rather high significance ranks. The confusions for SAP show several face-value interpretations, see Table XXIII, which end when GREU is introduced in the signal. This provides further support to the fact that EM SAP GREU was a fairly easily-recognized string due to its frequency as a unit in Catalan, despite the fact that SAP is reduced by a process which is not productive in English (regressive voicing assimilation) and one which does not occur in the same context as in English (regressive place assimilation). CAP was also reduced by regressive voicing assimilation, but this did not hinder recognition at all. In fact, all non-natives had recognized this item within three gates of its complete introduction in the acoustic signal, see Figure 28. They were not deterred even by some initial confusion with the string "que acabi," see Table XXVI, which was shown by natives as well.

Therefore we see that for 8 of 12 lexical items in the English test sentence and 9 of 16 lexical items in the Catalan test sentence, the prediction that non-native recognition should be better for L2 processes which occur in the L1 in the same or similar contexts (=P/=C), than for those processes which are similar but appear in different contexts (=P/≠C), or for those processes that are different in L1 and L2 (≠P) was borne out. In the cases where the prediction was not supported, we suggest that the results may be accounted for by other factors such as frequency effects and top-down strategies.

6.3 Native & Non-native Casual Speech Processing & Modeling

The data yielded by the experiments on native and non-native casual speech processing may be examined in relation to current speech processing modeling. First, results may be interpreted as evidencing the use of both bottom-up and top-down information processing. Non-natives, especially, tended to rely on bottom-up, signal information, providing great phonetic detail in the absence of much phonological processing which prevented correct interpretation. When natives provided confusions based on bottom-up only information, the confusions were usually correctly reinterpreted phonologically a few gates after the conditioning context was made available. This was seen, for example, in the cases of compensation for vowel lowering due to nasalization in English and the correct identification of strings that do and do not provide contexts for post-lexical assimilation in Catalan, *e.g.*, QUE CAP DELS and EM SAP, respectively. Non-natives, however, were seen to be more reticent to revise initial incorrect interpretations or at least they took longer to do so, as seen in the many face-value interpretations. For example, the dentalized nasal strings in FRIEND THE and ONE THAT, interpreted as /n/s, as well as the [g̊]s in GO and GREU, usually reported as /k/s, were most often left underanalyzed even in final responses.

Non-natives succeeded in unraveling many of the consequences of reduction by correctly applying L2 phonology. Palatalization and manner assimilation in the English sequence IS YOUR showed relatively high recognition despite early face-value interpretations and parsing problems. FRIEND more often than not recovered from early confusions involving a lower vowel and the flap in GO TO was eventually recognized as a /t/ or /d/ by two-thirds of the non-native subjects. In turn, the Catalan sequence EM SAP GREU also showed relatively high recognition, even though the offset of SAP and the onset of GREU showed many early face-value interpretations.

The offset of CAP is an instance where non-natives were able to rectify initial misinterpretations once they correctly analyzed the conditioning context for assimilation (the onset of DELS).

Yet, some non-natives may have failed to recognize items likely because L1 phonology was inadvertently applied. Final responses showed the American English flap reported as /r/ by one-quarter of Catalan informants and the final [d] in BED was interpreted as a voiceless obstruents two-thirds of the time. Also, there was an early failure to identify the nasal in UN, possibly because Catalan oral vowels preceding nasals are only slightly nasalized, while American English vowels preceding nasals are known to show much heavier nasalization (Solé, 1995). Thus, a nasal was not cued for non-natives. This is the exact opposite of what happened with the English test sentence, where many Catalans were unable to or slow to compensate for the effects of heavy nasalization on neighboring segments, causing them to identify lower vowels and segments that were not phonological nasals as phonological nasals. It is the influence of L1 in both of these cases guiding many listeners' judgment.

Top-down strategy use may also be inferred from the results. Evidence may be grouped into issues relating to syntactic/semantic predictability, both online and offline, and goodness-of-fit. Regarding online recognition, we see that THAT in the English sentence and EM SAP GREU and UN COP DE MÀ in the Catalan sentence showed quick and high recognition from natives most probably due to their high predictability, particularly as syntactic/semantic units for the last two examples. Predictability is also likely the reason why non-natives showed higher group recognition for ONE (75%) THAT (42%) in comparison to FRIEND (58%) THE (25%), which involved essentially the same type of reduction. Very much related to the idea of predictability are those responses that may be labeled garden path responses. *Garden path response* is a term borrowed from work on sequential recognition (Davis, Marslen-Wilson & Gaskell, 2002), which may be ascribed to some of the data here. Within the signal, multiple, redundant cues are present. As the listener assesses each cue, (s)he forms a hypothesis about the signal and makes a decision. Moving from cue to cue, hypothesis to hypothesis, the listener proceeds down a path of interpretation. Garden paths are what a listener is said to follow after making an incorrect interpretation, but one congruent with the signal. In order to arrive at the intended interpretation, they are forced to backtrack. Different garden paths have been posited to explain listeners' behavior. *Lexical garden paths* may explain why a listener would identify individual shorter words in a (concatenated) longer word, *e.g.*, AS SENT *vs*. ACCENT. *Frequency garden path*s may explain when a listener identifies a word fitting the given phonetic information based on assumptions of frequency. And finally, *semantic/syntactic garden paths* may account for selection of a lexical item given the syntactic position or the meaning derived from previous context given in the sentence. IS YOUR FRIEND THE ONE was followed in different cases by confusions such as "I," "who," and "like," which may be selections based on semantic/syntactic information or possibly frequency. The frequent collocation "bug bite" was an early confusion for BED BY T(EN). "Em semb(la)" was predicted by some subjects for EM S(AP) and "que acab(i)" was a common confusion for QUE CAP, most likely due to frequency effects.

Regarding offline recognition, evidence of top-down processing may be found through analysis of the non-native responses per gate per subject, see Appendix B. Examination shows that many non-natives made a last-minute effort to create more grammatically well-formed final responses. Informants knew that they should aim to produce an acceptable sentence, so many made an effort to reanalyze their responses during the last few gates in order to impose some measure of syntactic/semantic coherence on what they had identified.

Goodness-of-fit, a perceptual strategy associated with TRACE (McClelland & Elman, 1986) that may only be carried out with the availability and use of top-down information, is evidenced in the final response of native participant 9 for the English sentence and to some degree by non-native participant 12 for the Catalan sentence. We see that, based on the available acoustic information these participants were able to identify, they imposed the closest phonetic interpretations possible, "As if I know when I" [ˈɪʒəʳˈ**fɹẽn̪ə**ˈ**wʌ̃n̪ə**] and "se cosmopolitan" [ʃiˈ**kɔts**ˈn**om**ˈ**puɣið̞u**ˈ**n**] respectively, thus successfully accounting for most of the phonetic information available. Yet, critically, not all of the acoustic signal is properly accounted for, directly conflicting with the Possible Word Constraint (PWC), proposed by Norris, McQueen, Cutler & Butterfield (1997).

Further confounding evidence for the PWC is the unintentional ambiguity that was inherent, particularly in the English signal. Recall again the example of [ˈlesn̩ˈsevn̩] (Lindblom, 1988), which may be interpreted as LESSON SEVEN or LESS THAN SEVEN. The frequency with which "can" was confused for CAN'T and "get a" was confused for GO TO shows the high degree of phonological ambiguity in the signal. The PWC is rendered powerless to guide parsing in the face of a phonetic signal which may be segmented according to at least two different phonological forms. Moreover, the delay in recognition of CAN'T and GO TO and their replacement of "can" and "get a" suggests that there is some sort of top-down evaluation guiding these decisions. Though many researchers in word recognition modeling, particularly the creators of Shortlist (Norris, 1994) and Merge (Norris, McQueen & Cutler, 2000) and the PWC (Norris, McQueen, Cutler & Butterfield, 1997), are staunchly against the incorporation of top-down information in modeling because they claim it is superfluous, in this study, top-down strategies appear to have been used by some participants and furthermore appear to be valid and helpful for listeners.

Whether or not bottom-up and top-down information is necessary and used in speech processing translates to the direction future modeling will follow. If both types of strategies are used, as evidenced in this study, models which permit feedback, such as TRACE and the Distributed Cohort Model, more accurately represent the flow of information in normal human (connected) speech processing than do Shortlist and Merge, which claim to be feed-forward only. However, it remains to be clarified how processing should be structured and which levels should allow two-way information flow. For example, early distortions in a word in TRACE are not an obstacle because goodness-of-fit interpretations (evidence for which we have just seen) may be imposed by superior levels; though, they are an obstacle in the DCM and may block lexical access. This is a feature of the DCM that has often been criticized by model makers because of its inefficiency; however, there are several occasions in the two test sentences where we see clear evidence of the early distortion of a word becoming a serious deterrent, blocking recognition, particularly for many non-natives—the onsets of THE, THAT, GO and TO, as well as GREU and QUE. When reduction is not properly backtracked and is instead interpreted at face-value, a breakdown, equal to distortion in the DCM, occurs and ultimately blocks access to the intended item.

In relation to prelexical versus lexical accounts of speech processing, the results present evidence in favor of each of these accounts. Though there is no evidence from the results that better perceivers actually considered prelexical cues before beginning lexical processing, there is evidence that less successful perceivers missed low-level cues that may have helped them in recognition. For example, in terms of allophonic variation, the lack of an intense burst and long VOT lag for the [g̊] in GO (cueing that it is not a /k/) and the length of the vowel in BED (revealing it is not a /t/) were often overlooked and thus could not guide recognition. In terms of stress, the Metrical Segmentation Strategy (MSS) (Cutler and Norris, 1988) posits that stress serves as a cue for beginning a lexical search[14]. This strategy has been shown to be more applicable to languages like English than Catalan, which is closer to a syllable-timed language, though it shows strong vowel reduction. Regarding native English-speaking listeners' L1 and L2 processing, in American Participant 9's final sentence, we see that the stress of FRIEND was not viewed as a cue to an onset, as [f] was taken as the offset of "if," which is evidence against the MSS. By contrast, we see some Americans having problems in parsing DONAR (stressed on the second syllable), particularly in locating its onset. It could very well be that the stress on the second syllable of this item caused a setback to English ears because of an expectation for stress on first syllables, which is evidence for the MSS. Though, again, in the case of COP, this item was stressed and there were still problems in parsing. Regarding native Catalan-speaking listeners' L1 processing, there is little to observe. Word recognition was typically so immediate, the number of confusions were few. Concerning native Catalan-speaking listeners' L2 processing, it may be that the syllable played some role. For example, the portion ONE THAT CAN'T [ˈwʌ̃n̪əˈkʰæ̃ŋ], yielded a range of non-native confusions: "anaka," "anecanc," and "naika." The series CAN'T GO TO [ˈkʰæ̃ŋg̊əɾə] appeared in confusions such as "cankaro" and "naked anguero," among others. The misparsing and the clumping together of (often) open syllables found in these responses, in many respects, reflects the priority of the syllable, rather than stress. Though these confusions may be

[14] Whether this is to apply to both word and sentence stress is unclear from the literature. Since all of the test items are monosyllables, stress here will be considered in terms of sentence stress.

cited as the result of low-level, phonetic interpretation of the signal, they could stem from strategies listeners have developed appropriate for processing Catalan.

With respect to lexical accounts, native speech segmentation and recognition was not shown here to be sequential for either the English or the Catalan test sentence, that is to say that natives did not consistently need to hear the following word in the test sentence to recognize an item. Non-native segmentation and recognition on the other hand appeared to be more sequential, since the following onset was available in twice as many cases for non-natives as for natives; but, we can not conclude L2 recognition was necessarily sequential. Because the aim of this study was to assess how natives and learners perceive and segment highly coarticulated, reduced speech and recognize words and to ascertain whether ease of processing is related to similarities between L2 and the native language, items were not selected on the basis of lexical neighborhood density, consequently the results do not throw light on the lexical competition account.

Consideration of the final responses for the two test sentences suggests that though most current speech processing models are limited to word recognition, as are all those described in the introduction, future models which strive to process normal, everyday speech must balance coherence on both a local, lexical, level as well as on a global, sentence and context, level. Natives across languages, in general, had less difficulty than non-natives in recognizing the utterances as intended. Non-natives on the other hand showed strong divergence in their final interpretations, often encountering great difficulty in producing a grammatical sentence. A trade-off between phonetic information with syntactic/semantic information was seen to exist. In trying to make sense of the acoustic signal, many listeners aimed at recognizing words, which in the end often did not create a coherent sentence. Last-minute efforts to create a coherent sentence often led to the sacrifice of phonetic detail.

The ideal model must be able to handle variation (both coarticulatory variation and reduced speech), correctly parse speech, and recognize grammatical and pragmatically-adequate utterances. This research underscores that understanding speech is an extremely complex task and that many aspects of language-specific experience, on both lower and higher levels, play themselves out in processing. Therefore, it is critical that the model incorporate information stemming from a number of sources, involving low-level phonetic information found in the signal, as well as higher-level information stemming from phonological knowledge and the lexicon.

7 CONCLUSIONS

This study has examined casual speech processing by natives and non-natives in English and Catalan. Empirical evidence has shown that non-natives, both American and Catalan, generally required significantly more time than natives to recognize words online as intended and showed lower total recognition percentages than natives. Non-natives demonstrated a tendency to rely on bottom-up, signal information, though they did apply L2 phonology correctly at times and L1 phonology incorrectly at others. Natives, on the other hand, tended to employ more top-down phonological knowledge and to take advantage of frequency effects and predictability to analyze the phonetic signal. Though, native offline final responses were generally correct overall, and always syntactically correct, non-native final responses frequently exhibited top-down interpretations featuring a trade-off between phonetic information and syntax/semantics. The data therefore supports the idea that, in general, the process of word recognition in casual speech for natives versus non-natives is different.

We may conclude that cross-linguistic differences, of the type studied in the perception of individual phones in research relating to cross-language speech perception models such as PAM (e.g., Best, 1995), do play a certain role in L2 perception of connected speech and the recognition of words. The data supported that recognition was generally better for words reduced by L2 processes which occur in the L1 in the same or similar contexts (=P/=C), than for those processes which are similar but appear in different contexts (=P/≠C), or for those processes that are different in L1 and L2 (≠P). Two-thirds of the English lexical items and more than half of the Catalan lexical items bore out these predictions. This was demonstrated with a system which ranked reduction processes using labels to denote cross-linguistic similarity/difference in process and context, the output of which was compared to a significance ranking based on the statistical differences found using ANOVAs conducted on five different data sets for each item. Other factors such as frequency, however, must also be taken into account. Future research in this area on recognition of reduced and non-reduced speech by natives and non-natives, in addition to the use of test items selected for frequency, is needed to better assess the role of reduction processes in speech recognition.

Finally, observations of the experimental data were considered in relation to certain issues in spoken word recognition modeling such as the flow of information, processing strategies, and segmentation of the signal. We saw that there was evidence of the use of both bottom-up and top-down information processing by natives and non-natives during online and offline recognition. The low-level Metrical Segmentation Strategy (Cutler and Norris, 1988) and the Possible Word Constraint (Norris *et al*, 1997) in addition to the top-down strategy of goodness-of-fit were considered in relation to the data. Regarding segmentation, though neither natives nor non-natives showed consistent sequential recognition, non-natives showed a tendency toward more sequential segmentation than natives. Lexical segmentation was not evaluated in this study due to the methodology.

Therefore, this study has analyzed native and non-native casual speech processing from a number of different angles. The results are relevant to several areas of study including psycholinguistics, cross-linguistic speech perception and modeling, spoken word recognition modeling, and potentially even second-language teaching. The data reveal that native and non-native casual speech perception is not the same. L1 does play a role in cross-linguistic speech perception, moreover experience with reduction processes, and the contexts where they occur, is highly relevant to L2 word recognition in casual speech.

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Appendix A

Instructions and Questionnaire for the English experiment

Thank you for agreeing to participate in this experiment!

The presentation consists of two blocks, each containing an English sentence that will be presented to you bit by bit. For each segment[15], you are asked to listen to the sound (by pressing the left button in front of the touchpad) and then write down what you have just heard in normal English spelling on the response sheet. As you continue through the presentation, if you hear no change in the beginning of the sentence, you only need to write down the new information; but, if you change your mind about what you have heard, please re-write the sentence from the beginning. At segment 24 however, please write the complete sentence. You are allowed to advance through the presentation at your own pace; however DO NOT change or cross out any of your previous responses.

A brief practice session is included to illustrate how the experiment works.

First, please provide the following information:

#

(QUESTIONNAIRE)

NAME:
CONTACT ADDRESS (ie. email or phone number):
AGE:
PLACE OF BIRTH:

LIST THE PLACES YOU HAVE LIVED FOR ANY SIGNIFICANT LENGTH OF TIME:

LANGUAGES SPOKEN OR STUDIED:

[15] Note that in the experiment, "gates" were referred to as "segments." "Segment," though potentially more transparent to the test participants, may be confused with technical terminology.

Response Sheet for the English experiment[16]

PART ONE

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

[16] The response sheet was printed horizontally (orientation: landscape).

Sample Response Sheet for the English experiment

PRACTICE SESSION

1 Ay
2 I lie
3 like
4 ing
5 I like English.

Instructions for the Catalan experiment[17]

Instruccions:
Gràcies per col·laborar en aquest experiment. La presentació està dividida en dues parts. Primer, hi ha una sessió de pràctica per què vegis com funciona l'experiment i després l'experiment. Sentiràs una frase en català fragment per fragment. Per sentir cada fragment, clica el botó esquerra del ratolí sobre la icona de l'altaveu. Si vols, pots sentir el fragment més d'un cop. Després de cada segment, escriu el que sents en el full de respostes en ortografia catalana normal. Per passar al següent segment, prem la fletxa avall del teclat. A mida que avança la presentació, si no sents cap diferència en el començament de la frase, només afegeix la nova informació que vagis sentint. Si vols modificar algun fragment anterior, al punt on estàs, has de rescriure tota la frase a partir del punt que vols canviar. No pots canviar o ratllar respostes anteriors. Al arribar al fragment 24, escriu la frase completa.

[17] A recorded version of the instructions played aloud while students were presented with a printed version.

Questionnaire for the Catalan experiment

QUESTIONARÍ #_____

Nom i cognoms:

Direcció de correu electrònic:

Edat:

Lloc de naixement:

Quins idiomes parles?:

Quin(s) idioma(es) parles a casa?:

Quin(s) idioma(es) parles amb els amics?:

(Només per a no-natius)

Anys que fa que parles català:

Anys que fa que vius a Catalunya:

Cursos de català fets:

Número d'hores al dia que escoltes català?:

Número d'hores al dia que parles català?:

Quin nivell penses que tens?

Inicial Mitjà Avançat Natiu/Bilingüe

Altre:

Response sheet for the Catalan experiment[18]

EXPERIMENT 1

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

12.

13.

14.

15.

16.

17.

18.

19.

20.

21.

[18] The response sheet was printed horizontally (orientation: landscape).

22.

23.

24.

Sample Response Sheet for the Catalan Experiment

SESSIÓ DE PRÀCTICA

1	mag
2	M’agrada
3	lan
4	l’anglé
5	M’agrada l’anglés.

Appendix B

Informants' responses by group to the test sentences[19]

AM1	Is 5	your 5	friend 7	the 8	one 8	that 10	can't 15	go X	to X	bed 17	by 19	ten? 22
1	Ish											
2	Ish--	uv										
3	Ish--	uv--	f									
4	Ish--	uv	fe									
5	Is	your	fret									
6	Is	your	fret									
7	Is	your	friend	no								
8	Is	your	friend	the	one							
9	Is	your	friend	the	one who							
10	Is	your	friend	the	one	that						
11	Is	your	friend	the	one	that	ka					
12	Is	your	friend	the	one	that	can					
13	Is	your	friend	the	one	that	ca					
14	Is	your	friend	the	one	that	can	ge--				
15	Is	your	friend	the	one	that	can't	ge-	-t/ a			
16	Is	your	friend	the	one	that	can't	ge-	-t/ a	b--		
17	Is	your	friend	the	one	that	can't	ge-	-t/ a	bed		
18	Is	your	friend	the	one	that	can't	ge-	-t/ a	bed		
19	Is	your	friend	the	one	that	can't	ge-	-t/ a	bed	by	
20	Is	your	friend	the	one	that	can't	ge-	-t/ a	bed	by--	te
21	Is	your	friend	the	one	that	can't	ge-	-t/ a	bed	by	T
22	Is	your	friend	the	one	that	can't	ge-	-t/ a	bed	by	ten
23	Is	your	friend	the	one	that	can't	ge-	-t/ a	bed	by	ten?
24	Is	your	friend	the	one	that	can't	ge-	-t/ a	bed	by	ten?
AM2	Is 4	your 4	friend 6	the 7	one 8	that 10	can't 15	go 17	to 17	bed 17	by 19	ten? 21
1	Ij											
2	Ij-	-a										
3	I	jut										
4	Is	your										
5	Is	your	fr									
6	Is	your	friend									
7	Is	your	friend	the								
8	Is	your	friend	the	one							
9	Is	your	friend	the	one							
10	Is	your	friend	the	one	that						
11	Is	your	friend	the	one	that						
12	Is	your	friend	the	one	that	came					
13	Is	your	friend	the	one	that	can					
14	Is	your	friend	the	one	that	can	on				
15	Is	your	friend	the	one	that	can't	ge-	-t			
16	Is	your	friend	the	one	that	can't	ge-	-t	g		
17	Is	your	friend	the	one	that	can't	go	to	bed		
18	Is	your	friend	the	one	that	can't	go	to	bed		
19	Is	your	friend	the	one	that	can't	go	to	bed	by	
20	Is	your	friend	the	one	that	can't	go	to	bed	by	
21	Is	your	friend	the	one	that	can't	go	to	bed	by	ten
22	Is	your	friend	the	one	that	can't	go	to	bed	by	ten
23	Is	your	friend	the	one	that	can't	go	to	bed	by	ten
24	Is	your	friend	the	one	that	can't	go	to	bed	by	ten.

[19] Responses for each subject by each gate (column 1), listed by experiment (English, then Catalan) and group (natives, then non-natives). The responses are formatted so that material is listed according to lexical item. The top line for each subject indicates at which gate an item was identified and if the item was never identified an "X" is listed. A dash at the end of a cell and at the beginning of the following cell indicates an incorrectly parsed item. A hyphen indicates that subjects actually interpreted a lexical item's acoustic information as part of two different words. Otherwise responses have been typed as they were found on the subjects' response sheets.

AM3	Is 1	your 5	friend 22	the 9	one 8	that 10	can't 18	go 17	to 17	bed 17	by 19	ten? 21
1	Is											
2	Is	ya										
3	Is	ya	jf									
4	Is	ya	f									
5	Is	your	fa									
6	Is	your	fat									
7	Is	your	fin-	-al								
8	Is	your	fin-	-al	one							
9	Is	your	fan	the	one							
10	Is	your	fan	the	one	that						
11	Is	your	fan	the	one	that	ca					
12	Is	your	fan	the	one	that	can					
13	Is	your	fan	the	one	that	can					
14	Is	your	fan	the	one	that	can	coo				
15	Is	your	fan	the	one	that	can	co-	-duk			
16	Is	your	fan	the	one	that	can	ca-	-du-	-bu		
17	Is	your	fan	the	one	that	can	go	to	bed		
18	Is	your	fan	the	one	that	can't	ge-	-t / a	bed		
19	Is	your	fan	the	one	that	can't	ge-	-t / a	bed	by	
20	Is	your	fan	the	one	that	can't	ge-	-t / a	bed	by	
21	Is	your	fan	the	one	that	can't	ge-	-t / to	bed	by	10
22	Is	your	friend	the	one	that	can't	ge-	-t / to	bed	by	10
23	Is	your	friend	the	one	that	can't	ge-	-t / to	bed	by	10
24	Is	your	friend	the	one	that	can't	ge-	-t / to	bed	by	10
AM4	Is 3	your 3	friend 5	the 7	one 8	that 10	can't X	go 17	to 17	bed 17	by 19	ten? 24
1	Is--	-a										
2	Is--	-a										
3	Is	your										
4	Is	your	f									
5	Is	your	friend									
6	Is	your	friend									
7	Is	your	friend	the								
8	Is	your	friend	the	one							
9	Is	your	friend	the	one							
10	Is	your	friend	the	one	that						
11	Is	your	friend	the	one	that						
12	Is	your	friend	the	one	that	ca					
13	Is	your	friend	the	one	that	ca					
14	Is	your	friend	the	one	that	can	c				
15	Is	your	friend	the	one	that	can	ca-	-d			
16	Is	your	friend	the	one	that	can	ca-	-da-	-b		
17	Is	your	friend	the	one	that	can	ca- (or go)	-da- (to)	-bed (or bed)		
18	Is	your	friend	the	one	that	can	ca-	-da-	-bed		
19	Is	your	friend	the	one	that	can	go	to	bed	by	
20	Is	your	friend	the	one	that	can	go	to	bed	by	
21	Is	your	friend	the	one	that	can	go	to	bed	by	t
22	Is	your	friend	the	one	that	can	go	to	bed	by	te
23	Is	your	friend	the	one	that	can	go	to	bed	by	te
24	Is	your	friend	the	one	that	can	go	to	bed	by	ten.

AM5	Is 1	your 3	friend 7	the 7	one 8	that 10	can't 15	go 23	to 23	bed 17	by 23	ten? 23
1	Is											
2	Is	it										
3	Is	your										
4	Is	it										
5	Is	your	fact									
6	Is	your	fact									
7	Is	your	friend	the								
8	Is	your	friend	the	one							
9	Is	your	friend	the	one							
10	Is	your	friend	the	one	that						
11	Is	your	friend	the	one	that						
12	Is	your	friend	the	one	that	can					
13	Is	your	friend	the	one	that	can					
14	Is	your	friend	the	one	that	can					
15	Is	your	friend	the	one	that	can't	ge-	-t			
16	Is	your	friend	the	one	that	can't	ge-	-t / a			
17	Is	your	friend	the	one	that	can't	ge-	-t / a	bed		
18	Is	your	friend	the	one	that	can't	ge-	-t / a	bed		
19	Is	your	friend	the	one	that	can't	ge-	-t / a	bug	bi-	-te
20	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	bi-	-te
21	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	bi-	-te
22	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	bi-	-te
23	Is	your	friend	the	one	that	can't	go	to	bed	by	ten
24	Is	your	friend	the	one	that	can't	go	to	bed	by	ten
AM6	Is 1	your 4	friend 9	the 9	one 9	that 10	can't 16	go 24	to 24	bed 17	by 19	ten? 24
1	is											
2	is	ya										
3	is	you-	-f									
4	is	your	fa									
5	is	your	fe									
6	is	your	feth									
7	is	your	fen-	-o								
8	is	your	fen-	-oi								
9	is	your	friend	the	one							
10	is	your	friend	the	one	that						
11	is	your	friend	the	one	that						
12	is	your	friend	the	one	that	ca					
13	is	your	friend	the	one	that	can					
14	is	your	friend	the	one	that	can	c				
15	is	your	friend	the	one	that	can	c-	-d			
16	is	your	friend	the	one	that	can't	ge-	-t /a	b		
17	is	your	friend	the	one	that	can't	ge-	-t /a	bed		
18	is	your	friend	the	one	that	can't	ge-	-t /a	bed		
19	is	your	friend	the	one	that	can't	ge-	-t /a	bed	by	
20	is	your	friend	the	one	that	can't	ge-	-t /a	bed	bi-	-te
21	is	your	friend	the	one	that	can't	ge-	-t /a	bug	bi-	-te
22	is	your	friend	the	one	that	can't	ge-	-t /a	bed	by	tel
23	is	your	friend	the	one	that	can't	ge-	-t /a	bed	by	tet
24	is	your	friend	the	one	that	can't	go	to	bed	by	ten

AM7	Is 1	your 2	friend 8	the 9	one 9	that 10	can't X	go 22	to 22	bed 22	by 19	ten? 22
1	Is											
2	Is	your										
3	Is	your										
4	Is	your	f									
5	Is	your	fa									
6	Is	your	fat									
7	Is	your	fen-	-a								
8	Is	your	friend	th								
9	Is	your	friend	the	one							
10	Is	your	friend	the	one	that						
11	Is	your	friend	the	one	that						
12	Is	your	friend	the	one	that	ca					
13	Is	your	friend	the	one	that	can					
14	Is	your	friend	the	one	that	can	c				
15	Is	your	friend	the	one	that	can	co				
16	Is	your	friend	the	one	that	can	coul-	-d			
17	Is	your	friend	the	one	that		coul-	-d / a			
18	Is	your	friend	the	one	that		cu-	-t / a			
19	Is	your	friend	the	one	that		cu-	-t / a	bud	by	
20	Is	your	friend	the	one	that		cu-	-t / a	bud	by	
21	Is	your	friend	the	one	that		coul-	-d / a	bug	bi-	-te
22	Is	your	friend	the	one	that	could	go	to	bed	by	ten
23	Is	your	friend	the	one	that	can	go	to	bed	by	ten
24	Is	your	friend	the	one	that	can	go	to	bed	by	ten?
AM8	Is 2	your 2	friend 4	the 8	one 8	that 10	can't 14	go X	to X	bed 18	by 19	ten? 22
1	Ish											
2	Is	your										
3	Is	your	f									
4	Is	your	friend									
5	Is	your	friend									
6	Is	your	friend									
7	Is	your	friend	know								
8	Is	your	friend	the	one							
9	Is	your	friend	the	one							
10	Is	your	friend	the	one	that						
11	Is	your	friend	the	one	that	c					
12	Is	your	friend	the	one	that	can					
13	Is	your	friend	the	one	that	can					
14	Is	your	friend	the	one	that	can't					
15	Is	your	friend	the	one	that	can't	ge-	-t / a			
16	Is	your	friend	the	one	that	can't	ge-	-t / a	b		
17	Is	your	friend	the	one	that	can't	ge-	-t / a	bet		
18	Is	your	friend	the	one	that	can't	ge-	-t / a	bed		
19	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	by	
20	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	by	
21	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	bi-	-te
22	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	by	ten
23	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	by	ten
24	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	by	ten?

AM9	Is 1	your X	friend X	the X	one X	that X	can't 14	go 19	to 19	bed 17	by 19	ten? 21
1	Is											
2	Is	a										
3	Is-	-a										
4	I	ga-	-f									
5	I	ja-	-fa									
6	Is	e-	-ffect									
7	As	i-	-f / I	know								
8	As	i-	-f / I	know	I							
9	As	i-	-f / I	know	Im							
10	As	i-	-f / I	know	when	I						
11	As	i-	-f / I	know	when	I	ca					
12	As	i-	-f / I	know	when	I	can					
13	As	i-	-f / I	know	when	I	can					
14	As	i-	-f / I	know	when	I	can't	ge-	-t			
15	As	i-	-f / I	know	when	I	can't	ge-	-t / ove			
16	As	i-	-f / I	know	when	I	can't	ge-	-t / a	bit		
17	As	i-	-f / I	know	when	I	can't	ge-	-t / a	bed		
18	As	i-	-f / I	know	when	I	can't	ge-	-t / a	bed		
19	As	i-	-f / I	know	when	I	can't	go	to	bed	by	
20	As	i-	-f / I	know	when	I	can't	go	to	bed	by	
21	As	i-	-f / I	know	when	I	can't	go	to	bed	by	ten
22	As	i-	-f / I	know	when	I	can't	go	to	bed	by	ten
23	As	i-	-f / I	know	when	I	can't	go	to	bed	by	ten
24	As	i-	-f / I	know	when	I	can't	go	to	bed	by	ten.
AM10	Is 12	your 12	friend 12	the 12	one 9	that 12	can't 24	go X	to X	bed 19	by 19	ten? 23
1	itch											
2	ij-	-it										
3	if-	-i-	-f									
4	ij-	-i-	-fa									
5	ij-	-i-	-fat									
6	ij-	-i-	-fat									
7	ij-	-i-	-fat	no								
8	ij-	-i-	-fat	nona								
9	ij-	-i-	-fat	no	one							
10	ij-	-i-	-fat	no	one	e						
11	ij-	-i-	-fat	no	one	ee						
12	Is	your	friend	the	one	that	can					
13	Is	your	friend	the	one	that	can					
14	Is	your	friend	the	one	that	can	g				
15	Is	your	friend	the	one	that	can	ge-	-t / a			
16	Is	your	friend	the	one	that	can	ge-	-t / a	b		
17	Is	your	friend	the	one	that	can	ge-	-t / a	be		
18	Is	your	friend	the	one	that	can	ge-	-t / a	be		
19	Is	your	friend	the	one	that	can	ge-	-t / a	bed	by	
20	Is	your	friend	the	one	that	can	ge-	-t / a	bed	by	
21	Is	your	friend	the	one	that	can	ge-	-t / a	bed	by	t
22	Is	your	friend	the	one	that	can	ge-	-t / a	bed	by	te
23	Is	your	friend	the	one	that	can	ge-	-t / a	bed	by	ten
24	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	by	ten?

AM11	Is 1	your 2	friend 5	the 7	one 7	that 10	can't 15	go X	to X	bed 17	by 19	ten? 22
1	Is											
2	Is	your										
3	Is	your	f									
4	Is	your	f									
5	Is	your	friend									
6	Is	your	friend									
7	Is	your	friend	the	one							
8	Is	your	friend	the	one							
9	Is	your	friend	the	one							
10	Is	your	friend	the	one	that						
11	Is	your	friend	the	one	that						
12	Is	your	friend	the	one	that	can					
13	Is	your	friend	the	one	that	can					
14	Is	your	friend	the	one	that	can					
15	Is	your	friend	the	one	that	can't	ge-	-t			
16	Is	your	friend	the	one	that	can't	ge-	-t / a			
17	Is	your	friend	the	one	that	can't	ge-	-t / a	bed		
18	Is	your	friend	the	one	that	can't	ge-	-t / a	bed		
19	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	by	
20	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	by	
21	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	bi-	-te
22	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	by	ten
23	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	by	ten
24	Is	your	friend	the	one	that	can't	ge-	-t / a	bed	by	ten

AM12	Is 1	your 2	friend 5	the 6	one 7	that 10	can't 15	go 17	to 17	bed 18	by 19	ten? 21
1	Is											
2	Is	your										
3	Is	your										
4	Is	your										
5	Is	your	friend									
6	Is	your	friend	the								
7	Is	your	friend	the	one							
8	Is	your	friend	the	one							
9	Is	your	friend	the	one							
10	Is	your	friend	the	one	that						
11	Is	your	friend	the	one	that						
12	Is	your	friend	the	one	that	can					
13	Is	your	friend	the	one	that	can					
14	Is	your	friend	the	one	that	can					
15	Is	your	friend	the	one	that	can't					
16	Is	your	friend	the	one	that	can't	ge-	-t			
17	Is	your	friend	the	one	that	can't	go	to			
18	Is	your	friend	the	one	that	can't	go	to	bed		
19	Is	your	friend	the	one	that	can't	go	to	bed	by	
20	Is	your	friend	the	one	that	can't	go	to	bed	by	
21	Is	your	friend	the	one	that	can't	go	to	bed	by	ten
22	Is	your	friend	the	one	that	can't	go	to	bed	by	ten
23	Is	your	friend	the	one	that	can't	go	to	bed	by	ten
24	Is	your	friend	the	one	that	can't	go	to	bed	by	ten

CAT1	Is 3	your 4	friend 21	the X	one X	that X	can't 13	go X	to X	bed X	by 19	ten? 22
1	Ish											
2	Is--	-you										
3	Is	you										
4	Is	your										
5	Is	your	fa									
6	Is	your	fat									
7	I	you	fat	nou								
8	I	you	fat	nou	a							
9	I	you	fat	nou	an							
10	I	you	fat	nou	an-	-a						
11	I	you	fat	nou	an-	-ak						
12	I	you	fat	nou	an-	-ak	-a					
13	I	you	fat	nou	and	I	can't					
14	I	you	fat	nou	and	I	can't	k				
15	I	you	fat	nou	and	I	can't	kind	g			
16	I	you	fat	nou	and	I	can't	kind	g			
17	I	you	fat	nou	and	I	can't	kind	g	that		
18	I	you	fat	nou	and	I	can't	kind	g	that		
19	I	you	fat	nou	and	I	can't	kind	g	that	by	
20	I	you	fat	nou	and	I	can't	kind	g	that	bi-	-te
21	Is	your	friend	a				kin-	-d / o-	-f / vet	by	
22	Is	your	friend	a				kin-	-d / o-	-f / vet	by	ten
23	Is	your	friend	a				kin-	-d / o-	-f / vet	by	ten
24	Is	your	friend						a-	-bout		ten
CAT2	Is 6	your 6	friend 7	the X	one 9	that 13	can't X	go X	to X	bed X	by 22	ten? 24
1	Ish											
2	E-	-gy										
3	E-	-gy	-b									
4	E-	-gy	-f									
5	E-	-gy	fat									
6	Is	your	fath									
7	Is	your	friend	no								
8	Is	your	friend	no								
9	Is	your	friend	no	one							
10	Is	your	friend	no	one	like						
11	Is	your	friend	no	one	like						
12	Is	your	friend	no	one	naik						
13	Is	your	friend	no--	-one	that	can					
14	Is	your	friend	no	one	that	can	com				
15	Is	your	friend	no	one	that	can	kin-	-d / o	f		
16	Is	your	friend	no	one	that	can	kin-	-d / o	f		
17	Is	your	friend	no	one	that	can	kin-	-d / o	f bit		
18	Is	your	friend	no	one	that	can	kin-	-d / o	f bit		
19	Is	your	friend	no	one	that	can	kin-	-d / o	f bit	bi-	-te
20	Is	your	friend	no	one	that	can	kin-	-d / o	f bit	bi-	-te
21	Is	your	friend	no	one	that	can	kin-	-d / o	f bit	bi-	-te
22	Is	your	friend	no	one	that	can	kin-	-d / o	f bit	by	te
23	Is	your	friend	no	one	that	can	kin-	-d / o	f bit	by	te
24	Is	your	friend	no	one	that	can	kin-	-d / o	f bit	by	ten

CAT3	Is 1	your X	friend X	the X	one X	that X	can't X	go X	to X	bed X	by 19	ten? 24
1	Is											
2	Ig											
3	E-	-gy										
4	iz-	-e-	-v									
5	iz-	-e-	-fat									
6	(H)e	jus(t)	fad									
7	(H)e	ju-	-v / had	no								
8	He	ju-	-v / had	no	i							
9	He	ju-	-v / had	no	an							
10	He	ju-	-v / had	no	an-	-ec						
11	He	ju-	-v / had	no	an-	-ec-	-a					
12	He	ju-	-v / had	no	an-	-e-	-can					
13	He	ju-	-v / had	no	an-	-e-	-can-	-c				
14	He	ju-	-v / had	no	an-	-e	can	ge-	-t / of			
15	He	ju-	-v / had	no	an-	-e	can	ge-	-t / a	b		
16	He	ju-	-v / had	no	an-	-e	can	ge-	-t / a	b		
17	He	ju-	-v / had	no	an-	-e	can	ge-	-t / a	bit		
18	He	ju-	-v / had	no	an-	-e	can	ge-	-t / a	bit		
19	He	ju-	-v / had	no	an-	-e	can	ge-	-t / a	bit	by	
20	He	ju-	-v / had	no	an-	-e	can	ge-	-t / a	bit	by	
21	He	ju-	-v / had	no	an-	-e	can	ge-	-t / a	bit	by	t
22	He	ju-	-v / had	no	an-	-e	can	ge-	-t / a	bit	by	ta
23	He	ju-	-v / had	no	an-	-e	can	ge-	-t / a	bit	by	tax
24	Is	you	fond	he			can	ge-	-t / a	bit	by	ten
CAT4	Is X	your X	friend X	the X	one 9	that X	can't X	go X	to X	bed X	by 19	ten? 23
1	Ish											
2	Is-	-u										
3	I-	-yu-	-v									
4	I	you'-	-ve									
5	If	you'-	-ve fath									
6	If	you	efac									
7	If	you	find	an								
8	If	you	find	none								
9	If	you	find	no	one							
10	If	you	find	no	one	at						
11	If	you	find	no	one	at-	-k					
12	If	you	find	no	one	at	ka					
13	If	you	find	no	one	at	can					
14	If	you	find	no	one	at	can-	-k				
15	If	you	find	no	one	at	can-	-ka-	-ro	but		
16	If	you	find	no	one	at	can-	-ka-	-r / or-	-b		
17	If	you	find	no	one	at	can-	-ka-	-ro	but		
18	If	you	find	no	one	at	can-	-ka-	-ro	buta		
19	If	you	find	no	one	I	can	ca-	-re	but	by	
20	If	you	find	no	one	I	can	ca-	-re / o-	-f / but	by	
21	If	you	find	no	one	I	can	ca-	-re / o-	-f / but	by	t
22	If	you	find	no	one	I	can	ca-	-re / o-	-f / but	by	ta
23	If	you	find	no	one	I	can	ca-	-re / o-	-f / but	by	te(n)
24	If	you	find	no	one	I	can	ca-	-re / o-	-f / but	by	ten

CAT5	Is X	your X	friend X	the X	one X	that X	can't X	go X	to X	bed X	by 19	ten? 22
1	Each											
2	E-	-gypt										
3	E-	-gypt										
4	A	gi-	-f									
5	A	gi-	-fet									
6	As-	-ia	fed									
7	As-	-ia	fed	no								
8	If	I	fed	no	I							
9	If	I	fed	no	an							
10	If	I	fed	no	an	egg						
11	If	I	fed	no	an	egg						
12	If	I	fed	no	a	naked						
13	If	I	fed	no	a	naked						
14	If	I	fed	no	a	naked						
15	If	I	fed	no	a	naked	an-	-gue-	-ro			
16	If	I	fed	no	a	naked	an-	-gue-	-ro	but		
17	If	I	fed	no	a	naked	an-	-gue-	-ro	but		
18	If	I	fed	no	a	naked	an-	-gue-	-ro	but		
19	If	I	fed	no	a	naked	an-	-gue-	-ro	but	by	
20	If	I	fed	no	a	naked	an-	-gue-	-ro	but	by	
21	If	I	fed	no	a	naked	an-	-gue-	-ro	but	bi-	-te
22	If	I	fed	no	a	naked	an-	-gue-	-ro	but	by	ten
23	If	I	fed	no	a	naked	an-	-gue-	-ro	but	by	ten
24	If	I	fed	not	a	naked/nak	an-	-gue-	-ro	but	by	ten

CAT6	Is 1	your 4	friend 6	the 8	one 9	that 10	can't X	go X	to X	bed X	by 19	ten? 23
1	Is											
2	Is	ya										
3	Is	yo										
4	Is	your	f									
5	Is	your	fre									
6	Is	your	friend									
7	Is	your	friend	ol								
8	Is	your	friend	the	wa							
9	Is	your	friend	the	one							
10	Is	your	friend	the	one	that						
11	Is	your	friend	the	one	that	c					
12	Is	your	friend	the	one	that	ca					
13	Is	your	friend	the	one	that	can					
14	Is	your	friend	the	one	that	can	g				
15	Is	your	friend	the	one	that	can	cu				
16	Is	your	friend	the	one	that	can	coul-	-d			
17	Is	your	friend	the	one	that	can	coul-	-d / ha-	-ve / had		
18	Is	your	friend	the	one	that	can	coul-	-d / ha-	-ve / had	bu	
19	Is	your	friend	the	one	that	can	coul-	-d / ha-	-ve bit	by	
20	Is	your	friend	the	one	that	can	coul-	-d / ha-	-ve bit	by	
21	Is	your	friend	the	one	that	can	coul-	-d / ha-	-ve bit	by	t
22	Is	your	friend	the	one	that	can	coul-	-d / ha-	-ve bit	by	te
23	Is	your	friend	the	one	that	can	coul-	-d / ha-	-ve bit	by	ten
24	Is	your	friend	the	one	that	ken	coul-	-d / ha-	-ve / had	by	ten

CAT7	Is 1	your 3	friend 6	the X	one 8	that X	can't X	go X	to X	bed X	by 19	ten? 24
1	Is	Y										
2	Is	yo										
3	Is	your										
4	Is	your	f									
5	Is	your	fa									
6	Is	your	friend									
7	Is	your	friend	no								
8	Is	your	friend	no-	-one							
9	Is	your	friend	no-	-one							
10	Is	your	friend	no-	-one	like						
11	Is	your	friend	no-	-one	like						
12	Is	your	friend	no-	-one	like	a					
13	Is	your	friend	no-	-one	like	an					
14	Is	your	friend	no-	-one	like	an-	-k				
15	Is	your	friend	no-	-one	like	an	coul-	-d			
16	Is	your	friend	no-	-one	like	an	coul-	-d / ha-	-ve b		
17	Is	your	friend	no-	-one	like	an	coul-	-d / ha-	-ve bit		
18	Is	your	friend	no-	-one	like	an	coul-	-d / ha-	-ve bit		
19	Is	your	friend	no-	-one	like	an	coul-	-d / ha-	-ve bet	by	
20	Is	your	friend	no-	-one	like	an	coul-	-d / ha-	-ve bet	by	
21	Is	your	friend	no-	-one	like	an	coul-	-d / ha-	-ve bet	by	
22	Is	your	friend	no-	-one	like	an	coul-	-d / ha-	-ve bet	by	
23	Is	your	friend	no-	-one	like	an	coul-	-d / ha-	-ve bet	by	
24	Is	your	friend			like	Anne	coul-	-d / ha-	-ve bet	by	ten?
CAT8	Is 3	your 4	friend 7	the 9	one 9	that 13	can't X	go X	to X	bed 17	by 19	ten? 24
1	Ish											
2	Ish-	-a										
3	Is	you										
4	Is	your	fa									
5	Is	your	fre									
6	Is	your	fred									
7	Is	your	friend	n								
8	Is	your	friend	no								
9	Is	your	friend	the	one							
10	Is	your	friend	the	one	ne						
11	Is	your	friend	the	one	neck						
12	Is	your	friend	the	one	neck-	-a					
13	Is	your	friend	the	one	that	can					
14	Is	your	friend	the	one	that	can	k				
15	Is	your	friend	the	one	that	can	ku				
16	Is	your	friend	the	one	that	can	coul-	-d / a			
17	Is	your	friend	the	one	that	can	coul-	-d / a	bed		
18	Is	your	friend	the	one	that	can	coul-	-d / a	bed		
19	Is	your	friend	the	one	that	can	coul-	-d / a	bed	by	
20	Is	your	friend	the	one	that	can	coul-	-d / a	bed	by	
21	Is	your	friend	the	one	that	can	coul-	-d / a	bed	by	ti
22	Is	your	friend	the	one	that	can	coul-	-d / a	bed	by	te
23	Is	your	friend	the	one	that	can	coul-	-d / a	bed	by	tack
24	Is	your	friend	the	one	that		coul-	-d / ha-	-ve bed	by	ten?

CAT9	Is X	your X	friend X	the X	one 8	that 13	can't X	go X	to X	bed 17	by 19	ten? 23
1	Each											
2	Each	e										
3	Each	o-	-f									
4	Each	o-	-f									
5	Each	o-	-f / at									
6	Each	o-	-f / at									
7	Each	o-	-f / at	nel								
8	Each	o-	-f / at	no-	-one							
9	Each	o-	-f / at	no--	-one							
10	Each	o-	-f / at	no--	-one	ac						
11	Each	o-	-f / at	no--	-one	ac						
12	Each	o-	-f / at	no--	-one	ac-	-e					
13	Each	o-	-f / at	no--	-one	that	can					
14	Each	o-	-f / at	no--	-one	that	can	c				
15	Each	o-	-f / at	no--	-one	that	can	ce-	-re-	-v		
16	Each	o-	-f / at	no--	-one	that	can	ce-	-re-	-v b		
17	Each	o-	-f / at	no--	-one	that	can	ce-	-re-	-v bed		
18	Each	o-	-f / at	no--	-one	that	can	ce-	-re-	-v bed		
19	Each	o-	-f / at	no--	-one	that	can	ce-	-re-	-v bed	by	
20	Each	o-	-f / at	no--	-one	that	can	ce-	-re-	-v bed	by	
21	Each	o-	-f / at	no--	-one	that	can	ce-	-re-	-v bed	bi-	-te
22	Each	o-	-f / at	no--	-one	that	can	ce-	-re-	-v bed	by	tel
23	Each	o-	-f / at	no--	-one	that	can	ce-	-re-	-v bed	by	ten
24	Joe		feared	that no--	-one			coul-	-d / ha-	-ve /come	by	ten
CAT10	Is 5	your 5	friend 10	the 9	one 9	that X	can't 20	go X	to X	bed X	by 19	ten? X
1	ish											
2	ish-	-ap										
3	ig-	-ep										
4	ig-	-e-	-fa									
5	is	your	fat									
6	is	your	fath									
7	is	your	fend-	-up								
8	is	your	fen	no	a							
9	is	your	fen	the	one							
10	is	your	friend	the	one	neck						
11	is	your	friend	the	one	naik						
12	is	your	friend	the	one	naik	a					
13	if	you	find	no	one	I	can					
14	if	you	find	no	one	I	can	c(u)				
15	if	you	find	no	one	I	can	cu-	-t / up			
16	if	you	find	no	one	I	can	cu-	-t / up / o-	-f / it		
17	if	you	find	no	one	I	can	cu-	-t / up / o-	-f / it		
18	is	your	friend	the	one	I	can	ca-	-ra-	-bet		
19	is	your	friend	the	one	I	can	coul-	-dn't	get	by	
20	is	your	friend	the	one	I	can't	coul-	-dn't	get	by	
21	is	your	friend	the	one	I	can't / it	coul-	-dn't	get	bi-	-te
22	is	your	friend	the	one	I	can't / it	coul-	-dn't	get	bi-	-ter
23	is	your	friend	the	one	I	can't	kin-	-d / o-	-f / in-	-vi-	-te /her?
24	is	your	friend	the	one	I	can't	kin-	-d / o-	-f / in-	-vi-	-te /him?

CAT11	Is 2	your 2	friend 24	the X	one 8	that 10	can't 13	go X	to X	bed X	by 19	ten? 24
1	Ish											
2	Is	your										
3	Is	your	f--									
4	Is	your	fam									
5	Is	your	fath									
6	Is	your	father									
7	Is	your	fat	no								
8	Is	your	fat	no	one							
9	Is	your	fat	no	one							
10	Is	your	fat	no	one	that						
11	Is	your	fat	no	one	that	can					
12	Is	your	fat	no	one	I	can					
13	Is	your	fat	no	one	I	can't					
14	Is	your	fat	no	one	I	can't	g--				
15	Is	your	fat	no	one	I	can't	ge-	-t			
16	Is	your	fat	no	one	I	can't	ge-	-t / a	bit		
17	Is	your	fat	no	one	I	can't	ge-	-t / a	bit / of		
18	Is	your	fat	no	one	I	can't	ge-	-t / a	bit / of		
19	Is	your	fat	no	one	I	can't	ge-	-t / a	bit	by	
20	Is	your	fat	no	one	I	can't	ge-	-t / a	bit	bi-	-te
21	Is	your	fat	no	one	I	can't	ge-	-t / a	bit	'bi--	-ty'
22	Is	your	fat	no	one	I	can't	ge-	-t / a	bit	by	ta
23	Is	your	fat	no	one	I	can't	ge-	-t / a	bit	by	tie
24	Is	your	friend	no	one	that	can't	'coul-	-d' / a	bit	by	ten?
CAT12	Is 5	your 5	friend X	the X	one 14	that X	can't X	go X	to X	bed X	by 19	ten? 24
1	ij											
2	i-	-je										
3	i-	-je										
4	i	-je-	-f									
5	Is	your	fa									
6	Is	your	fat									
7	Is	your	fat	nou								
8	Is	your	fat	know								
9	Is	your	fat	know	and							
10	Is	your	fat	know	and	ec						
11	Is	your	fat	know	and	egg						
12	Is	your	fat	know	and	e-	-ke					
13	Is	your	fat	know	an	e-	-ke					
14	Is	your	fat	no	one		can					
15	Is	your	fat	no	one		can	ca-	-re / up			
16	Is	your	fat	no	one		can	ca-	-re / up	but		
17	Is	your	fat	no	one		can	ca-	-re / up	but		
18	Is	your	fat	no	one		can	ca-	-re / up	but		
19	Is	your	flat					ca-	-re-	-d / up	by	
20	Is	your	flat					ca-	-re-	-d / up	by	
21	Is	your	flat					ca-	-re-	-d / up	by	ti
22	Is	your	flat					ca-	-re	up	by	te
23	Is	your	flat					ca-	-re	up	by	te
24	Is	your	fat,	no	one		can	ca-	-re	up	by	ten?

C1	Em 1	sap 3	greu 5	que 8	cap 12	dels 14	dos 16	xicots 19	no 21	em 22	pugui 24	donar 25	un 26	cop 27	de 28	mà. 31
1	Em															
2	Em	s														
3	Em	sap														
4	Em	sap	g													
5	Em	sap	greu													
6	Em	sap	greu													
7	Em	sap	greu	q												
8	Em	sap	greu	que												
9	Em	sap	greu	que	ac											
10	Em	sap	greu	que	aca											
11	Em	sap	greu	que	acabi											
12	Em	sap	greu	que	cap	de										
13	Em	sap	greu	que	cap	de										
14	Em	sap	greu	que	cap	dels										
15	Em	sap	greu	que	cap	dels	d									
16	Em	sap	greu	que	cap	dels	dos									
17	Em	sap	greu	que	cap	dels	dos	xi								
18	Em	sap	greu	que	cap	dels	dos	xico								
19	Em	sap	greu	que	cap	dels	dos	xicots								
20	Em	sap	greu	que	cap	dels	dos	xicots								
21	Em	sap	greu	que	cap	dels	dos	xicots	no							
22	Em	sap	greu	que	cap	dels	dos	xicots	no	em						
23	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pu					
24	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui					
25	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar				
26	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un			
27	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop		
28	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	
29	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	m
30	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	m
31	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
32	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
C2	Em 1	sap 4	greu 5	que 12	cap 12	dels 14	dos 15	xicots 19	no 21	em 22	pugui 23	donar 25	un 26	cop 29	de 29	mà. 30
1	Em															
2	Em	s														
3	Em	se														
4	Em	sap														
5	Em	sap	greu													
6	Em	sap	greu													
7	Em	sap	greu													
8	Em	sap	greu	pe												
9	Em	sap	greu	pe-	-c											
10	Em	sap	greu	pe-	-car											
11	Em	sap	greu	pe-	-cap											
12	Em	sap	greu	que	cap	d										
13	Em	sap	greu	que	cap	del										
14	Em	sap	greu	que	cap	dels										
15	Em	sap	greu	que	cap	dels	dos									
16	Em	sap	greu	que	cap	dels	dos	x								
17	Em	sap	greu	que	cap	dels	dos	xi								
18	Em	sap	greu	que	cap	dels	dos	xico								
19	Em	sap	greu	que	cap	dels	dos	xicots								
20	Em	sap	greu	que	cap	dels	dos	xicots								
21	Em	sap	greu	que	cap	dels	dos	xicots	no							
22	Em	sap	greu	que	cap	dels	dos	xicots	no	em						
23	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui					
24	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	do				
25	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar				
26	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un			
27	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	c		
28	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	co		
29	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	
30	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
31	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
32	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma

C3	Em 3	sap 6	greu 7	que 9	cap 10	dels 13	dos 15	xicots 18	no 21	em 22	pugui 25	donar 26	un 26	cop 29	de 31	mà. 31
1	N															
2	m	si														
3	Em	se														
4	Em	se														
5	Em	s'a-	-cr													
6	Em	sap	gre													
7	Em	sap	greu													
8	Em	sap	greu	q												
9	Em	sap	greu	que												
10	Em	sap	greu	que	cap											
11	Em	sap	greu	que	cap											
12	Em	sap	greu	que	cap	del										
13	Em	sap	greu	que	cap	dels										
14	Em	sap	greu	que	cap	dels										
15	Em	sap	greu	que	cap	dels	dos									
16	Em	sap	greu	que	cap	dels	dos									
17	Em	sap	greu	que	cap	dels	dos	si								
18	Em	sap	greu	que	cap	dels	dos	xicots								
19	Em	sap	greu	que	cap	dels	dos	xicots								
20	Em	sap	greu	que	cap	dels	dos	xicots								
21	Em	sap	greu	que	cap	dels	dos	xicots	no							
22	Em	sap	greu	que	cap	dels	dos	xicots	no	em						
23	Em	sap	greu	que	cap	dels	dos	xicots	no	em						
24	Em	sap	greu	que	cap	dels	dos	xicots	no	em	p					
25	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui					
26	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un			
27	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	c		
28	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	co		
29	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop		
30	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	d	
31	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
32	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
C4	Em 1	sap 5	greu 6	que 10	cap 11	dels 14	dos 15	xicots 18	no 21	em 22	pugui X	donar 25	un 26	cop 29	de 30	mà. 30
1	Em	s														
2	Em	se														
3	Em	sec														
4	Em	sec														
5	Em	sap	g													
6	Em	sap	greu													
7	Em	sap	greu													
8	Em	sap	greu	q												
9	Em	sap	greu	q	q											
10	Em	sap	greu	que	aca											
11	Em	sap	greu	que	cap											
12	Em	sap	greu	que	cap	d										
13	Em	sap	greu	que	cap	del										
14	Em	sap	greu	que	cap	dels										
15	Em	sap	greu	que	cap	dels	dos									
16	Em	sap	greu	que	cap	dels	dos	su								
17	Em	sap	greu	que	cap	dels	dos	sh								
18	Em	sap	greu	que	cap	dels	dos	xicots								
19	Em	sap	greu	que	cap	dels	dos	xicots								
20	Em	sap	greu	que	cap	dels	dos	xicots								
21	Em	sap	greu	que	cap	dels	dos	xicots	no							
22	Em	sap	greu	que	cap	dels	dos	xicots	no	em						
23	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pug					
24	Em	sap	greu	que	cap	dels	dos	xicots	no	em	puguin					
25	Em	sap	greu	que	cap	dels	dos	xicots	no	em	puguin	donar				
26	Em	sap	greu	que	cap	dels	dos	xicots	no	em	puguin	donar	un			
27	Em	sap	greu	que	cap	dels	dos	xicots	no	em	puguin	donar	un	c		
28	Em	sap	greu	que	cap	dels	dos	xicots	no	em	puguin	donar	un	co		
29	Em	sap	greu	que	cap	dels	dos	xicots	no	em	puguin	donar	un	cop		
30	Em	sap	greu	que	cap	dels	dos	xicots	no	em	puguin	donar	un	cop	de	mà.
31	Em	sap	greu	que	cap	dels	dos	xicots	no	em	puguin	donar	un	cop	de	mà.
32	Em	sap	greu	que	cap	dels	dos	xicots	no	em	puguin	donar	un	cop	de	mà.

C5	Em 1	sap 5	greu 6	que 8	cap 11	dels 14	dos 17	xicots 20	no 22	em 22	pugui 23	donar 26	un 28	cop 30	de 30	mà. 30
1	em															
2	em	se														
3	em	sec														
4	em	sec														
5	em	sap	gr													
6	em	sap	greu													
7	em	sap	greu													
8	em	sap	greu	que												
9	em	sap	greu	que	ca											
10	em	sap	greu	que	ca											
11	em	sap	greu	que	cap											
12	em	sap	greu	que	cap	del										
13	em	sap	greu	que	cap	del										
14	em	sap	greu	que	cap	dels										
15	em	sap	greu	que	cap	dels	es									
16	em	sap	greu	que	cap	dels	es									
17	em	sap	greu	que	cap	dels	dos	xi								
18	em	sap	greu	que	cap	dels	dos	xico								
19	em	sap	greu	que	cap	dels	dos	xicot								
20	em	sap	greu	que	cap	dels	dos	xicots								
21	em	sap	greu	que	cap	dels	dos	xicots	no-	-m						
22	em	sap	greu	que	cap	dels	dos	xicots	no	em						
23	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui					
24	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	don				
25	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	dona				
26	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	u			
27	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un-	-c		
28	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	co		
29	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop-	-d	
30	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
31	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
32	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.

C6	Em 1	sap 5	greu 7	que 8	cap 11	dels 14	dos 15	xicots 19	no 20	em 22	pugui 23	donar 25	un 26	cop 29	de 29	mà. 30
1	em															
2	em	s														
3	em	se														
4	em	sac														
5	em	sap	g													
6	em	sap	gre													
7	em	sap	greu													
8	em	sap	greu	que												
9	em	sap	greu	que												
10	em	sap	greu	que	ca											
11	em	sap	greu	que	cap											
12	em	sap	greu	que	cap	de										
13	em	sap	greu	que	cap	del										
14	em	sap	greu	que	cap	dels										
15	em	sap	greu	que	cap	dels	dos									
16	em	sap	greu	que	cap	dels	dos	xi								
17	em	sap	greu	que	cap	dels	dos	xi								
18	em	sap	greu	que	cap	dels	dos	xico								
19	em	sap	greu	que	cap	dels	dos	xicots								
20	em	sap	greu	que	cap	dels	dos	xicots	no							
21	em	sap	greu	que	cap	dels	dos	xicots	no							
22	em	sap	greu	que	cap	dels	dos	xicots	no	em						
23	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui					
24	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	do				
25	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar				
26	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un			
27	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	c		
28	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	co		
29	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	
30	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà
31	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà
32	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.

C7	Em 2	sap 5	greu 6	que 11	cap 11	dels 12	dos 15	xicots 18	no 21	em 21	pugui 23	donar 25	un 26	cop 28	de 30	mà. 30
1	En															
2	Em	s														
3	Em	se														
4	Em	sec														
5	Em	sap														
6	Em	sap	greu													
7	Em	sap	greu													
8	Em	sap	greu	per												
9	Em	sap	greu	per												
10	Em	sap	greu	pe-	-ca											
11	Em	sap	greu	que	cap											
12	Em	sap	greu	que	cap	dels										
13	Em	sap	greu	que	cap	dels	d									
14	Em	sap	greu	que	cap	dels	d									
15	Em	sap	greu	que	cap	dels	dos									
16	Em	sap	greu	que	cap	dels	dos									
17	Em	sap	greu	que	cap	dels	dos	si								
18	Em	sap	greu	que	cap	dels	dos	xicots								
19	Em	sap	greu	que	cap	dels	dos	xicots								
20	Em	sap	greu	que	cap	dels	dos	xicots								
21	Em	sap	greu	que	cap	dels	dos	xicots	no	em						
22	Em	sap	greu	que	cap	dels	dos	xicots	no	em						
23	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui					
24	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	v				
25	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar				
26	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un			
27	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	c		
28	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop		
29	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop		
30	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
31	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
32	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
C8	Em 5	sap 5	greu 5	que 8	cap 11	dels 14	dos 15	xicots 18	no 20	em 21	pugui 23	donar 25	un 26	cop 26	de 27	mà. 28
1	En															
2	En															
3	En	sec														
4	En	sec														
5	Em	sap	greu													
6	Em	sap	greu													
7	Em	sap	greu													
8	Em	sap	greu	que												
9	Em	sap	greu	que	c											
10	Em	sap	greu	que	cab											
11	Em	sap	greu	que	cap											
12	Em	sap	greu	que	cap	de l										
13	Em	sap	greu	que	cap	de l										
14	Em	sap	greu	que	cap	dels										
15	Em	sap	greu	que	cap	dels	dos									
16	Em	sap	greu	que	cap	dels	dos	s								
17	Em	sap	greu	que	cap	dels	dos	xi								
18	Em	sap	greu	que	cap	dels	dos	xicots								
19	Em	sap	greu	que	cap	dels	dos	xicots								
20	Em	sap	greu	que	cap	dels	dos	xicots	no							
21	Em	sap	greu	que	cap	dels	dos	xicots	no	em						
22	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pu					
23	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui					
24	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	du				
25	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar				
26	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop		
27	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	
28	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
29	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
30	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
31	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
32	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.

C9	Em 1	sap 5	greu 5	que 8	cap 12	dels 13	dos 15	xicots 18	no 20	em 21	pugui 23	donar 25	un 26	cop 27	de 28	mà. 29
1	Em															
2	Em	s														
3	Em	se														
4	Em	se														
5	Em	sap	greu													
6	Em	sap	greu													
7	Em	sap	greu													
8	Em	sap	greu	que												
9	Em	sap	greu	que	ac											
10	Em	sap	greu	que	acabi											
11	Em	sap	greu	que	acabi											
12	Em	sap	greu	que	cap	de										
13	Em	sap	greu	que	cap	dels										
14	Em	sap	greu	que	cap	dels										
15	Em	sap	greu	que	cap	dels	dos									
16	Em	sap	greu	que	cap	dels	dos									
17	Em	sap	greu	que	cap	dels	dos	xi								
18	Em	sap	greu	que	cap	dels	dos	xicots								
19	Em	sap	greu	que	cap	dels	dos	xicots								
20	Em	sap	greu	que	cap	dels	dos	xicots	no							
21	Em	sap	greu	que	cap	dels	dos	xicots	no	em						
22	Em	sap	greu	que	cap	dels	dos	xicots	no	em	p					
23	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui					
24	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	do				
25	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	u			
26	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un			
27	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop		
28	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	
29	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
30	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
31	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	ma
32	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
C10	Em 3	sap 5	greu 6	que 8	cap 11	dels 14	dos 15	xicots 19	no 21	em 21	pugui 23	donar 25	un 26	cop 29	de 29	mà. 30
1	m															
2	ens															
3	em	seg														
4	em	seg														
5	em	sap	gr													
6	em	sap	greu													
7	em	sap	greu													
8	em	sap	greu	que												
9	em	sap	greu	que	aq											
10	em	sap	greu	que	acab											
11	em	sap	greu	que	cap											
12	em	sap	greu	que	cap	del										
13	em	sap	greu	que	cap	del										
14	em	sap	greu	que	cap	dels										
15	em	sap	greu	que	cap	dels	dos									
16	em	sap	greu	que	cap	dels	dos	xi								
17	em	sap	greu	que	cap	dels	dos	xic								
18	em	sap	greu	que	cap	dels	dos	xico								
19	em	sap	greu	que	cap	dels	dos	xicots								
20	em	sap	greu	que	cap	dels	dos	xicots	n							
21	em	sap	greu	que	cap	dels	dos	xicots	no	em						
22	em	sap	greu	que	cap	dels	dos	xicots	no	em						
23	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui					
24	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	do				
25	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar				
26	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un			
27	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	c		
28	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	co		
29	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	
30	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
31	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
32	em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.

C11	Em 1	sap 5	greu 5	que 7	cap 11	dels 13	dos 15	xicots 18	no 20	em 21	pugui 23	donar 25	un 26	cop 27	de 28	mà. 30
1	Em															
2	Ems															
3	Em	sec														
4	Em	sec														
5	Em	sap	greu													
6	Em	sap	greu													
7	Em	sap	greu	que												
8	Em	sap	greu	que												
9	Em	sap	greu	que	aq											
10	Em	sap	greu	que	acab											
11	Em	sap	greu	que	cap											
12	Em	sap	greu	que	cap	d'aq										
13	Em	sap	greu	que	cap	dels										
14	Em	sap	greu	que	cap	dels										
15	Em	sap	greu	que	cap	dels	dos									
16	Em	sap	greu	que	cap	dels	dos									
17	Em	sap	greu	que	cap	dels	dos	xiu								
18	Em	sap	greu	que	cap	dels	dos	xicots								
19	Em	sap	greu	que	cap	dels	dos	xicots								
20	Em	sap	greu	que	cap	dels	dos	xicots	no							
21	Em	sap	greu	que	cap	dels	dos	xicots	no	em						
22	Em	sap	greu	que	cap	dels	dos	xicots	no	em	p					
23	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui					
24	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	tr				
25	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar				
26	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un			
27	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop		
28	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	
29	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	d'ull	
30	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà
31	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà
32	Em	sap	greu	que	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà.
C12	Em 4	sap 5	greu 6	que 9	cap 12	dels 14	dos 14	xicots 17	no 21	em X	pugui X	donar 25	un 26	cop 27	de 28	mà. 30
1	En															
2	En	s														
3	En	sem														
4	Em	semb														
5	Amb	sap	gre													
6	Amb	sap	greu													
7	Amb	sap	greu													
8	Amb	sap	greu	qu												
9	Amb	sap	greu	que	pe											
10	Amb	sap	greu	que	acab											
11	Amb	sap	greu	que	acasa											
12	Amb	sap	greu	que	cap											
13	Amb	sap	greu	que	cap	de										
14	Amb	sap	greu	que	cap	dels	dos									
15	Amb	sap	greu	que	cap	dels	dos									
16	Amb	sap	greu	que	cap	dels	dos									
17	Em	sap	greu	que	cap	dels	dos	xicots								
18	Em	sap	greu	que	cap	dels	dos	xicots								
19	Em	sap	greu	que	cap	dels	dos	xicots								
20	Em	sap	greu	que	cap	dels	dos	xicots								
21	Em	sap	greu	que	cap	dels	dos	xicots	no							
22	Em	sap	greu	que	cap	dels	dos	xicots	no							
23	Em	sap	greu	que	cap	dels	dos	xicots	no	amb	puguin					
24	Em	sap	greu	que	cap	dels	dos	xicots	no	amb	puguin					
25	Em	sap	greu	que	cap	dels	dos	xicots	no	amb	puguin	donar				
26	Em	sap	greu	que	cap	dels	dos	xicots	no	amb	puguin	donar	un			
27	Em	sap	greu	que	cap	dels	dos	xicots	no	amb	puguin	donar	un	cop		
28	Em	sap	greu	que	cap	dels	dos	xicots	no	amb	puguin	donar	un	cop	de	
29	Em	sap	greu	que	cap	dels	dos	xicots	no	amb	puguin	donar	un	cop	de	
30	Em	sap	greu	que	cap	dels	dos	xicots	no	amb	puguin	donar	un	cop	de	ma
31	Em	sap	greu	que	cap	dels	dos	xicots	no	amb	puguin	donar	un	cop	de	ma
32	Em	sap	greu	que	cap	dels	dos	xicots	no	amb	puguin	donar	un	cop	de	ma

A1	Em 1	sap 2	greu 4	que X	cap 13	dels 14	dos 21	xicots 20	no 22	em X	pugui 25	donar 25	un 30	cop 30	de 31	mà. 31
1	Em															
2	Em	sap														
3	Em	sap														
4	Em	sap	greu													
5	Em	sap	greu													
6	Em	sap	greu													
7	Em	sap	greu													
8	Em	sap	greu	per												
9	Em	sap	greu	per												
10	Em	sap	greu	per	que											
11	Em	sap	greu	per	que											
12	Em	sap	greu	per	que											
13	Em	sap	greu	per	cap											
14	Em	sap	greu	per	cap	dels										
15	Em	sap	greu	per	cap	dels										
16	Em	sap	greu	per	cap	dels										
17	Em	sap	greu	per	cap	dels		xi								
18	Em	sap	greu	per	cap	dels		xi								
19	Em	sap	greu	per	cap	dels		xi								
20	Em	sap	greu	per	cap	dels		xicots								
21	Em	sap	greu	per	cap	dels	dos	xicots								
22	Em	sap	greu	per	cap	dels	dos	xicots	no							
23	Em	sap	greu	per	cap	dels	dos	xicots	no		puguin					
24	Em	sap	greu	per	cap	dels	dos	xicots	no		puguin					
25	Em	sap	greu	però a	cap	dels	dos	xicots	no		pugui	donar				
26	Em	sap	greu	però a	cap	dels	dos	xicots	no		pugui	donar				
27	Em	sap	greu	però a	cap	dels	dos	xicots	no		pugui	donar				
28	Em	sap	greu	però a	cap	dels	dos	xicots	no		pugui	donar				
29	Em	sap	greu	però a	cap	dels	dos	xicots	no		pugui	donar				
30	Em	sap	greu	però a	cap	dels	dos	xicots	no		pugui	donar	un	cop		
31	Em	sap	greu	però a	cap	dels	dos	xicots	no		pugui	donar	un	cop	de	mà
32	Em	sap	greu	però a	cap	dels	dos	xicots	no		pugui	donar	un	cop	de	mà
A2	Em 1	sap 5	greu 5	que 8	cap 11	dels 12	dos 15	xicots 18	no 20	em X	pugui X	donar 31	un 30	cop 30	de 30	mà. 30
1	Em															
2	Em	s														
3	Em	s														
4	Em	sa														
5	Em	sap	greu													
6	Em	sap	greu													
7	Em	sap	greu													
8	Em	sap	greu	que												
9	Em	sap	greu	que												
10	Em	sap	greu	que	a											
11	Em	sap	greu	que	cap											
12	Em	sap	greu	que	cap	d'els										
13	Em	sap	greu	que	cap	d'els										
14	Em	sap	greu	que	cap	d'els										
15	Em	sap	greu	que	cap	d'els	dos									
16	Em	sap	greu	que	cap	d'els	dos									
17	Em	sap	greu	que	cap	d'els	dos	chi								
18	Em	sap	greu	que	cap	d'els	dos	chicots								
19	Em	sap	greu	que	cap	d'els	dos	chicots								
20	Em	sap	greu	que	cap	d'els	dos	chicots	no							
21	Em	sap	greu	que	cap	d'els	dos	chicots	no							
22	Em	sap	greu	que	cap	d'els	dos	chicots	no	en	pod					
23	Em	sap	greu	que	cap	d'els	dos	chicots	no	han	pog					
24	Em	sap	greu	que	cap	d'els	dos	chicots	no	han	pogut					
25	Em	sap	greu	que	cap	d'els	dos	chicots	no	han	pogut					
26	Em	sap	greu	que	cap	d'els	dos	chicots	no	han	pogut					
27	Em	sap	greu	que	cap	d'els	dos	chicots	no	han	pogut					
28	Em	sap	greu	que	cap	d'els	dos	chicots	no	han	pogut					
29	Em	sap	greu	que	cap	d'els	dos	chicots	no	han	pogut					
30	Em	sap	greu	que	cap	d'els	dos	chicots	no	han	pogut		un	cop	de	main
31	Em	sap	greu	que	cap	d'els	dos	chicots	no		puc	donar	un	cop	de	main
32	Em	sap	greu	que	cap	d'els	dos	chicots	no	m'en	pogut	donar	un	cop	de	main

A3	Em 1	sap 5	greu 6	que 9	cap 12	dels 14	dos 15	xicots 18	no 21	em 32	pugui X	donar 27	un 31	cop 31	de 31	mà. 31
1	Em															
2	Em	se														
3	Em	sa														
4	Em	sa														
5	Em	sap	g													
6	Em	sap	greu													
7	Em	sap	greu													
8	Em	sap	greu													
9	Em	sap	greu	que												
10	Em	sap	greu	que	acaba											
11	Em	sap	greu	que	acaba											
12	Em	sap	greu	que	al cap	d										
13	Em	sap	greu	que	al cap	del										
14	Em	sap	greu	que	al cap	dels										
15	Em	sap	greu	que	al cap	dels	dos									
16	Em	sap	greu	que	al cap	dels	dos	xi								
17	Em	sap	greu	que	al cap	dels	dos	xi								
18	Em	sap	greu	que	al cap	dels	dos	xicots								
19	Em	sap	greu	que	al cap	dels	dos	xicots								
20	Em	sap	greu	que	al cap	dels	dos	xicots								
21	Em	sap	greu	que	al cap	dels	dos	xicots	no							
22	Em	sap	greu	que	al cap	dels	dos	xicots	no							
23	Em	sap	greu	que	al cap	dels	dos	xicots	no		puguin					
24	Em	sap	greu	que	al cap	dels	dos	xicos	no		puguin					
25	Em	sap	greu	que	al cap	dels	dos	xicos	no		puguin					
26	Em	sap	greu	que	al cap	dels	dos	xicos	no		puguin	do				
27	Em	sap	greu	que	al cap	dels	dos	xicos	no		puguin	donar				
28	Em	sap	greu	que	al cap	dels	dos	xicos	no		puguin	donar		comp-	-te	
29	Em	sap	greu	que	al cap	dels	dos	xicos	no		puguin	donar		comp-	-te	
30	Em	sap	greu	que	al cap	dels	dos	xicos	no		puguin	donar		comp-	-te	m
31	Em	sap	greu	que	al cap	dels	dos	xicos	no		puguin	donar	un	cop	de	mà
32	Em	sab	greu	que	al cap	dels	dos	xicots	no	me	puguin	donar	un	cop	de	mà
A4	Em X	sap 29	greu 29	que X	cap 11	dels 14	dos 21	xicots 19	no 21	em X	pugui X	donar X	un X	cop 32	de 31	mà. 31
1	Am															
2	Am	s														
3	Am	se														
4	Am	sec														
5	Am	sec-	-cri													
6	Am	sec-	-crir													
7	Am	sa	creu													
8	Am	sa	creu	cua												
9	Am	sa	creu	pa												
10	Am	sa	creu	pa	ca											
11	Am	sa	creu	pa	cap											
12	Am	sa	creu	pa	cap	del										
13	Am	sa	creu	pa	cap	del										
14	Am	sa	creu	pa	cap	dels										
15	Am	sa	creu	pa	cap	dels	d									
16	Am	sa	creu	pa	cap	dels	doç									
17	Am	sa	creu	pa	cap	dels	doç	i								
18	Am	sa	creu	pa	cap	dels	doç	i								
19	Am	sa	creu	pa	cap	dels	do	xicos								
20	Am	sa	creu	pa	cap	dels	do	xicos								
21	Am	sa	creu	pa	cap	dels	dos	xicos	no							
22	Am	sa	creu	pa	cap	dels	dos	xicos	no-	-n						
23	Am	sa	creu	pa	cap	dels	dos	xicos	no		pud					
24	Am	sa	creu	pa	cap	dels	dos	xicos	no		pude					
25	Am	sa	creu	pa	cap	dels	dos	xicos	no		puden					
26	Am	sa	creu	pa	cap	dels	dos	xicos	no		puden					
27	Am	sa	creu	pa	cap	dels	dos	xicos	no		puden					
28	Am	sa	creu	pa	cap	dels	dos	xicos	no		puden		an-	-c		
29	Am	sap	greu	p'	cap	dels	dos	xicos	no		pueden		a			
30	Am	sap	greu	p'	cap	dels	dos	xicos	no		pueden		an	cap		
31	Am	sap	greu	p'	cap	dels	dos	xicos	no		pueden		an	cap	de	ma
32	Am	sap	greu	p'	cap	dels	dos	xicos	no		pueden		an	cop	de	má

A5	Em 1	sap 5	greu 5	que X	cap 11	dels 13	dos 14	xicots 18	no 21	em X	pugui X	donar 25	un 26	cop 27	de 28	mà. 30
1	Em															
2	Em-	-s														
3	Em	sec														
4	En	sec														
5	Em	sap	greu													
6	Em	sap	greu													
7	Em	sap	greu													
8	Em	sap	greu	per												
9	Em	sap	greu	per												
10	Em	sap	greu	per	ca											
11	Em	sap	greu	per	cap											
12	Em	sap	greu	per	cap	del										
13	Em	sap	greu	per	cap	dels										
14	Em	sap	greu	per	cap	dels	dos									
15	Em	sap	greu	per	cap	dels	dos	po								
16	Em	sap	greu	per	cap	dels	dos	chi								
17	Em	sap	greu	per	cap	dels	dos	chico								
18	Em	sap	greu	per	cap	dels	dos	chicots								
19	Em	sap	greu	per	cap	dels	dos	chicots								
20	Em	sap	greu	per	cap	dels	dos	chicots								
21	Em	sap	greu	per	cap	dels	dos	chicots	no							
22	Em	sap	greu	per	cap	dels	dos	chicots	no							
23	Em	sap	greu	per	cap	dels	dos	chicots	no		pogue					
24	Em	sap	greu	per	cap	dels	dos	chicots	no		poguer					
25	Em	sap	greu	per	cap	dels	dos	chicots	no		pogue	donar				
26	Em	sap	greu	per	cap	dels	dos	chicots	no		pogue	donar	un			
27	Em	sap	greu	per	cap	dels	dos	chicots	no		pogue	donar	un	cop		
28	Em	sap	greu	per	cap	dels	dos	chicots	no		pogue	donar	un	cop	de	
29	Em	sap	greu	per	cap	dels	dos	chicots	no		pogue	donar	un	cop	de	
30	Em	sap	greu	per	cap	dels	dos	chicots	no		pogue	donar	un	cop	de	má
31	Em	sap	greu	per	cap	dels	dos	chicots	no		pogue	donar	un	cop	de	má
32	En	sap	greu	per	cap	dels	dos	chicots	no	en	poguer	donar	un	cop	de	má
A6	Em 1	sap 3	greu 5	que X	cap 11	dels 13	dos 15	xicots 19	no 21	em 23	pugui 24	donar 26	un 27	cop 29	de 30	mà. 30
1	Em															
2	Em	sa														
3	Em	sap														
4	Em	sap	g													
5	Em	sap	greu													
6	Em	sap	greu													
7	Em	sap	greu	q												
8	Em	sap	greu	per												
9	Em	sap	greu	per	a											
10	Em	sap	greu	per	ca											
11	Em	sap	greu	per	cap											
12	Em	sap	greu	per	cap	de										
13	Em	sap	greu	per	cap	dels										
14	Em	sap	greu	per	cap	dels	d									
15	Em	sap	greu	per	cap	dels	dos									
16	Em	sap	greu	per	cap	dels	dos	x								
17	Em	sap	greu	per	cap	dels	dos	xi								
18	Em	sap	greu	per	cap	dels	dos	xico								
19	Em	sap	greu	per	cap	dels	dos	xicots								
20	Em	sap	greu	per	cap	dels	dos	xicots	n							
21	Em	sap	greu	per	cap	dels	dos	xicots	no							
22	Em	sap	greu	per	cap	dels	dos	xicots	no-	-m						
23	Em	sap	greu	per	cap	dels	dos	xicots	no	em	p					
24	Em	sap	greu	per	cap	dels	dos	xicots	no	em	pugui					
25	Em	sap	greu	per	cap	dels	dos	xicots	no	em	pugui	d				
26	Em	sap	greu	per	cap	dels	dos	xicots	no	em	pugui	donar				
27	Em	sap	greu	per	cap	dels	dos	xicots	no	em	pugui	donar	un	c		
28	Em	sap	greu	per	cap	dels	dos	xicots	no	em	pugui	donar	un	co		
29	Em	sap	greu	per	cap	dels	dos	xicots	no	em	pugui	donar	un	cop		
30	Em	sap	greu	per	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà
31	Em	sap	greu	per	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà
32	Em	sap	greu	per	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà

A7	Em 1	sap 2	greu 5	que X	cap 11	dels 13	dos 15	xicots 18	no 21	em 22	pugui 23	donar 25	un 26	cop 27	de 27	mà. 30
1	Em															
2	Em	sap														
3	Em	sap	g													
4	Em	sap	g													
5	Em	sap	greu													
6	Em	sap	greu													
7	Em	sap	greu													
8	Em	sap	greu	per												
9	Em	sap	greu	per-	-què											
10	Em	sap	greu	per	q											
11	Em	sap	greu	per	cap											
12	Em	sap	greu	pel	cap	del										
13	Em	sap	greu	per	cap	dels										
14	Em	sap	greu	per	cap	dels										
15	Em	sap	greu	per	cap	dels	dos									
16	Em	sap	greu	per	cap	dels	dos	x								
17	Em	sap	greu	per	cap	dels	do	xi								
18	Em	sap	greu	per	cap	dels	do	xicots								
19	Em	sap	greu	per	cap	dels	do	xicots	g							
20	Em	sap	greu	per	cap	dels	do	xicots	g							
21	Em	sap	greu	per	cap	dels	do	xicots	no							
22	Em	sap	greu	per	cap	dels	do	xicots	no	em						
23	Em	sap	greu	per	cap	dels	do	xicots	no	en	pugui					
24	Em	sap	greu	per	cap	dels	do	xicots	no	en	pugui	do				
25	Em	sap	greu	per	cap	dels	do	xicots	no	en	pugui	donar				
26	Em	sap	greu	per	cap	dels	do	xicots	no	en	pugui	donar	un			
27	Em	sap	greu	per	cap	dels	do	xicots	no	en	pugui	don	un	cop	de	
28	Em	sap	greu	per	cap	dels	do	xicots	no	en	pugui	don	un	cop	de	
29	Em	sap	greu	per	cap	dels	do	xicots	no	en	pugui	don	un	cop	d'ull	
30	Em	sap	greu	per	cap	dels	do	xicots	no	en	pugui	don	un	cop	de	mà
31	Em	sap	greu	per	cap	dels	do	xicots	no	en	pugui	don	un	cop	de	mà
32	Em	sap	greu	perquè	cap	dels	dos	xicots	no	em	pugui	donar	un	cop	de	mà
A8	Em 1	sap X	greu X	que 8	cap 11	dels X	dos 19	xicots 19	no 21	em 21	pugui 32	donar X	un 32	cop 30	de 31	mà. 31
1	Em															
2	Em	s														
3	Em	se														
4	Em	sec														
5	Em	sac-	-r													
6	Em	se	creu													
7	Em	se	creu													
8	Em	se	creu	que												
9	Em	se	creu	qu'a												
10	Em	se	creu	que	ca											
11	Em	se	creu	que	cap											
12	Em	se	creu	que	cap	del										
13	Em	se	creu	que	cap	del										
14	Em	se	creu	que	cap	del s										
15	Em	se	creu	que	cap	del s-	-us									
16	Em	se	creu	que	cap	del s-	-us									
17	Em	se	creu	que	cap	del s-	-o-	-ci								
18	Em	se	creu	que	cap	del s-	-o-	-cico								
19	Em	se	creu	que	cap	del	dos	chicos								
20	Em	se	creu	que	cap	del	dos	chicos								
21	Em	se	creu	que	cap	del	dos	xicos	no	m'						
22	Em	se	creu	que	cap	del	dos	xicos	no	me	p					
23	Em	se	creu	que	cap	del	dos	xicos	no		puguim					
24	Em	se	creu	que	cap	del	dos	xicos	no		pugi-	-d				
25	Em	se	creu	que	cap	del	dos	xicos	no		pugio-	-d				
26	Em	se	creu	que	cap	del	dos	xicos	no		pugi	d'en				
27	Em	se	creu	que	cap	del	dos	xicos	no		pugi	d'en-		-c		
28	Em	se	creu	que	cap	del	dos	xicos	no		pugi	d'en-	-on-	-c		
29	Em	se	creu	que	cap	del	dos	xicos	no		pugi	d'en-	-on-	-cop		
30	Em	se	creu	que	cap	del	dos	xicos	no		pugi	d'en		cop	de-	-ma
31	Em	se	creu	que	cap	del	dos	xicos	no		pugi	d'		cop	de	man
32	Em	se	creu	que	al cap	de	dos	xicos	no		pugui	don	un	cop	de	ma

A9	Em 3	sap 6	greu 6	que 9	cap 15	dels 14	dos 15	xicots 19	no 21	em 22	pugui 23	donar 25	un X	cop X	de X	mà. X
1	Amb															
2	En	s														
3	Em	s														
4	Em	se														
5	Em	sec														
6	Em	sap	greu													
7	Em	sap	greu													
8	Em	sent	greu													
9	Em	sent	greu	que												
10	Em	sent	greu	que	acabi											
11	Em	sent	greu	que	acabi											
12	Em	sent	greu	que	acap	del										
13	Em	sent	greu	que	acap	del										
14	Em	sent	greu	que	acap	dels										
15	Em	sent	greu	que	a cap	dels	dos									
16	Em	sent	greu	que	a cap	dels	dos									
17	Em	sent	greu	que	a cap	dels	dos	j								
18	Em	sent	greu	que	a cap	dels	dos	xi								
19	Em	sent	greu	que	a cap	dels	dos	xicots								
20	Em	sent	greu	que	a cap	dels	dos	xicots								
21	Em	sent	greu	que	a cap	dels	dos	xicots	no							
22	Em	sent	greu	que	a cap	dels	dos	xicots	no	em	p					
23	Em	sent	greu	que	a cap	dels	dos	xicots	no	em	pugui					
24	Em	sent	greu	que	a cap	dels	dos	xicots	no	em	pugui					
25	Em	sent	greu	que	a cap	dels	dos	xicots	no	em	pugui	donar				
26	Em	sent	greu	que	a cap	dels	dos	xicots	no	em	pugui	donar	e			
27	Em	sent	greu	que	a cap	dels	dos	xicots	no	em	pugui	donar	en-	-c		
28	Em	sent	greu	que	a cap	dels	dos	xicots	no	em	pugui	donar	en-	-co		
29	Em	sent	greu	que	a cap	dels	dos	xicots	no	em	pugui	donar	en-	-comp-	-te	
30	Em	sent	greu	que	a cap	dels	dos	xicots	no	em	pugui	donar	en-	-comp-	-te	m
31	Em	sent	greu	que	a cap	dels	dos	xicots	no	em	pugui	donar	en	comp-	-te	mal
32	Em	sap	greu	que	a cap	dels	dos	xicots	no	em	pugui	donar	en	compte	de-	-mà
A10	Em 2	sap 4	greu 6	que 8	cap 11	dels 14	dos 15	xicots 18	no 21	em 22	pugui X	donar 31	un 30	cop 30	de 30	mà. 31
1	En															
2	Em	s														
3	Em	se														
4	Em	sap														
5	Em	sap	gr													
6	Em	sap	greu													
7	Em	sap	greu	q												
8	Em	sap	greu	que												
9	Em	sap	greu	qu'a												
10	Em	sap	greu	qu'a-	-cab											
11	Em	sap	greu	que	cap											
12	Em	sap	greu	que	cap	de										
13	Em	sap	greu	que	cap	del										
14	Em	sap	greu	que	cap	dels										
15	Em	sap	greu	que	cap	dels	dos									
16	Em	sap	greu	que	cap	dels	dos	x								
17	Em	sap	greu	que	cap	dels	dos	xi								
18	Em	sap	greu	que	cap	dels	dos	xicots								
19	Em	sap	greu	que	cap	dels	dos	xicots								
20	Em	sap	greu	que	cap	dels	dos	xicots	n							
21	Em	sap	greu	que	cap	dels	dos	xicots	no							
22	Em	sap	greu	que	cap	dels	dos	xicots	no-	-'m						
23	Em	sap	greu	que	cap	dels	dos	xicots	no	han						
24	Em	sap	greu	que	cap	dels	dos	xicots	no	han	pogut					
25	Em	sap	greu	que	cap	dels	dos	xicots	no	han	pogut	anar				
26	Em	sap	greu	que	cap	dels	dos	xicots	no	han	pogut	anar	a			
27	Em	sap	greu	que	cap	dels	dos	xicots	no	han	pogut	anar	en-	-c		
28	Em	sap	greu	que	cap	dels	dos	xicots	no	han	pogut	anar	an-	-co		
29	Em	sap	greu	que	cap	dels	dos	xicots	no	han	pogut	anar	en	com		
30	Em	sap	greu	que	cap	dels	dos	xicots	no	han	pogut	anar	un	cop	de	
31	Em	sap	greu	que	cap	dels	dos	xicots	no	han	pogut	donar	un	cop	de	mà
32	Em	sap	greu	que	cap	dels	dos	xicots	no	han	pogut	donar	un	cop	de	mà

A11	Em X	sap 26	greu X	que X	cap 11	dels 14	dos 15	xicots 18	no 21	em X	pugui X	donar X	un X	cop X	de X	mà. X
1	Am															
2	Amb	se														
3	Am	sec														
4	Am	sec	la													
5	Am	s-	-creu													
6	Am	set	creu													
7	Am	set	creu													
8	Am	set	creu	par												
9	Am	set	creu	per	ca											
10	Am	set	creu	par	ca											
11	Am	set	creu	par	cap											
12	Am	set	creu	par	cap	del										
13	Am	set	creu	par	cap	del										
14	Am	set	creu	par	cap	dels										
15	Am	set	creu	par	cap	dels	dos									
16	Am	set	creu	par	cap	de	duo-	-x								
17	Am	set	creu	per	cap	dels	do	schi								
18	Am	set	creu	per	cap	dels	dos	chicos								
19	Am	set	creu	per	cap	dels	dos	chicos								
20	Am	set	creu	per	cap	dels	dos	chicos	No-	-rt						
21	Am	set	creu	per	cap	dels	dos	chicos	no	mes						
22	Am	set	creu	per	cap	dels	dos	chicos	no		pu					
23	Am	set	creu	per	cap	dels	dos	chicos	no		purgi					
24	Am	s'-	-creu	per	cap	del	dos	chicos	no		pui-	-d				
25	Am	s'-	-creu	per	cap	dels	dos	chicos	no		pui-	-do				
26	Am	sap	creu	per	cap	dels	dos	chicos	no		pui-	-do				
27	Am	sap	creu	per	cap	dels	dos	chicos	no		pui-	-don				
28	Am	sap	creu	per	cap	dels	dos	chicos	no		pui	d-	-on-	-cor		
29	Am	sap	creu	per	cap	dels	dos	chicos	no		pui	d-	-en-	-cor		
30	Am	sap	creu	per	cap	dels	dos	chicos	no		pui	d-	-en-	-cor	de-	-man
31	Am	sap	creu	per	cap	dels	dos	chicos	no		pui	d-	-en-	-cor	de-	-man
32	Am	sap	creu	per	cap	dels	dos	chicos	no		pui	d-	-en-	-cor	de-	-man
A12	Em 32	sap X	greu X	que 9	cap 11	dels X	dos 32	xicots X	no X	em X	pugui X	donar X	un X	cop X	de 32	mà. X
1	En															
2	En	se														
3	En	sep														
4	En	sep	e													
5	En	sep	gre													
6	En	sep	cre													
7	En	sep	cre													
8	En	sep	cre													
9	En	sep	cre	que												
10	En	sep	cre	que	ca											
11	En	sep	cre	que	cap											
12	En	sep	cre	que	cap	de										
13	En	sep	cre	que	cap	del										
14	En	sep	cre	que	cap	del										
15	En	sep	cre	que	cap	desl										
16	En	sep	cre	que	cap	desl	lo									
17	En	sep	cre	que	cap	desl	lo	ju								
18	En	sep	cre	que	cap	desl	lo	ju								
19	En	sep	cre	que	cap	desl	lo	juci								
20	En	sep	cre	que	cap	desl	lo	juco								
21	En	sep	cre	que	cap	desl	lo	juco i								
22	En	sep	cre	que	cap	desl	lo	juco i	mos							
23	En	sep	cre	que	cap	desl	lo	juco i	mos		pol					
24	En	sep	cre	que	cap	desl	lo	juco i	mos		pol i-	-tan				
25	En	sep	cre	que	cap	desl	lo	juco i	mos		pol i-	-tan				
26	En	sep	cre	que	cap	desl	lo	juco i	mos		pol i-	-tan	amb			
27	En	sep	cre	que	cap	desl	lo	juco i	mos		pol i-	-tan	amb			
28	En	sep	cre	que	cap	desl	lo	juco i	mos		pol i-	-tan	en			
29	En	sep	cre	que	cap	desl	lo	juco i	mos		pol i-	-tan	pa			
30	En	sep	cre	que	cap	desl	lo	juco i	mos		pol i-	-tan	on			
31	En	sep	cre	que	cap	desl	lo	juco i	mos		pol i-	-tan	on	co-	-de	
32	Em	sa	creu		cap		dos	se cos-	-mo-		-poli-	-tan	al	can	de	mar

Appendix C

ANOVA results[20]

TOTAL %				
English Item	AM Ttl	CAT Ttl	ANOVA result	level of significance
IS	100%	75%	F (1,22) = 3.667, p = 0.069	
YOUR	92%	67%	F (1,22) = 2.302, p = 0.143	
FRIEND	92%	58%	F (1,22) = 3.826, p = 0.063	
THE	92%	25%	F (1,22) = 18.526, p = 0.000	**
ONE	92%	75%	F (1,22) = 1.158, p = 0.294	
THAT	92%	42%	F (1,22) = 8.609, p = 0.008	**
CAN'T	83%	25%	F (1,22) = 11.468, p = 0.003	**
GO	67%	0%	F (1,22) = 22.0, p = 0.000	**
TO	67%	0%	F (1,22) = 22.0, p = 0.000	**
BED	100%	17%	F (1,22) = 55.0, p = 0.000	**
BY	100%	100%	F (1,22) = --, p = --	
TEN?	100%	92%	F (1,22) = 1.0, p = 0.328	
PEAK %				
English Item	AM peak	CAT peak	ANOVA result	level of significance
IS	58%	25%	F (1,22) = 2.839, p = 0.106	
YOUR	33%	25%	F (1,22) = 0.186, p = 0.670	
FRIEND	25%	(33%) 17%/17%	F (1,22) = 0.234, p = 0.633	
THE	33%	17%	F (1,22) = 0.846, p = 0.368	
ONE	50%	42%	F (1,22) = 0.155, p = 0.698	
THAT	83%	25%	F (1,22) = 11.468, p = 0.003	**
CAN'T	42%	17%	F (1,22) = 1.8, p = 0.193	
GO	33%	0%	F (1,22) = 5.5, p = 0.028	*
TO	33%	0%	F (1,22) = 5.5, p = 0.028	*
BED	67%	17%	F (1,22) = 7.615, p = 0.011	*
BY	92%	92%	F (1,22) = 0.0, p = 1	
TEN?	(67%) 33%/33%	50%	F (1,22) = 0.647, p = 0.430	
AM PEAK				
English Item	AM %	CAT %	ANOVA result	level of significance
IS	58%	25%	F (1,22) = 2.839, p = 0.106	
YOUR	33%	8%	F (1,22) = 2.302, p = 0.143	
FRIEND	33%	0%	F (1,22) = 5.5, p = 0.028	*
THE	42%	0%	F (1,22) = 7.857, p = 0.010	**
ONE	67%	25%	F (1,22) = 4.661, p = 0.042	*
THAT	83%	17%	F (1,22) = 17.6, p = 0.000	**
CAN'T	58%	17%	F (1,22) = 5.0, p = 0.036	*
GO	33%	0%	F (1,22) = 5.5, p = 0.028	*
TO	33%	0%	F (1,22) = 5.5, p = 0.028	*
BED	67%	17%	F (1,22) = 7.615, p = 0.011	*
BY	92%	92%	F (1,22) = 0.0, p = 1	
TEN?	33%	0%	F (1,22) = 5.5, p = 0.028	*

[20] Cells marked with two asterisks indicate $p < 0.05$. Cells marked with one asterisk indicate p = / < 0.05.

AM 50% GATE				
English Item	AM %	CAT %	ANOVA result	level of significance
IS	58%	25%	*F* (1,22) = 2.839, *p* = 0.106	
YOUR	50%	17%	*F* (1,22) = 3.143, *p* = 0.090	
FRIEND	58%	33%	*F* (1,22) = 1.478, *p* = 0.237	
THE	58%	8%	*F* (1,22) = 8.609, *p* = 0.008	**
ONE	67%	25%	*F* (1,22) = 4.661, *p* = 0.042	*
THAT	83%	17%	*F* (1,22) = 17.6, *p* = 0.000	**
CAN'T	58%	17%	*F* (1,22) = 5.0, *p* = 0.036	*
GO	50%	0%	*F* (1,22) = 11.0, *p* = 0.003	**
TO	50%	0%	*F* (1,22) = 11.0, *p* = 0.003	**
BED	67%	17%	*F* (1,22) = 7.615, *p* = 0.011	*
BY	92%	92%	*F* (1,22) = 0.0, *p* = 1	
TEN?	67%	17%	*F* (1,22) = 7.615, *p* = 0.011	*

TIMECOURSE OF RECOGNITION		
English Item	ANOVA result	level of significance
IS	*F* (1,22) = 3.557, *p* = 0.073	
YOUR	*F* (1,22) = 2.266, *p* = 0.146	
FRIEND	*F* (1,22) = 5.518, *p* = 0.028	*
THE	*F* (1,22) = 19.322, *p* = 0.000	**
ONE	*F* (1,22) = 2.031, *p* = 0.168	
THAT	*F* (1,22) = 11.730, *p* = 0.002	**
CAN'T	*F* (1,22) = 7.350, *p* = 0.013	*
GO	*F* (1,22) = 13.073, *p* = 0.002	**
TO	*F* (1,22) = 13.073, *p* = 0.002	**
BED	*F* (1,22) = 37.343, *p* = 0.000	**
BY	*F* (1,22) = 0.040, *p* = 0.843	
TEN?	*F* (1,22) = 9.605, *p* = 0.005	**

TOTAL %				
Catalan Item	CAT Ttl	AM Ttl	ANOVA result	level of significance
EM	100%	83%	F (1,22) = 2.2, p = 0.152	
SAP	100%	83%	F (1,22) = 2.2, p = 0.152	
GREU	100%	75%	F (1,22) = 3.667, p = 0.069	
QUE	100%	50%	F (1,22) = 11.0, p = 0.003	**
CAP	100%	100%	F (1,22) = --, p = --	
DELS	100%	83%	F (1,22) = 2.2, p = 0.152	
DOS	100%	100%	F (1,22) = --, p = --	
XICOTS	100%	92%	F (1,22) = 1.0, p = 0.328	
NO	100%	92%	F (1,22) = 1.0, p = 0.328	
EM	92%	50%	F (1,22) = 5.851, p = 0.024	*
PUGUI	83%	42%	F (1,22) = 5.0, p = 0.036	*
DONAR	100%	67%	F (1,22) = 5.5, p = 0.028	*
UN	100%	67%	F (1,22) = 5.5, p = 0.028	*
COP	100%	75%	F (1,22) = 3.667, p = 0.069	
DE	100%	83%	F (1,22) = 2.2, p = 0.152	
MÀ	100%	75%	F (1,22) = 3.667, p = 0.069	
PEAK %				
Catalan Item	CAT peak	AM peak	ANOVA result	level of significance
EM	58%	58%	F (1,22) = 0.0, p = 1	
SAP	75%	25%	F (1,22) = 7.333, p = 0.013	*
GREU	(83) 42%/42%	33%	F (1,22) = 0.164, p = 0.689	
QUE	50%	(50%) 25%/25%	F (1,22) = 1.571, p = 0.223	
CAP	58%	75%	F (1,22) = 0.710, p = 0.409	
DELS	67%	50%	F (1,22) = 0.647, p = 0.430	
DOS	75%	58%	F (1,22) = 0.710, p = 0.409	
XICOTS	50%	50%	F (1,22) = 0.0, p = 1	
NO	58%	75%	F (1,22) = 0.710, p = 0.409	
EM	50%	25%	F (1,22) = 1.571, p = 0.223	
PUGUI	67%	17%	F (1,22) = 7.615, p = 0.011	*
DONAR	83%	33%	F (1,22) = 7.615, p = 0.011	*
UN	92%	25%	F (1,22) = 18.526, p = 0.000	**
COP	42%	33%	F (1,22) = 0.164, p = 0.689	
DE	33%	33%	F (1,22) = 0.0, p = 1	
MÀ	67%	42%	F (1,22) = 1.478, p = 0.237	
CAT PEAK				
Catalan Item	CAT %	AM %	ANOVA result	level of significance
EM	58%	58%	F (1,22) = 0.0, p = 1	
SAP	92%	58%	F (1,22) = 3.826, p = 0.063	
GREU	42%	42%	F (1,22) = 0.0, p = 1	
QUE	58%	25%	F (1,22) = 2.839, p = 0.106	
CAP	67%	75%	F (1,22) = 0.186, p = 0.670	
DELS	100%	83%	F (1,22) = 2.2, p = 0.152	
DOS	83%	67%	F (1,22) = 0.846, p = 0.368	
XICOTS	58%	50%	F (1,22) = 0.155, p = 0.698	
NO	92%	83%	F (1,22) = 0.355, p = 0.557	
EM	92%	33%	F (1,22) = 12.535, p = 0.002	**
PUGUI	67%	17%	F (1,22) = 1.478, p = 0.237	
DONAR	83%	33%	F (1,22) = 7.615, p = 0.011	*
UN	92%	17%	F (1,22) = 28.742, p = 0.000	**
COP	92%	25%	F (1,22) = 18.526, p = 0.000	**
DE	42%	17%	F (1,22) = 1.8, p = 0.193	
MÀ	83%	33%	F (1,22) = 7.615, p = 0.011	*

50% GATE				
Catalan Item	CAT %	AM %	ANOVA result	level of significance
EM	58%	58%	F (1,22) = 0.0, p = 1	
SAP	92%	58%	F (1,22) = 3.826, p = 0.063	
GREU	83%	67%	F (1,22) = 0.846, p = 0.368	
QUE	58%	25%	F (1,22) = 2.839, p = 0.106	
CAP	67%	75%	F (1,22) = 0.186, p = 0.670	
DELS	100%	83%	F (1,22) = 2.2, p = 0.152	
DOS	83%	67%	F (1,22) = 0.846, p = 0.368	
XICOTS	58%	50%	F (1,22) = 0.155, p = 0.698	
NO	92%	83%	F (1,22) = 0.355, p = 0.557	
EM	92%	33%	F (1,22) = 12.535, p = 0.002	**
PUGUI	67%	42%	F (1,22) = 1.478, p = 0.237	
DONAR	83%	33%	F (1,22) = 7.615, p = 0.011	*
UN	92%	17%	F (1,22) = 28.742, p = 0.000	**
COP	50%	17%	F (1,22) = 3.143, p = 0.090	
DE	67%	17%	F (1,22) = 7.615, p = 0.011	*
MÀ	83%	33%	F (1,22) = 7.615, p = 0.011	*

TIMECOURSE OF RECOGNITION		
Catalan Item	ANOVA result	level of significance
EM	F (1,22) = 3.035, *p* = 0.095	
SAP	F (1,22) = 4.368, *p* = 0.048	*
GREU	F (1,22) = 4.846, *p* = 0.038	*
QUE	F (1,22) = 10.273, *p* = 0.004	**
CAP	F (1,22) = 0.693, *p* = 0.414	
DELS	F (1,22) = 2.060, *p* = 0.165	
DOS	F (1,22) = 2.991, *p* = 0.098	
XICOTS	F (1,22) = 1.154, *p* = 0.294	
NO	F (1,22) = 1.485, *p* = 0.236	
EM	F (1,22) = 9.534, *p* = 0.005	**
PUGUI	F (1,22) = 8.222, *p* = 0.009	**
DONAR	F (1,22) = 12.236, *p* = 0.002	**
UN	F (1,22) = 26.703, *p* = 0.000	**
COP	F (1,22) = 10.883, *p* = 0.003	**
DE	F (1,22) = 7.380, *p* = 0.013	*
MÀ	F (1,22) = 8.979, *p* = 0.007	**

Appendix D

<u>Spectrogram for the second Catalan test sentence: *En Pau és aquest que pren dos iogurts per berenar?*</u>