# Attenuation of information during native/ non-native interactions

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DOCTORAL THESIS UPF / 2013

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*A todos los que habéis sufrido daños colaterales mientras escribía esta tesis. Gracias por vuestra paciencia y ayuda.*

# Acknowledgements

En primer lugar, me gustaría darle las gracias a mis padres, **Emiliano Rodríguez** y **Rosa María Cuadrado**, y a mi hermano, **Javier Rodríguez**, por estar <u>siempre</u> ahí y apoyarme de todas las maneras posibles en cada momento, por hacerme sentir querida y especial. Gracias por hacerme creer en mis capacidades, y por proporcionarme una buena educación; por su compañía constante, pese a la distancia física. Estas gracias se extienden a toda mi familia, a **mis abuelos, mis tías, tíos y primos**. Por alegrarse tanto de verme cada vez que vuelvo a casa. Y ojala que siga siendo así por muchos años.

En segundo lugar, me gustaría agradecerle a mi supervisor, **Albert Costa**, que me haya acompañado durante todos estos años y me haya convertido en una persona más crítica. Te doy las gracias por ver mis fallos con precisión y ayudarme a corregirlos. Y por supuesto, por haberme dado la oportunidad de haber hecho esta tesis.

Unas gracias enormes a **Carlos Romero**, ¡gran sufridor de esta tesis! Gracias por haber llegado como el mejor compañero, en cada faceta de mi vida, que jamás hubiera podido pensar. Por llenarme de senaridad y de buenos momentos, por hacerme reír hasta que me duele la cara y me entra la tos, por bailar conmigo en el salón. Gracias por sacar lo más puro de mí, por hacer que se me olvide la vergüenza, la timidez, los miedos y los complejos. Por tu ayuda, tu apoyo, ¡por tus patatas fritas! Por hacerte de querer cada día un poco más. Confío en que este párrafo pasará de moda nunca.

Gracias a mi compañera y amiga **Carolina Sánchez**. Las cosas hubieran sido muy distintas sin ti, y me alegro mucho de haberte tenido cerca para descargar frustraciones, hablar de nuestras cosas dentro y fuera de la ciencia,

acompañarme en cañas y paseos para despejar nuestras mentes, darme apoyo y hacerme sentir una persona importante para ti.

A mis amigos **Dani, Xico y Álex**. A Dani, por permanecer a través de los años, por siempre estar ahí. Por las infinitas conversaciones, risas y bailes que nos hemos echado juntos. Por llevarme en bici por Barcelona a las 6 de la mañana, siendo el mejor fin de fiesta. Por ser un amigo de los buenos. A Xico, el único gran amigo que conservo de máster en Ciencia Cognitiva y Lenguaje que fue el preludio de esta tesis. Por ser estimulante, por compartirse conmigo, por haber encontrado un compañero de alma. Y gracias a Álex, por haberme sacado tanto de casa a pasar buenos ratos juntos a través de todo el territorio catalán. Por haber sido mi primer amigo de verdad en Barcelona y persistir tras los años, gracias a tu sentido del humor y a tu desenfado.

Gracias a **Jordi Navarra** por su apoyo y por brindarme una nueva oportunidad en ciencia. Por todo el ruido que hemos hecho y los proyectos que están por venir. Gracias a **José Manuel Igoa**, quien fue mi profesor de Psicología del Lenguaje en la carrera. De él es la culpa de que me interesara en el lenguaje, dado a su buen hacer y su capacidad para transmitir una asignatura tan compleja. Gracias también a **Salvador Soto-Faraco**, por su acogida en el Máster en Ciencia Cognitiva y Lenguaje, impartiendo una de las asignaturas más interesantes del mismo, y por las conversaciones e interacciones compartidas a lo largo de estos años. Igualmente, gracias a **Núria Sebastián Gallés**, especialmente en los primeros momentos de beca. Gracias también a **Luca Bonatti** y a **JuanMa Toro** por su compañía y complicidad dentro y fuera de nuestras clases de catalán. Gracias a **Cristina Cuadrado, Xavier Mayoral, Silvia Blanch, Florencia Nava, Santa Taberner, Beatriz Abad y Jaume Condal** por su soporte administrativo, técnico y personal.

Finally, very especial thanks to **Gabriella Vigliocco** and **David Vinson**, who taught me a large amount of things during my time in London. With you I approached a new way of working that really made an impact on me. I felt encouraged, motivated and fulfilled, and I deeply thank you for that. Thanks too to the other lab members, especially **Tiziana, Rob, Jessica, Evi, Patricia and Luisa** who were more friends than colleagues. Thanks to **Mark, Robin, Neal, Pamela, James, Julia, Laura, Stefan, Alex and Tanuja**. Thanks also to **John Draper** for his help and good sense of humour.

Y, por supuesto, a **todos los participantes** que de forma anónima han hecho que mis experimentos fueran posibles.

# Abstract

The main objective of this dissertation is to study the relationship between attenuation of information and non-nativeness, and to analyze the nature of the attenuation of information phenomenon. Previous research has shown that when natives speak to non-natives, they simplify speech performing *foreigner talk*. Also, there is mounting evidence indicating that native speakers go through *attenuation of information,* which refers to the reduction of words in several ways (as having shorter durations) as a consequence of being predictable. It has been shown that when natives speak to natives, attenuation is beneficial for comprehension as it signals the informational status of words. What remains unsolved is whether foreigner talk and attenuation can interact in an optimal way for guaranteeing the understanding of non-native listeners. This is the first question that I address in the first study included in the present dissertation. Secondly, there is evidence showing that native speakers attenuate information both in monologue and dialogue contexts, and that non-natives only attenuate in monologue, being unclear whether non-natives perform attenuation during conversations. This constitutes the second question that I address in the second study of this dissertation. Finally, literature is unclear about the role that semantics and articulation play in attenuation: do speakers attenuate second mentioned words because it is the second time that the concept is evoked or that the word is articulated? We investigate this issue with a novel approach based on bilingualism. We provide evidence suggesting that natives shape attenuation under some circumstances when talking to non-natives, and additionally perform foreigner talk to improve the signal. We also show that non-natives attenuate information both in monologue and in dialogue. Finally, we show that attenuation is mainly modulated by semantics. The current dissertation extends our knowledge about attenuation of information *per se* and its relation to native/non-native interactions.

# Resumen

El objetivo principal de esta tesis es el de estudiar la relación entre la atenuación de la información y el fenómeno de ser no nativo de la lengua, junto a examinar la naturaleza de la atenuación. Investigaciones previas muestran que cuando los hablantes nativos se comunican con no nativos, los nativos simplifican el lenguaje mediante *foreigner talk*. Así mismo, hay bastante evidencia a favor de que los nativos experimentan *atenuación de la información,* que se refiere a que cuando las palabras son predecibles, se ven reducidas en diversas formas (como tener duraciones más cortas). Se ha mostrado que cuando hablantes nativos interactúan con oyentes nativos, la atenuación es beneficiosa para la comprensión al señalar el estado informacional de las palabras. Lo que aún no está claro es si el *foreigner talk* y la atenuación pueden interactuar de modo óptimo para garantizar la comprensión de los no nativos. Esta es la primera pregunta que abordo en el primer estudio de esta tesis. En segundo lugar, hay evidencia de que los nativos atenúan tanto en monólogo como en diálogo, y de que los no nativos atenúan en monólogo, pero no está claro si los no nativos atenúan durante las conversaciones. Esto constituye la segunda pregunta que abordo en el segundo estudio de esta tesis. Finalmente, la literatura en atenuación no es clara respecto al rol que tienen la semántica y la articulación de palabras en atenuación: ¿la atenuación se debe a que es la segunda vez que el hablante accede a un concepto o que articula una palabra? Investigamos esta cuestión mediante el bilingüismo. En este trabajo, mostramos que los nativos controlan la atenuación sólo para la intensidad de la palabra cuando hablan con no nativos, y también utilizan *foreigner talk* para mejorar la señal. También mostramos que los no nativos atenúan tanto en monólogo cómo en diálogo. Finalmente, mostramos que la atenuación se ve mayoritariamente influida por la semántica. Esta tesis extiende nuestro conocimiento sobre la atenuación de la en sí misma y en relación a las interacciones entre nativos y no nativos.

# Preface

Any of us, as human beings, interact with a variety of people in several occasions per day. During these interactions, we adapt the way in which we communicate to each other. This adaptation, which is observed from copying our partner's body posture or mimicking his/her gestures, to utter the same lexical or syntactic forms, is the key to successful understanding. Adaptations are in most of the cases, automatic and effort-free, making communication a simple task where talking to each other is normally easier than giving a conference in front of an audience.

However, the interactions of our everyday life might differ in how easy/hard they are to carry, and in how likely it is that we *align* with our conversational partner(s). With *alignment* we refer to the result of the coordination between speakers who share representations at some level of language. It implies that interlocutors share their *situation models,* being multi-dimensional representations containing information about space, time, causality, intentionality and currently relevant individuals (see Johnson-Laird, 1983, Sanford & Garrod, 1981 and Zwaan & Radvansky, 1998). The situation of having not so easy conversations in which it is hard to align with the interlocutor can be observed in a variety of scenarios, as when we speak to kids or to elder people, or when we explain something elaborated to a naïve audience.

In our modern multicultural society, it is becoming increasingly common that we interact in our first language with a non-native speaker; also, that we interact in our second (or other) language with a native or with another non-native speaker. In fact, data from the Eurobarometer of 2001, 2006 and 2012 shows that overall in Europe, 53% of Europeans reported speaking at least one language apart from their mother tongue, and 26% more than two, being in 2006 a 56% and a 28% respectively, and a 54% and a 25% in 2012 (see

Figure 1). In the case of Spain, in 2006, 44% of the population reported speaking another language in addition to their mother tongue (Spanish, Catalan, Basque or Galician), which increased to 46% in 2012; and 19% reported speaking more than two languages in 2006, being a 18% in 2012 (see Figure 2). In the United States, 11% of the population was bilingual in 1980, 14% in 1990, and 20% in 2007 (Shin & Kominski, 2010). Therefore, I believe that it is of crucial relevance to comprehend the underlying mechanisms of conversation when a non-native speaker is involved.
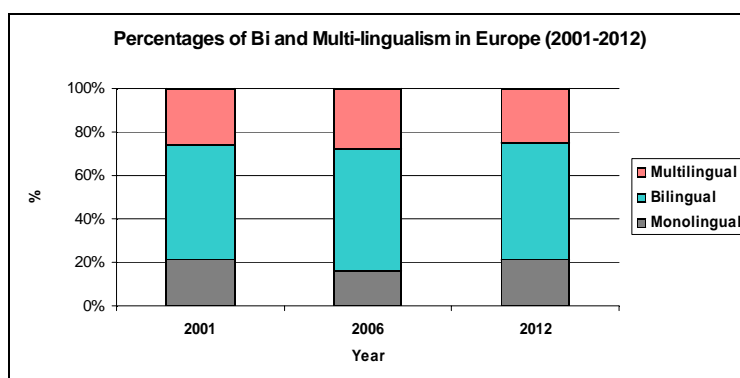


**Figure 1.** Percentages of monolingualism, bilingualism and multilingualism in Europe (years 2001, 2006 and 2012).
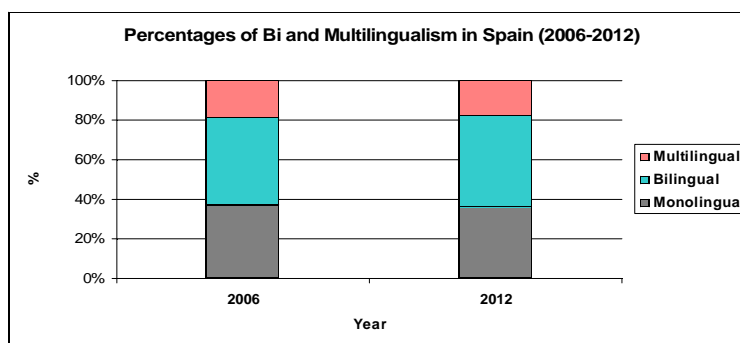


**Figure 2.** Percentages of monolingualism, bilingualism and multilingualism in Spain (years 2006 and 2012).

In this scenario, there are a variety of factors that might shape the smoothness of the conversation, as language fluency, language background

or speech rate of the conversational partners, to name a few. In addition, in situations in which a non-native speaker is involved, both partners make efforts to be understood. When a native speaker is talking to a non-native, the speaker performs a type of adaptation known as *foreigner talk* (e.g.: Woolridge, 2001), which implies tailoring speech to the needs of the non-native. In the current dissertation, we aim at exploring the dynamics of native/non-native interactions. More specifically, we will look at the interaction between foreigner talk and a pervasive phenomenon in native-native interactions which is known to influence the informativeness of conversations: *attenuation of information*. Attenuation of information is characterized by the fact that when words are predictable, they are reduced for several variables such as word duration, intensity or pitch. It has been shown to have a valuable pragmatic effect, as it signals the informational status of words in conversations (as "this word is new" or "it has already been presented, so we are still talking about the same thing"). However, as the signal is attenuated, attenuation also implies intelligibility loss.

Experimental evidence shows that natives' comprehension is not hampered by the intelligibility loss of attenuation, but rather benefits native listeners due to the pragmatic gain of word shortening (Birch & Clifton, 1995; Dahan, 2002; Fowler & Housum, 1987; Terken & Noteboom, 1987). However, it is still unknown whether attenuation is equally helpful when the producer or the listener of the message is a non-native speaker, due to a poorer mastering of the non-native language. We conducted a series of experiments in which non-native speakers acted as producers or as listeners (Experimental Sections 1 & 2) in order to see whether attenuation interacts with linguistic background. In addition, we aimed to shed light on the origin of the attenuation effect, and to better understand how conceptual and articulatory modulations are involved in its occurrence (Experimental Section 3).

Therefore, in this thesis we explore, first, the interaction between the linguistic status of speakers and listeners and attenuation of information; and secondly, the origin of the attenuation of information phenomenon. In particular:

- In case a native speakers interacts with a non-native listener, how foreigner talk interacts with attenuation of information.

- In case a non-native speaker interacts with a native listener, whether the non-native would be under the influence of attenuation of information.

- The role that articulatory and conceptual modulations have in generating the attenuation of information phenomenon.

Before presenting the Experimental Section of this dissertation, the most relevant aspects of audience design and attenuation of information in relation to interactions in which non-native speakers are involved are presented in Chapter 1, which constitutes the theoretical background of the dissertation.

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# 1    GENERAL INTRODUCTION

## 1.1    Description of audience design, attenuation of information and non-nativeness

A conversation is a joint activity which aims at communicative success, as interlocutors work together on the common task of producing an understandable conversation (Clark, 1996). To do so, speakers need to be flexible enough to rapidly adapt to each other. When having a conversation, interlocutors coordinate their utterances through turn-taking and adjust their production and comprehension processes: while the speaker produces speech, the listener comprehends the message (see Gambi & Pickering, 2011; see also Menenti et al., 2011 and Stephens et al., 2010 for fMRI experimental support on production-comprehension coordination).

Coordination in conversation is not only about turn-taking, but also requires aligning mental states. *Alignment* is the result of the coordination between speakers who share the same representation at some level of language, and can be observed at any linguistic level (see Pickering & Garrod, 2004). For instance, if two speakers in a conversation make use of the same word for a concept, they are lexically aligned (Brennan & Clark, 1996; Garrod & Anderson, 1987; Garrod & Clark, 1993); if speakers employ the same syntactic form when describing events or objects, they are syntactically aligned (Branigan et al., 2007; Cleland & Pickering, 2003; Pickering & Ferreira, 2008; for evidence of syntactic alignment across languages see Hartsuiker et al., 2004). Speakers also converge in the phonetic realisation of repeated words during the course of a conversation (Pardo et al., 2006), especially if they share the native language (see Kim et al., 2011). Speakers also align in tone of voice (Neumann & Strack, 2000), accent and speech rate

(Giles et al., 1991) and pauses (Cappella & Planalp, 1981). In addition, alignment occurs in a non-linguistic level, copying body posture and movements during interactions (Bargh & Chartrand, 1999; Shockley et al., 2003) or facial expressions (Bavelas et al., 1986).

## Types of Alignment

Lexical Alignment: one speaker utters a certain lexical choice which is copied by the other listener.





Syntactic alignment: one speaker utters a certain syntactic structure which is copied by the other speaker.
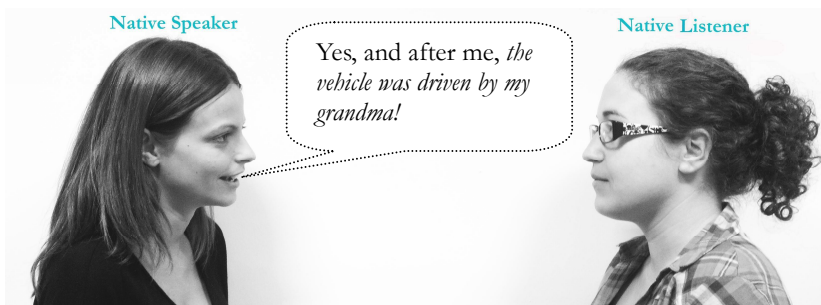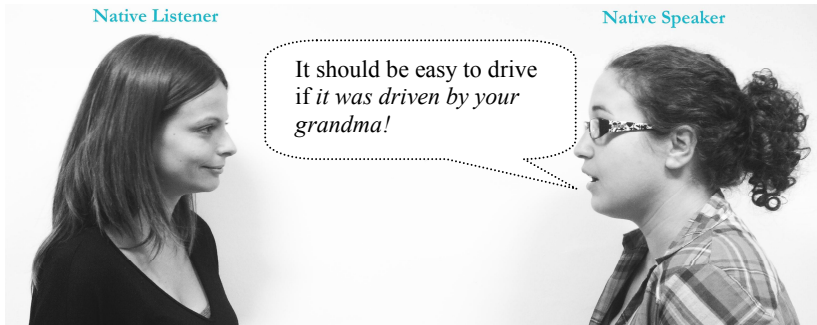
**Figure 3.** Representation of lexical and syntactic alignment by a dyad of native speakers.

Furthermore, several mechanisms have been suggested to account for alignment (see Branigan, 2010, and Garrod & Pickering, 2007). I would like to highlight three: alignment as priming, alignment as audience design and alignment as agreement between interlocutors. Alignment as audience design is the most important for this thesis. When speakers align as a consequence of *priming*, it is because the priming mechanisms make that the speakers' representations got automatically aligned at a low level of processing. Being aligned by priming implies that the speaker might not be very affected by extra linguistic information like the speaker's beliefs about the interlocutor (see, for instance, Branigan et al., 2010). This mechanism seems to dominate conversations when partners are balanced regarding their language proficiency and knowledge of the topic under discussion. When they are not balanced, alignment as priming would not be very dominant, as considering the needs of the listener requires elaborating the message accordingly. Under this scenario, alignment occurs as *audience design*, being the second type of mechanism for alignment. *Audience design* refers to the phenomenon of adjusting our behavior to facilitate the interaction with another person (Clark & Carlson, 1982; Clark & Murphy, 1982). Finally, alignment may arise as the result of *agreement between interlocutors*. Agreement can be achieved explicitly, as if speakers openly discuss about how to refer to an expression, or implicitly. Alignment through implicit negotiation is observed, for instance, when the

speaker first refers to an object with a label and the interlocutor responds to that lexical choice with no apparent trouble, as it would imply that both conversational partners acknowledge and accept that label (see, for example, Brennan and Clark, 1996, or Metzing and Brennan, 2003).

Going back to the idea of audience design, sometimes speakers perform audience design because the listener is on less favorable conditions than the speaker. For instance, the listener might have less knowledge of the topic under discussion, listening problems or can be a non-native speaker of the target language. Within the frame of *Lindblom's theory of hyper- and hypo-articulation* (1990), which is crucial to understand the dynamics of audience design and attenuation of information, designing utterances for the audience carries hyper-articulation. In a nutshell, Lindblom's theory defends that when the contextual factors are supportive, speakers would tend to hypo-articulate. However, if the context is not good enough, due to reasons as background noise or any perceptual problem by the listener, speakers would hyper-articulate to enhance the quality of the signal.

The case that is especially relevant for the current dissertation is when the native speaker considers that it is necessary to perform audience design because the conversational partner is a non-native speaker. If this is the case, then the speaker would make use of the *foreigner talk* speech register (for more on this topic, see section 1.2.1. in the introduction). Foreigner talk is the type of audience design examined in this work, in which one of our concerns is whether speakers align their mental states and representations considering the knowledge and needs of the conversational partner. Concretely, we are interested in whether audience design/foreigner talk can influence a pervasive phenomenon in speech production which shapes the informativeness of conversations, namely attenuation of information. In a nutshell, attenuation of information refers to the shortening of words along

several features, such as duration or intensity, occurring when words are predictable due to factors as frequency or prior mention.

Crucially, and within Lindblom's theory (1990), attenuation of information leads to hypo-articulation, and audience design leads to hyper-articulation. Now, imagine that a native speaker is talking to a non-native speaker (so he/she should hyper-articulate) about some information that is predictable (for which he/she should hypo-articulate). How do these two forces interact?

### 1.1.1 Audience design and attenuation of information in native → non-native interactions

As it was just stated, on one hand, designing utterances for a listener carries hyper-articulation. On the other hand, attenuation of information, the phenomenon for which speakers attenuate predictable words, involves hypo-articulation. Attenuation is characterized by having a pragmatic benefit and an intelligibility drawback. The pragmatic benefit of attenuation is that attenuated forms serve as a cue signaling the informational status of referents. It allows speakers to discern between referents that have just been introduced in the discourse (full forms), and those referring to the same entity than before (attenuated forms). There is mounting evidence in support of the pragmatic benefit of attenuation (Birch & Clifton, 1995; Dahan, 2002; Fowler & Housum, 1987; Terken & Noteboom, 1987). However, as attenuation involves hypo-articulation, the signal that the listener receives in second mentions would be less clear than in first mentions, there being the intelligibility drawback. In those interactions in which both speakers are natives, intelligibility loss does not seem to be a problem: speakers benefit from the pragmatic gain to track the informational status of words while still understanding the attenuated form. However, when a non-native speaker is a listener in the conversation, the weight that the pragmatic benefit and the

intelligibility drawback have might change. This is the first issue of interest of the present work.

Imagine that a native and a non-native speaker are having a conversation. When the non-native is listening, although it is likely that he/she would benefit from the pragmatic value of attenuation to follow the informational status of words as well as the native, he/she might have more trouble to decode the acoustic signal when this is less clear due to attenuation. Considering the evidence from Bradlow & Alexander (2007), I believe that it is likely that non-natives are as able to benefit from the pragmatic aid of attenuation as natives. Concretely, authors showed that non-native listeners took advantage of the contextual information (as would be the signaling of informational status in our case) where sentences could be highly or low constrained, in a similar way than natives when provided with a sufficiently clear signal. Taking into account this result, I hypothesize that the most beneficial scenario when non-natives act as listeners would be the one in which native speakers perform both foreigner talk and attenuation of information. This way, non-natives would have a sufficiently good signal (through foreigner talk) while being able to follow word's informational status (through attenuation).

However, it is not obvious that Bradlow & Alexander's (2007) results can be applied to our case. This is because in their study there was no real interaction between speaker and listener: natives or non-natives listened alone to sentences embedded in noise, whereas in the current dissertation natives and non-natives deal with face-to-face communication. Also, there are reasons to believe that the interaction between foreigner talk and attenuation of information is plausible. In the study of Baker & Bradlow (2009), it was examined whether the probability of a word (e.g.: repeated words versus new words) interacted with speech style, considering plain (this

is, normal) and *clear speech*. Clear speech is a simplified speech register delivered by speakers when they are aware that listeners have a perceptual difficulty (see Uchanski, 2005, and Smiljanić and Bradlow, 2009). Authors found that attenuation of information was present in both plain and clear speech. Therefore, performing the clear speech register led to longer durations overall, but the size of attenuation was comparable between plain and clear speech styles.

**Foreigner Talk Enhancements**

Native listener

Non-native speaker

Excuse me,
she was doing
what?

Native Speaker

Oh yes, sorry, she was
looking at him and he
was not aware

Non-native listener

**Figure 4.** Example of a situation requiring foreigner talk enhacements. When the native speaker talks to another native, she uses infrequent words such as "chick" and "stalk". When the same speakers talks to a non-native, even she chooses a more frequent term as "girl" instead of "chick", the non-native does not understand what "stalking" means and asks for clarification. As a consequence, the non-native employs a circumlocution to guarantee communication.

## 1.1.2    Audience design and attenuation of information in non-native → native interactions

So far I referred to a situation in which a non-native speaker listens to a native speaker, being the first focus of this dissertation. The second focus is placed on the situation in which the non-native speaks, rather than listens. Concretely, assuming the pragmatic benefit of attenuation, our second main question is whether non-native speakers would attenuate predictable words in an interactive situation. The reasons why non-natives might not be under

the influence of attenuation relate to their differences with the native speaker and to their difficulties in producing the foreign language due to a variety of reasons. Following Costa and collaborators (2008), and just to name just a few language problems that the non-native might have, the idea that the native and the non-native can have about the topic of the conversation, or about an element in particular might not coincide at some point of the conversation. Also, native's and non-native's speech might depart due to the intrusions played by the non-native's first language to his/her second language (for instance, a native speaker of Spanish might use a low frequency English word which is frequent in Spanish, as it occurs with English words that have Latin roots).

Other potential difficulties of the non-native relate to lexical choices, which although the non-native may think that a certain expression is the best choice to convey his/her intentions, it might not be appropriately chosen (as incorporating certain "shades" of the meaning of L2 words might be difficult, see, for instance de Groot, 1989; de Groot & Keijzer, 2000; Van Hell & Mahn, 1997; Francis, 2005). In addition, the non-native speaker might either mispronounce a word or avoid its use because of doubts about its pronunciation, or being unsure about how to use certain syntactic constructions. He/she might also have an atypical speech rate compared to the native's. All the aforementioned difficulties that the non-native speaker might encounter add processing load both on the non-native speaker and on his/her audience. This fact might reduce the chances of conversational success.

**Some of the problems faced by the non-native**



**Figure 5.** Example of the problems that the non-native speaker might face when involved in conversation with a native. First, the less familiarity with the language at all levels (phonological, lexical…) impairs her comprehension. This is accentuated by the fast speech rate of the native. As a consequence, the non-native asks for clarification.

Baker and collaborators' work (2011) is the first to address attenuation in non-native speakers. Authors showed that non-native speakers attenuated predictable words as natives did. This was assessed through a text reading task in which some items were repeated and authors analysed how duration decreased from first to second mentions. Baker et al's (2011) study is very relevant for the second focus of interest of this dissertation. However, we are going beyond Baker et al.'s (2011) work in two aspects. First, examining attenuation effects when non-natives are involved in a real communicative situation (that is, during conversation). Second, considering more indicators

of attenuation of information than duration, namely, intensity, mean pitch, pitch excursion and pitch range (see Experimental Section 2).

Baker et al's (2011) results suggest that, at least to what concerns speech production in monologue, the difficulties that non-native speakers have to face when speaking in a foreign language do not reduce the chances of attenuation to happen. However, it is still open whether the same applies when non-natives are involved in conversation.

## 1.2  **Audience design and special speech registers**

In some occasions, designing utterances for listeners involves the use of a *simplified speech register*. A simplified speech register is, as defined by Ferguson & DeBose (1977) a *"more or less conventionalised variety of language used by members of a speech community to address people whose knowledge of the language is felt to be less than normal."*

Several speech registers have been described depending on the needs of the audience and on the specific modifications made for that audience. One example is *motherese*, a speech register directed to infants which is characterised, for instance, by exaggerated prosodic contours and for the use of a simple language (see Burnham et al., 2002; Fernald and Kuhl, 1987; Fernald & Simon, 1984; Glucksberg et al., 1966; Shatz & Gelman, 1973; Snow, 1972). Another simple speech register is *elderspeak*, directed to elderly people and defined by higher provision of information or more frequency of pauses and simple syntactic constructions (see Kemper et al., 1995; Kintsch & Keenan, 1973). However, for the purposes of the current dissertation I would like to focus on *foreigner talk,* in which natives adapt their speech to a non-native audience. In addition, I would also outline the main properties of clear speech. This is due to its theoretical relevance and also

because non-native speakers might use some sort of clear speech when talking to natives (as showed in Experimental Section 2).

## 1.2.1    **Foreigner Talk**

Foreigner talk is a simplified form of language delivered by native speakers when interacting with non-native speakers (for various definitions see Campbell, 1977; Ferguson, 1971; James, 1986; Lattey, 1981 or Wenk, 1978). Although there has been some discussion about foreigner talk having a negative weight, such as being the way that non-natives talked (Ferguson, 1971; Valdman, 1981; for a review, see Varonis & Gass, 1982), I would focus on foreigner talk as a means of enhancing the non-native speaker's understanding.

Foreigner talk comprehends a number of modifications that occur at any level of language (see Table 1 for a summary of its main features). Due to the characteristics of our experimental setting, our analyses are limited to those modifications occurring at an articulatory/phonological level of language. Concretely: 1) whether native speakers speak slower towards non-natives than towards natives (in accordance with Chaudron, 1979; Henzl, 1979; Kelch, 1985; Nelson, 1992; Ramamurti, 1980); 2) whether native speakers enhance their signal through higher intensity (in accordance with Chaudron, 1979; Henzl, 1979; Ramamurti, 1980) and wider pitch range, as pitch range is use as a means to emphasize language (see Pierrehumbert & Hirschberg, 1990, but pitch range has been not reported so far, to our knowledge, as an indicator of foreigner talk); 3) whether native speakers display higher pitch and pitch excursion values when interacting with non-native speakers. Although Nelson (1992) failed to find differences between the mean pitch of utterances addressed to native and to non-native listeners, we aim at its exploration due the use of pitch as a means to signal

information as new or given, so speakers could highlight the informational status of words through pitch for those listeners which might be in trouble to follow the conversation.

In Long's terms (1983), native participants in the studies of our Experimental Section 1 could show *input* modifications. Input modifications refer to those changes made in the linguistic forms directed to native speakers. However, *interaction* modifications are applied during conversation, as comprehension checks or self-repetitions. Due to the nature of our experimental setting, which is primarily designed to generate attenuation of information, interaction modifications can not be addressed.

| **Articulatory and phonological** |
| --- |
| - Slower speech rate (Chaudron, 1979; Henzl, 1979; Kelch, 1985; Nelson, 1992; Ramamurti, 1980) |
| - Pauses after words (Henzl, 1979; Ramamurti, 1980) |
| - Intensity enhancement (Chaudron, 1979; Henzl, 1979; Ramamurti, 1980) |
| - Stressed and careful pronunciation (Nelson, 1992) |
| - Vowels are less reduced (Chaudron, 1979) |
| **Vocabulary** |
| - Avoidance of idioms, colloquialisms and slang (Chaudron, 1979; Henzl, 1979; Ramamurti, 1980). |
| - Minimal use of compound words (Henzl, 1979) |
| - Fewer pronominal words and higher use of names (Chaudron, 1979) |
| **Syntax** |
| - Omission of articles (Nelson, 1992) |
| - Repetition (Chaudron, 1979; Long, 1983; Nelson, 1992; Ramamurti, 1980) |
| - Use of short and well-formed sentences (Chaudron, 1979; Henzl, 1979) |

| |
|---|
| - Higher use of present tense, indicative, active verb form (Kelch, 1985; Long, 1983) |
| - Fewer use of subordinate sentences (Kelch, 1985; Long, 1983) |
| **Semantics & Discourse** |
| - Summary of non-syntactic utterances (Chaudron, 1979) |
| - "Filling the blank" for incomplete utterances (Chaudron, 1979) |
| - Gestures accompany speech (Chaudron, 1979; Ramamurti, 1980) |
| - Asking for confirmation (Long; 1983; Ramamurti, 1980) |
| - Offer of definitions (Nelson, 1992) |
| - Offer of corrections (Chaudron, 1979) |
| - No use of humour (Nelson, 1992) |
| - No use of idiomatic expressions (Nelson, 1992) |
| - Endearment terms (Chaudron, 1979) |
| - Toleration of ambiguity (Long, 1983) |
| - Select salient topics for conversation, making them salient (Long, 1983) |

**Table 1.** Summary of main features of foreigner talk.

Costa and collaborators (2008) propose some specific motivations that the native might have when performing foreigner talk (please note that here we refer to both input and interaction modifications). First, the native speaker may perform foreigner talk because he/she believes that its use would encourage alignment between interlocutors. On second place, foreigner talk could arise as a consequence of the feedback provided by the non-native, looking in need of a clearer signal. Thirdly, Costa et al. (2008) contemplate an alternative explanation for presence of foreigner talk: it might not be a decision made by the native speaker to facilitate communication, but rather, it could be partly due to linguistic alignment. Concretely, what Costa and collaborators (2008) mean is that, if for instance the non-native speaker uses high frequency words or simple syntactic constructions, the native speaker

might align to this simplified speech, copying non-natives rather than designing speech for them. In the context of the current dissertation, this last possibility can be ruled out in case native speakers perform "input" foreigner talk modifications. This is because listeners in our studies do not really provide with feedback to the speaker: their task consists in linking objects in a map, but give no further information or speak in a significant amount (but in the case of the "information" group in Experimental Section 1, that uttered clarification questions at six points in time during the task).

## 1.2.2      **Clear Speech**

Clear speech is a simplified speech register performed by speakers when they are aware that listeners have a perceptual difficulty. This perceptual difficulty can be the presence of background noise or hearing problems. Also, speakers may perform clear speech when interacting with non-native listeners (so some of the features of foreigner talk and clear speech overlap; see Uchanski (2005) and Smiljanić and Bradlow (2009) for a review). Concretely, the aim of performing clear speech is giving salient acoustic cues to the listener which may enhance his/her ability to access and comprehend the message.

Actually, it has been demonstrated that clear speech enhances listening performance. For instance, comprehension is increased up to a 26% compared to plain speech (see Payton et al., 1994). Its efficiency has been demonstrated in various populations like normal hearing and hearing impaired, native and non-native speakers, elderly adults and children with and without learning impairments, and in audio-only and audio-visual modalities for both young and old listeners (Bradlow & Bent, 2002; Bradlow et al., 2003; Chen, 1980; Gagne et al. 1994, 1995, 2002; Helfer, 1997, 1998; Liu et al., 2004; Picheny et al., 1985).

Clear speech modifications are divided between global and segmental adjustments. Global modifications enhance the overall salience of speech and arise independently of the language being spoken (Bradlow & Bent, 2002). Segmental modifications reflect the greater approximation of phonetic targets, making phonological categories more distinct for listeners (Lindblom, 1990). This implies that segmental clear speech adjustments would be language-dependent, where some adjustments would be more likely to occur in some languages than in others. In Table 2 we report the most common adjustments from plain to clear speech found in the literature.

| **Global modifications** |
| --- |
| - Lower speaking rate (Picheny et al., 1986) |
| - Higher frequency of pauses and longer duration of pauses (Picheny et al., 1986) |
| - Higher mean pitch and wider pitch range (Picheny et al., 1986) |
| **Segmental** |
| - Vowel formant changes (e.g.: Moon & Lindblom, 1994; Picheney et al., 1986) |
| - Bigger vowel space (Bradlow, 2002; Picheny et al., 1986; Smiljanić & Bradlow, 2008) |
| - Longer segment duration (e.g.: Picheny et al., 1986; Smiljanić & Bradlow, 2008) |
| - Fewer instances of consonant burst elimination (Bradlow et al., 2003; Picheny et al., 1986) |
| - Increased VOT differences between voiced and voiceless stops (Chen, 1980; Picheny et al., 1986; Smiljanić & Bradlow, 2008) |
| - Reduced alveolar flapping, (Bradlow, et al., 2003; Picheny et al., 1986). |
| - Less reduction of unstressed vowels to schwas (Picheny et al., 1986; Smiljanić & Bradlow, 2008). |

**Table 2.** Summary of main features of clear speech.

In the current dissertation, we do not generate scenarios that put speakers in the situation of performing clear speech *per se*. However, the foreigner talk used by natives when talking to non-natives overlap in some of its features with foreigner talk (as it is slower speech rate or a raise in intensity compared to plain speech/native listeners). Also, as suggested in the work included in Experimental Section 2, non-native speakers are also susceptible of performing clear speech. This is, they can be aware of the lower quality of their message, and then try to compensate it enhancing some speech features. Actually, there is evidence showing that non-native speakers can perform clear speech in spite of their language difficulties. I would like to highlight two studies.

In the study of Granlund and collaborators (2011), late Finnish-English bilinguals produced clear speech in both their L1 (Finnish) and in their L2 (English), where the clear speech modifications that bilinguals performed in both languages were compared with those of native English speakers. Global enhancements were observed from plain to clear speech, but no effect of language was found. For segmental enhancements, there were differences between plain and clear speech but not between languages for all the considered enhancements (but for voice onset time of the English /b/ and the Finnish /p/ in the plain speech condition). Granlund and collaborators' results suggest that late bilinguals modified their speech in a similar way than native speakers did. In addition, Smiljanić and Bradlow (2011) examined the intelligibility of plain and clear speech produced in American English by native and non-native speakers. Intelligibility measures were taken through playing previously recorded sentences to an independent group of listeners. Sentences were uttered by native American English speakers or by native Croatian speakers who were highly proficient in English, and either in plain or in clear speech. Also, listeners to those sentences could be native

American English speakers or native Croatian speakers highly proficient in English.

Of our interest lies in two of the issues examined by Smiljanić and Bradlow: first, how the linguistic status of the *talker* (native or non-native) interacted with speaking style (plain or clear) to determine intelligibility for non-native listeners. Second, how the linguistic status of the *listener* interacts with speaking style (plain or clear) to determine intelligibility for non-native talkers. This is very relevant because their questions are very similar to those outlined in this dissertation (especially to what concerns the experimental work developed in Experimental Sections 1 & 2). That is, we aim at elucidating whether non-native speakers are able to produce clear speech enhancements to compensate for their production difficulties. Also, we address whether the native speaker, aware of the non-native status of the listener, performs clear speech (in the shape of foreigner talk). Smiljanić and Bradlow's results (2011) showed that, effectively, natives and non-natives performed and benefited from clear speech enhancements.

## 1.3      **Attenuation of information**

### 1.3.1      **Causes, manifestations and processes**

Attenuation of information refers to the shortening of certain aspects of words when they are more or less predictable. There are several ways in which 1) words can be predictable and 2) attenuation can be manifested.

Starting with the sources of predictability, one of the most reported is repetition. For instance, imagine that a certain speaker has just introduced the utterance "I bought a new *car*" in a conversation. The word *car* would be

both in the speaker's and in the listener's mental model of the discourse, making it more accessible than new words (Chafe, 1976, 1994; Fowler & Housum, 1987; Gundel, 1988; Prince, 1992; Robertson & Kirsner, 2000). We chose repetition as the predictability source employed in the experimental work of this dissertation (generated through mentioning twice certain items in a map).

Word frequency is another predictability source of attenuation. That is, the high frequency word *car,* compared to the less frequent *vehicle* is easier to produce and then hypo-articulated (see Gregory et al., 1999; Jurafsky, 2001). The predictability of a word is also influenced by the sentence in which that word is embedded. For instance, the sentence "I am driving my new ___" makes the word *car* more likely than simply "I have got a new ___". This was originally stated in the classic example of Lieberman (1963), where it was showed that the duration of the word "nine" from speakers' utterances in a highly predictable context (e.g.: "a stitch in time saves ____") was shorter than in a low predictable context (e.g.: "the number that you will hear is ____"; for more evidence on sentence context see Bell et al., 2002; Hunnicutt, 1985; Jespersen, O., 1923; Jurafsky et al., 2001).

Finally, the last source of predictability that I would like to consider is predictability given surrounding words, concretely *joint* and *conditional* probabilities. The joint probability of a word refers to the prior probability of two words taken together; the conditional probability of a word refers to the probability of one word given another word (which can refer to the prior and to the next word). Predictability given surrounding words has been also studied with three words, this is, *trigram conditional probabilities*, differentiating between *forward conditional trigram* (the probability of a word given two previous words), *reverse conditional trigram* (the probability of a word given two next words) and *centred conditional trigram* (the probability of a word given a

previous and a next word; see Bell et al., 2002; Gregory et al., 1999).

When speakers perform attenuation, regardless of the predictability source, there are a number of ways in which it is manifested. For this dissertation, I would like to outline six manifestations, where five are actually examined in the studies included in Experimental Sections 1, 2 & 3. The most employed manifestation of attenuation is shortening of word's duration, which is reported as the difference between predictable words and unpredictable words (where predictable words are shorter). Attenuation can also be examined through word's intensity (measured in decibels), where predictable words are less intense than unpredictable words. Thirdly, predictable words have lower mean pitch (measured in hertz) than predictable words. In forth place, predictable words have lower pitch excursion (the maximum pitch value within a word, measured in hertz). In fifth place, predictable words have narrower pitch range, which signals how monotonous/dynamic the voice is (calculated through the subtraction of maximum and minimum hertz values). Some significant studies concerned with attenuation for duration, intensity and pitch-related measures come from Baker & Bradlow, 2009; Bell et al., 2002, 2003; Clark & Haviland, 1977; Fraundorf, Watson & Benjamin (under review); Fowler & Housum, 1987; Gregory et al., 1999; Lieberman, 1963; Samuel & Troicki, 1998; Watson et al., 2008. Duration, intensity, pitch, pitch excursion and pitch range are the five measures that we employed in the studies included in this thesis, as a means to provide a comprehensive account of how attenuation works *per se*, in relation to audience design and in relation to non-nativeness.
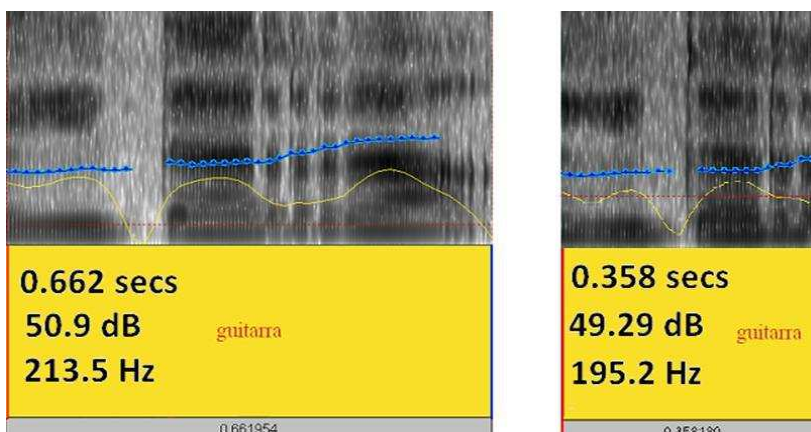
**Figure 6.** *Praat* extract of two mentions of the word "guitarra" uttered by one participant in our experiments. As it can be observed, the duration, intensity and pitch (and hence, maximum pitch and pitch range) decrease dramatically from the first to the second mention.

Finally, I would like to talk about *shortening of referential expressions,* as it may signal attenuation in longer units than words, and it is a measure commonly employed in the literature on attenuation (see Ariel, 1990; Chafe, 1976; Galati & Brennan, 2010; Grosz et al. 1995; Gundel et al., 1993). *Shortening of referential expressions* means that the first time that a referent is introduced in the discourse, it tends to be longer and more explicit than its subsequent times. For instance, imagine one person telling to a friend that she just bought a new red car. It is very likely that the first time that she refers to that object uses a construction of the type *my new red car*, where the second and subsequent times would be more similar to *my car*, *the car* or even *it*.

| Attenuation is manifested in... | Description | Is it examined in this dissertation? | Relevant references |
|---|---|---|---|
| Duration | Predictable words are longer than unpredictable words. This measure is alleged to be mainly articulatory. | Yes | Baker & Bradlow, 2009; Bell et al., 2002, 2003; Clark & Haviland, 1977; Fraundorf, Watson & Benjamin (under review); Fowler & Housum, 1987; Gregory et al., 1999; |

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| | | | Lieberman, 1963; Samuel & Troicki, 1998; Watson et al., 2008. |
|---|---|---|---|
| Intensity | Predictable words have lower intensity than unpredictable words. This measure is alleged to have a more social/discursive nature. | Yes | Fraundorf, Watson & Benjamin (under review); Watson et al., 2008. |
| Pitch | Predictable words have lower mean pitch than unpredictable words. It signals tone of voice and it is alleged to be mainly articulatory. | Yes | Watson et al., 2008. |
| Pitch Excursion | It refers to the maximum pitch value within a word. Predictable words have lower pitch excursion than unpredictable words. | Yes | Watson et al., 2008. |
| Pitch Range | It refers to the difference between the maximum and minimum pitch peaks within a word. It is alleged to reflect emphasis in conversation. Predictable words have narrower pitch range than unpredictable words. | Yes | Watson et al., 2008. |
| Referential Expressions | Referential expressions get shortened as a consequence of becoming predictable, reducing expressions to one word, or changing the article from indefinite to definite (e.g.: *a* car vs. *the* car). | No | Ariel, 1990; Chafe, 1976; Galati & Brennan, 2010; Grosz et al. 1995; Gundel et al., 1993. |

**Table 3.** List of the main manifestations of attenuation of information and its features.

Finally, two main processes responsible of attenuation have been acknowledged: *facilitation* and *audience design*. *Facilitation* means that a word might have privileged access because it is highly frequent or because it has been recently mentioned. Facilitation helps word production and, as a consequence, leads to attenuation of word/referents in several forms (e.g.: Bard & Aylett, 2004; Bell et al., 2009; Lindblom, 1990), shaping attenuation in any communicative situation (as in monologue and in dialogue). Attenuating because of *audience design* means that speakers perform attenuation because it is helpful for the listener (as it signals informational status; see Chafé, 1974). Attenuation driven by audience design is only likely to be observed in the presence of a listener, this is, in conversational

contexts.

## 1.3.2        Factors shaping attenuation (and their relation to the nature of attenuation)

In this section, I would like to talk about the factors that influence the attenuation of information phenomenon. Although this is of interest for the whole dissertation, it is especially relevant for the work included in Experimental Section 3, which aims at elucidating whether attenuation has a conceptual or an articulatory origin (or both).

A number of previous studies have provided with evidence which indirectly talks about the conceptual or articulatory nature of attenuation. I will speak about 1) word type; 2) self- and cross-repetitions; 3) types of giveness and 4) the multiple sources of attenuation. None of these issues are experimentally addressed in this work, but I believe that they are essential to get to a better understanding of the attenuation phenomenon.

First, I will speak about word type. It refers to how content and function words work differently and how this affects attenuation. Content words are meaningful words, such as nouns, verbs or adjectives. Function words are those words that structure sentences, as adjectives, conjunctions and the like. They differ along a series of characteristics. For instance, function words are more frequent, have shorter and less intense vowels and are prosodically different than content words (see Bell et al., 2009; Garrett, 1980; Lapointe & Dell, 1989; Lavoie, 2002; Selkirk, 1996; Shi et al., 2005). Crucially, content and function words experience attenuation in a different manner. Bell and collaborators (2009) performed a regression analysis on the Switchboard corpus of American telephone conversations (Greenberg et al., 1996),

finding that content words were attenuated and function words were not. This result indicates that meaningful words (content words) are more susceptible to be attenuated at least for word duration. In addition, Jurafsky and collaborators (2001) run regression analyses on two different datasets drawn from the Switchboard corpus (Greenberg et al. 1996) for content and function words separately. The duration of function words was mainly affected by the conditional probability of the preceding and following words, but repetition did not impact function word duration. Content words, however, were influenced by frequency and repetition. I believe that the fact that content and function words were influenced by different predictability factors in the case of Jurafsky (2001), and that function words were not attenuated in Bell's study (2009), is very informative to understand the nature of the attenuation of information phenomenon, speaking in favour of the crucial role of semantics.

On second place, *the issue of self- and cross-repetitions* refers to whether it is relevant for attenuation that the two mentions of a word are uttered by the same speaker (this is, self-repetition) or not. This is, if speaker A and speaker B are interacting, and the first mention of a word is uttered by speaker A, and the second mention by speaker B (this is, cross-repetition), would attenuation be different than if both mentions were uttered by the same speaker?

If articulation plays a crucial for attenuation, presumably more attenuation would be expected for self-repetitions than for cross-repetitions. But if semantics drive attenuation, it would be irrelevant who utters the second mention as long as both speakers listened to the first mention. However, results up to date are unclear. In the study of Bard and Aylett (2004, experiment 3) dyads of speakers completed Anderson's (1991) map task. Authors found that attenuation in word duration was present regardless of whether mentions were self or cross-repeated, supporting a bigger

implication of semantics than of articulation. However, Trón (2008), analyzed the Edinburgh maptask corpus (Anderson, 1991) showing that self-repetitions were more attenuated than cross-repetitions. While not denying the presence of conceptual influences, Trón's results speak in favour of a larger implication of articulation.

The third factor shaping attenuation is, assuming that a referent can be visually (e.g.: through pointing at it or displaying it in a screen) or linguistically given (this is, mentioning it), whether giveness type interacts with attenuation. Research that worked in these two types of giveness seems to agree in linguistic giveness being more powerful to evoke attenuation. In the study of Bard and collaborators (experiment 4, 2000), pairs of speakers performed a collaborative map task in which first and second mentions of words could be either visible to both conversational partners, or not visible to the listener. Listeners' assignment of given status was driven by linguistic mention, suggesting that visual giveness is only additive to the linguistic effect.

With a different methodology, Baumann & Hadelich (2003) addressed whether the activation state of an entity depends on the way this entity has been primed, either aurally or visually. Auditory primed referents were more activated than visually primed referents, suggesting visual primes are less "given" than linguistic primes. Both Bard et al. (2000) and Baumann & Hadelich (2003) studies suggest that linguistic giveness has a bigger role in attenuation (at least, for word duration) than visual giveness.

Finally, the study of Kahn & Arnold (2012) compared types of giveness to see how they influenced attenuation. In each trial there were eight objects, where three performed one out of five possible actions (although only the third object was the experimental target). Critically during the trial, the target object could be linguistically given, only visually given or not explicitly given

(control condition). The instruction giver had to describe those events to the instruction receiver. Authors found that both linguistic and non-linguistic giveness induced attenuation, but attenuation was larger for linguistically given than for visually given trials.

Kahn & Arnold's findings are framed within their *Facilitation-Based Reduction Hypothesis* (2012). The main idea of the Facilitation-Based Reduction Hypothesis is that attenuation is linked to the facilitation of speech production mechanisms; then, the more facilitated a word is, the more given and more attenuated. It implies that linguistically given referents would be more facilitated than visually given referents. Kahn & Arnold propose another alternative, the *Information Status Trigger Approach* (see Kahn & Arnold, 2012), where information is categorically represented as *given* or *not given*. Under this view, it would not matter if information is visually or linguistically given, as long as it is given. Simply, given informational statuses would trigger attenuated pronunciations and new informational status would trigger full pronunciations. Then, the Information Status Trigger Approach does not predict different amounts of attenuation based on if giveness is articulatory or visual. In contrast, the Facilitation-Based Reduction Hypothesis suggests that attenuation would emerge as a combination of the activation of a word's conceptual and linguistic representation, plus the priming of articulatory processes.

These two models can make different predictions about the origins of attenuation. This is, under the Information Status Trigger Approach, both repeat and switch trials would be attenuated and no differences would be expected between them. This is because what matters for attenuation is just that information is given, assigning most of the weight to semantics. However, for the Facilitation-Based Reduction Hypothesis, repeat trials would be more attenuated than switch trials because they are facilitated to a

bigger extent. That is, in repeat trials articulatory levels are also facilitated, but not in switch trials as the phonological forms are different. Thus, both articulatory and semantic modulations would be important.

The last feature shaping attenuation that I would like to consider is that attenuation seems to have multiple sources. This idea is developed in Watson and collaborators "Multi-Components Model" (2008), which would be further explained in the section 1.3.3. of this dissertation. It refers to the fact that some manifestations of attenuation, as duration, for instance, seem to be more automatic than others as intensity, which seems easier to control by the speaker.

Divergence between indicators within the same experiment has been found between duration and referential expressions (Anderson & Howarth, 2002; Bard et al., 2000; Bard & Aylett, 2004), duration, pitch and intensity (Watson et al., 2008) and duration and intensity (Fraundorf, Watson & Benjamin, under review).

In the case of Bard and collaborators (2000; 2004) and Anderson & Howarth (2002), attenuation for duration and referential expressions was examined under several conditions when pairs of participants completed Anderson's map task (1991). In all the cases, it was observed that attenuation of duration was somehow "egocentric". This is, in circumstances in which the speaker mentioned a landmark twice (so it was given for the speaker) but each mention was uttered to a different listener (so it was new for each of the listeners), speakers attenuated even though this jeopardized listeners' comprehension. Then, what the speaker knew determined attenuation for duration, rather than what the listener knew. However, the knowledge that the listener had shaped the shortening of referential expressions. When the speaker repeated a referential expression and the listener was new, referential expressions were not shortened. This evidence suggests that word duration

seems to be more difficult to control to facilitate listener's behavior than the shortening of referential expressions.

This divergence has been also observed for duration and pitch compared to intensity. In the study of Watson and colleagues (2008), authors addressed the contribution of predictability and importance to attenuation. This was done through the performance of a Tic Tac Toe game, where important movements (this is, those which block or win the game) are also very predictable. Authors argued that if attenuation is mainly related to importance, important movements would be acoustically prominent, but if it answers to predictability, predictable movements would not be acoustically prominent. Both hypotheses were true, but for different attenuation indicators. Important moves had higher intensity than unimportant moves, and unpredictable moves had longer duration and higher pitch, pitch excursion and pitch range than unpredictable moves. Considering their results, Watson et al. (2008) argued that duration and pitch-related measures would be more subjected to automatic, articulatory influences and intensity to more controllable, social, influences. In the study of Fraundorf, Watson & Benjamin (under review) a divergence between duration and intensity was also found. Then, the aforementioned results support the idea of prosodic prominence being a product of multiple sources.

| Authors | Looked at... | Outcome | Supports articulatory or semantic nature of attenuation? |
|---|---|---|---|
| Bell et al., 2009, and Jurafsky et al., 2001. | Word type: attenuation for content and function words. | Bell et al.: Attenuation only for content words. Jurafsky et al.: Attenuation working differently for function and content words. | Semantic |
| Bard & Aylett, 2004 and Trón, 2008. | Attenuation in self and cross-repetitions. | Bard & Aylett: same attenuation in self and cross-repetitions. Trón: more attenuation in self-repetitions. | Inconclusive |

| Bard et al., 2000; Baumann & Hadelich, 2003, Kahn & Arnold, 2012. | Visual and linguistic giveness. | All agree in linguistic giveness leading to more attenuation than visual giveness. | Does not deny the contribution of semantics, but attribute a higher role to articulation. |
|---|---|---|---|
| Anderson & Howarth, 2002; Bard & Aylett, 2004; Bard et al., 2000; Fraundorf, Watson & Benjamin (under review); Watson et al., 2008. | Attenuation as a phenomenon of multiple sources | Anderson & Howarth, Bard & Aylett and Bard et al.: divergence between duration and referential expressions. Fraundorf, Watson & Benjamin: divergence between duration and intensity. Watson et al.: divergence between duration and pitch-related measures with intensity. | N/a: does not speak about the nature of attenuation, but rather that attenuation has multiple sources which can be more or less hard to control by the speaker. |

**Table 4.** Summary of factors influencing the attenuation phenomenon.

## 1.3.3    **Models on attenuation (and audience design)**

In the literature of attenuation, a number of hypotheses and models have been proposed to account for attenuation of information and its relationship with audience design (for instance, see Clark's principle of *Least Collaborative Effort* (1986), Jurafsky's *Probabilistic Reduction Hypothesis* (2001) or Aylett & Turk's (2004; 2006) *Smooth Signal Redundancy Hypothesis*, amongst others). However, I selected the most relevant ones for the purposes of the current dissertation.

I would like to start with *Lindblom's theory of hyper- and hypo-articulation* (1990). It embraces a simple idea: the speaker only needs to articulate clearly enough for the listener to understand him/her. If the listener can supplement the acoustic input with information from other sources, speakers would hypo-articulate. However, in case the context is not very supportive and listeners have trouble to decode the signal, speakers would hyper-articulate. This

situation can be observed, for instance, when a non-native speaker is involved in conversation. If the context is optimal (e.g.: if there is no noise) natives talking to natives would hypo-articulate. However, even if the context is optimal, if a native speaks with a non-native, natives might hyper-articulate to improve the quality of the signal.

On second place, the *Dual Process Model* (Brown & Dell, 1987; Dell & Brown, 1991; Bard et al., 2000) is centred in explaining attenuation through facilitation and audience design forces, which would take place subsequently. Speakers would default to attenuate driven by fast and automatic processes, this is, by priming. This makes speech production "egocentric" at first instance, as speakers would do what is easier for themselves (like attenuating predictable referents). On second instance, the needs of the audience (if any) might be considered. It depends on whether the speaker has enough resources and information about the listener. This is because audience design processes would be slow and elaborated.

Within the Dual Process Model, the best way to produce speech is in a sequential manner (this is, first egocentrically, and then, driven by audience design). This is because being driven by automatic processes would represent a cognitive benefit. I agree that in most cases conversation would be a smooth, trouble-free enterprise. However, in other occasions conversations might not be so easy, as when interacting with non-natives, children, elderly people, and non-experts about the topic of conversation, so on and so forth. The Dual Process Model assumes that the characteristics of the listener are considered only at late stages because they assume that generating models of the audience is an elaborated and resource-demanding process. In Bard and collaborator's words (2000) "*adapting to actual but less likely internal states may be an evolutionary and cognitive luxury*".

This idea contrasts with numerous evidence showing that a simple bit of

information would suffice to tailor utterances for listeners. For instance: "the listener is naïve or familiar to my story" (Galati & Brennan, 2010); "the listener can see what I am doing or cannot" (Brennan, 2005; Nadig & Sedivy, 2002); "the listener can reach the object of the conversation or cannot" (Hanna & Tanenhaus, 2004); "the listener is currently gazing at this object, or is not" (Hanna & Brennan, 2007); "the listener is distracted or is not" (Rosa et al., under review). In fact, this assumption of speakers not needing to make elaborated models of listeners to perform audience design is shared by Galati & Brennan's *for the speaker" and "for the addressee" hypotheses,* which is the third model that I will outline.

Galati & Brennan's *"for the speaker" and "for the addressee" hypotheses* (2010) of attenuation in conversation also acknowledges the presence of priming and audience design forces, but supports that egocentric and audience design forces contribute to attenuation in an interactive manner (rather than sequentially, as proposed by the Dual Process Model). This is because considering the needs of the listener would not be a costly process. In their study of 2010, Galati & Brennan assessed whether speakers attenuate because it is easier for them or because attenuation aids the listener. Participants in their experiment told the same story three times. Critically, the second time that the story was told it could be addressed to the same listener than the first time (old listener) or to a new (naïve) listener. Attenuation was measured in word duration, amount of detail in the stories, completeness of the story, word counts, perspectives used across narrations and intelligibility ratings. If speakers attenuate because it is easy for them (this is, if they are mainly led by priming), attenuation should occur from the first to the second time and from the second to the third time that the story was told, regardless of whether the listener was naïve or old. This is because information would be more accessible to the speaker, and attenuating would be the easiest thing to do. However, if speakers take into consideration the knowledge and needs

of the listener, re-tellings to naïve listeners should go through less reduction than to old listeners.

The results of Galati & Brennan showed that speakers were flexible to the needs of the listener, being more informative with naïve listeners compared to old listeners for all the considered measures (except for word duration, for which no attenuation was found). This study supports that considering the knowledge and the needs of the audience would be an easy and effortless task (as long as the needs of the audience are clear).

I would like to close the model's section talking about Watson's *Multi-Components model* (2008), to which I have referred before in this introduction. The model is based on the assumption that attenuation is a multiple-source phenomenon, in which different factors contribute to attenuation in diverse ways.

The model is built on production and comprehension evidence. Regarding production evidence, one of the most relevant studies is the Tic Tac Toe game (Watson et al., 2008, outlined in section 1.3.2.). In this study, authors aimed at disentangling the role that predictability and importance have in attenuation. Watson et al. (2008) found that words uttered in predictable moves were shorter and had lower pitch-related values than those words uttered in unpredictable moves. Also, words uttered in important moves had higher intensity than words uttered in unpredictable moves. In addition, Watson et al. (2008) found that disfluencies and intonational boundaries, which are linked to production difficulties, were more likely to occur for words related to unpredictable moves. This was taken as an indication of duration and pitch-related measures as being dominated by articulation, and intensity mostly linked to discourse-level factors.

Regarding the supportive evidence of the model coming from the comprehension side, Isaacs & Watson (2009) showed that the intensity of a

word, but not its duration, aids at making meta-linguistic judgments of acoustic prominence. The assumption of acoustic prominence being a multi-components phenomenon has found further support in experimental work as Galati and Brennan (2010), Lam and Watson (2010, experiment 2) and Fraundorf, Watson & Benjamin (under review).

As a matter of fact, the current dissertation gives further support to Watson's Multi-Components model (2008). Along the Experimental Sections, it will be showed how the different manifestations of attenuation chosen for this thesis (that is, duration, intensity, pitch, pitch excursion and pitch range) show different patterns depending on the manipulated variables (as linguistic status of listener, linguistic status of speaker, amount of information about the listener or communicative context).

Without further delay, now I will present the Experimental Section of the present work.

## 2 Experimental section: studies of audience design, attenuation of information and non-nativeness.

In the current dissertation, we use attenuation of information as a phenomenon of our interest *per se* and also as a means to explore several aspects of native/non-native interactions (to be described in more detail in the following lines).

We employed the same collaborative map task across experiments with slight modifications depending on the question of interest. In every experiment, participants (also called *instruction givers*) engaged in the map task in which they interacted with an *instruction receiver*. The instruction giver acted as the speaker, and the instruction receiver, as the listener. There were a total of eight objects in each map, with two objects linked through an arrow. The participant's task was to tell the listener which were the two linked objects and in which manner, providing instructions such as "go from the monkey to the bottle", allowing the instruction receiver to draw links in paper maps. Crucially for examining attenuation of information, each object was mentioned twice in different pairs-of-objects combinations, so it was possible to investigate how the signal was attenuated from the first to the second mention of the objects.

This setting generated 48 recorded sentences per participant, which were split in two mentions, giving a total of 96 words for each of the participants that took part in the studies reported in this thesis. The duration of each word was manually extracted using Praat version 5.13.5 (Boersma & Weenink, 2008), placing word boundaries at the nearest zero-crossing on the waveform. Intensity, pitch and pitch excursion were automatically generated by the software when selecting the word. Pitch range was calculated through

the subtraction of maximum and minimum pitch values.

Concretely, in Experimental Section 1 we aimed at exploring whether the linguistic status of instruction receivers, who could be native or non-native speakers of Spanish, interacted with the attenuation performed by native Spanish speakers. While I assume that both natives and non-natives would benefit from the pragmatic advantage of attenuation, the question lied in whether intelligibility loss would harm the comprehension of non-native speakers more than then comprehension of native speakers. That is, the pragmatic benefit and the intelligibility loss appear as two opposed forces acting in attenuation. In this scenario, natives could 1) minimize attenuation, 2) perform attenuation but compensate intelligibility loss with foreigner talk enhancements or 3) both minimizing attenuation while performing foreigner talk. In addition, instruction givers could have more or less information about non-natives, providing us with the perfect context to explore if the amount of available information that the speaker have influences the interaction between attenuation and foreigner talk.

In Experimental Section 2, non-native speakers performed two tasks. First, the collaborative map task in which non-natives acted as instruction givers for Spanish native instruction receivers. Second, they read aloud a text in Spanish which contained repeated items as a means to explore attenuation of information through repetition in the context of monologue. The aim of performing these tasks was to answer two questions. First, if non-native speakers are under the effects of attenuation as natives are both in a non-interactive (monologue) and in an interactive (dialogue) situation with a native speaker. The second question was whether communicative context influence overall acoustic properties and attenuation of information for both native and non-native speakers. Although there is recent evidence showing that non-native speakers are under the influence of attenuation for word

duration in monologue (see Baker et al., 2011), it is not clear whether non-native speakers would be subjected to attenuation in a real communicative scenario in which they have to give a clear message to the audience while dealing with their production difficulties.

Finally, in Experimental Section 3, we aimed at exploring a different issue than how linguistic status and attenuation of information interact, namely, whether attenuation of information answers to conceptual or articulatory modulations when speakers are involved in an interaction. Literature is unclear about this issue, so we believed that it was necessary to directly address this question. The logic of the Experimental Section 3, thus, is the following: if the origin of attenuation is semantic (that is, if attenuation is related the evocation of the same concept twice), the label of the referent would not matter as long as the speaker refers to the same item in two occasions. However, if the origin of attenuation is articulatory, attenuation would be observed only if the referent is named twice with the same label.

There is also the possibility that conceptual and articulatory modulatons co-occur. It this was to be true, the same object named with different labels would be attenuated, but the same object named with the same label would be even more attenuated.

We explored the nature of the attenuation of information phenomenon through the use of bilingualism, where the exact same object can be referred to with different labels depending on the language. Thus, in the study included in Experimental Section 3, bilingual Spanish-Catalan instruction givers performed the collaborative map task with a Spanish-Catalan bilingual instruction receiver, where the two mentions of an object could be uttered in the same language (Spanish or Catalan) or there could be a language switch between mentions, as indicated by a flag in the upper part of the screen.

Finally, the current dissertation constitutes an advance regarding previous literature because:

- It explores whether a phenomenon which is mainly claimed to be automatic (e.g.: Bard et al., 2000) as it is attenuation of information, can be actually modulated when the listener is in need of a clearer signal. That is, it addresses for the first time whether attenuation of information and audience design/foreigner talk can work together for the benefit of communication.

- It explores to what extent performing foreigner talk requires to have elaborated or simple information about the listener. This is relevant as it can be applied to second language acquisition programs and improve second language learning.

- It explores the attenuation of information phenomenon through the analysis of different manifestations of attenuation: shorter duration, lower intensity, lower pitch, lower pitch excursion and narrower pitch range. As some manifestations are argued to be solely driven by articulation (as duration, pitch and pitch excursion) and some also influenced by discursive or social factors (as intensity or pitch range; see Watson et al., 2008), the questions addressed in this dissertation are answered with a complete picture of how attenuation works depending on the manifestation.

- Assuming that non-native language production is more effortful than native language production, it is unknown whether non-natives master to attenuate information in a communicatively relevant situation. This is important due to the pragmatic benefit that attenuation has in order to follow the informational status of

referents in conversation.

— While researchers have been dedicated to describe the attenuation phenomenon (as how it is manifested and which predictability conditions are optimal for its occurrence), no studies exploring whether its presence answers to semantic or to articulatory facilitation have been reported. Knowing the origins of the phenomenon would help reserchers interested in attenuation to design tasks that get the most of their experimental questions.

## 2.1 Audience design through attenuation of information in native/non-native spoken interactions

Rodríguez-Cuadrado, S., Costa, A. (submitted). Audience design through attenuation of information in native/non-native interactions. *Journal of the Acoustic Society of America.*

# Audience design through attenuation of information in native/non-native spoken interactions

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When non-native speakers are involved in dialogue, native speakers adapt their speech to achieve communicative success. In the present work, we investigate whether native speakers take into consideration the non-native status of listeners through the performance of foreigner talk, and whether foreigner talk interacts with attenuation of information. Attenuation of information means that when words are predictable they are reduced along several variables, being our focus duration, intensity and pitch-related measures. Crucially, this reduction has a pragmatic benefit, which is signaling the informational status of words (new vs. old), but also leads to intelligibility loss. As the foreigner talk effect shows that natives adapt to the linguistic status of addressees, our question relates to whether speakers prevent attenuation of information in order to preserve intelligibility, or whether speakers attenuate to signal informational status while enhancing speech through foreigner talk. Pairs or speakers engaged in a map referential task in which objects were mentioned twice, where native speakers talked either to another native or to a non-native. Results showed that native speakers perform foreigner talk over non-native speakers and attenuate second mentions of words, but fail to prevent attenuation of information when speaking to non-natives.

# INTRODUCTION

When speakers are involved in dialogue, they adapt to each other (see, for instance, Brennan & Clark, 1996; Cleland & Pickering, 2003; Giles et al., 1991; Neumann & Strack, 2000; Pardo et al., 2006). These adaptations are the key of successful interactions. The adaptations that speakers make depend on several issues, being the linguistic status of the listener a very relevant factor for the current work. This is, we tailor our messages depending on the person we are talking to. For instance, if we were to explain a cake recipe to a friend who knows how to cook, we would probably use specific vocabulary while being less detailed in the different processes involved in cooking. However, if our friend does not know how to cook, we would use general terms and explain every step in detail. Now imagine that we are talking to a non-native speaker. Even if he/she knows how to cook, we would likely avoid specific terms (e.g.: *lemon zest*) and use general terms and descriptions (e.g.: *just grate the lemon and put the tiny bits in the mix*). We might also speak slower, use simpler syntactic constructions and offer explanations.

The process of tailoring utterances and/or modify the speech register considering the characteristics and needs of the listener is known as *audience design* (Clark & Carlson, 1982; Clark & Murphy, 1982). If the listener is a non-native speaker of the language, those modifications are called *foreigner talk* (e.g.: see Campbell, 1977). Among the defining features of foreigner talk (for a review see Wooldridge, 2001), native speakers talking to non-natives generally speak slower, louder and have less vowel reduction than when talking to natives. Idiomatic expressions are avoided and high frequency words are used. Syntactic constructions are simple, using mostly present tense; speech is accompanied with gestures, and more repetitions and clarifications are included (Arthur et al., 1980; Ferguson, 1971; Henzl, 1979; Long, 1983; Nelson, 1992; Ramamurti, 1980; Tarone, 1980).

In this article, we explore the interaction of foreigner talk with a pervasive phenomenon in conversations, namely *attenuation of information*. In particular, we assess whether attenuation of information can be modulated by the linguistic status of the addressee. Attenuation of information, although providing with an important pragmatic benefit for the listener (this is, signaling the informational status of words), can have harmful effects on the comprehension of the non-native. This is because the non-native speaker might need a clearer signal to understand the language than the native.

In the current introduction, we will first describe the attenuation of information phenomenon. Then, we will justify why attenuation might work differently depending on the characteristics of the listener and outline how attenuation might interact with foreigner talk. Also, we will address the issue of whether having more or less information about the listener influences both foreigner talk and attenuation of information. To conclude, we will summarize our research questions and predictions.

*On the attenuation of information phenomenon*

Attenuation of information refers to the reduction of words produced in a given context when they are more or less predictable. There are several factors making words predictable. For instance, word frequency, as high frequency words are more predictable than low frequency words and hence they are produced in an attenuated fashion (Aylett & Turk, 2004; Baker & Bradlow, 2009; Baker et al., 2011; Bell et al., 2002; Fidelholtz, 1975; Jurafsky et al., 2001; Zipf, 1929). Other factor supporting attenuation of information is repetition. When information is introduced, it becomes predictable and thus reduced (this is also known as "repetition or change in the discourse status from *new* to *old*"). Word repetition is the type of predictability that we

will assess in the current work. Also, some sentence contexts lead to attenuation, together with the conditional and joint probability of words (for more on repetition, sentence context and joint and conditional probability of words leading to attenuation see Baker & Bradlow, 2009; Bell et al., 2001; 2002; Fowler, 1987; Hunnicutt, 1985; Jespersen, O., 1923; Jurafsky et al., 1998; 2001; Ladd, 2008; Lieberman, 1963; Prince, 1981).

Regarding the ways in which attenuation of information is manifested, it is known that predictable words have shorter durations and reduced intensity compared to unpredictable words. Also, words have lower mean pitch and lower pitch excursion (being pitch excursion the maximum pitch value within a word) and narrower pitch range (being the difference between maximum and minimum pitch values of a word; see Baker & Bradlow, 2009; Bell et al., 2002, 2003; Clark & Haviland, 1977; Fowler & Housum, 1987; Gregory et al., 1999; Lieberman, 1963; Samuel & Troicki, 1998; Watson et al., 2008). Attenuation is also manifested in consonant deletion (Bybee, 2000) and shortening of referential expressions (Ariel, 1990; Chafe, 1976; Galati & Brennan, 2010; Grosz et al. 1995; Gundel et al., 1993). Fundamentally, as a consequence of attenuation, words lose intelligibility (Bard & Aylett, 1999; Fowler & Housum, 1987; Lieberman, 1963), which could affect the understanding of the listener.

In addition, attenuation of information seems to be a strong effect that cannot be explained just by articulatory priming. When speakers read repeated words on a list, if the target word has been primed by a homophone, or if the second mention of a word refers to a new item of the same type, attenuation is not observed (Bard et al., 1989; Fowler, 1988). In addition, attenuation has been found when second mentions are anaphors of the target word (Fowler & Housum, 1987; McKoon & Ratcliff, 1980), when first and second mentions are uttered by different speakers or addressed to

different listeners (Anderson & Howarth, 2002; Bard et al., 2000; Bard & Aylett, 2004), and even when the first presentation of a word is not auditory, but visual (e.g.: Bard et al., 2000). Another characteristic of attenuation which is of special importance for the current work is that attenuation has been also found when speakers perform the *clear speech* register (Baker & Bradlow, 2009). Clear speech refers to those enhancements made by speakers when they are aware that listeners have a perceptual difficulty. We will go back to this issue later.

In the current work, we will address how attenuation of information is sensitive to the linguistic status of the listener through a version of Fraundorf, Watson & Benjamin's collaborative map task (Fraundorf, Watson & Benjamin, under review). The task involves a pair of speakers, one being the instruction giver and other being the instruction receiver. As it will be explained in detail in the methods section, the participant (or instruction giver) has pairs of objects linked by an arrow in a display of eight elements. His/her task is to tell the instruction receiver which objects are linked and in which manner (this is, following the direction of the arrow). Crucially, objects are mentioned twice, so we can investigate attenuation of information effects through previous mention and examine reduction for duration, intensity, pitch, pitch excursion and pitch range.

*Benefits and drawbacks of performing attenuation of information*

Attenuation of information is beneficial for the understanding of the listener, as it helps to keep track of the informational status of words indexing that the speaker is referring to the same entity than previously. This would suggest that at least one of the origins of attenuation of information is to promote understanding during conversations. Fowler & Housum (1987) presented first and second mentions of words to listeners who had to guess

whether the utterance was new or old. Participants showed that they were able to track the informational status of words based on an attenuated signal. Congruently, as new utterances tend to be accented and old utterances tend to be deaccented, Birch & Clifton (1995) found that listeners' understanding was better when new information was accented and given information deaccented. In addition, Terken & Noteboom (1987) found that accenting given information and deaccenting new information slowed reaction times. This evidence indicates that attenuated forms signal informational status. However, the other side of the coin reveals that attenuating information carries a decrease in intelligibility, as the signal loses clarity when the word is uttered for a second time (e.g.: Anderson & Howarth, 2002; Bard et al., 2000). This does not seem to be problematic for conversations in which two native speakers of a language are involved, where the pragmatic benefit of attenuation compensates intelligibility loss. However, would this be the case when a non-native speaker is involved in conversation? Even though we believe that it is likely that non-native speakers also benefit from the signaling of informational status, intelligibility loss can be more harmful for the non-native than for the native due to the potential language difficulties that the non-native might have.

The work of Bradlow & Alexander (2007) supports the possibility that non-native speakers benefit from the pragmatic aid of attenuation. In their study, native and non-native listeners performed a sentence-in-noise recognition task, finding that non-native listeners were as able as natives to benefit from contextual information when provided with a sufficiently clear signal. Then, Bradlow & Alexander's (2007) study suggests that non-native speakers might benefit as natives from the pragmatic aid of attenuation. However, even though non-natives were as able as natives to follow discourse status, it is still possible that they had trouble to decode the acoustic signal when this is attenuated due to potential difficulties in their second language. For instance,

non-native speakers performed worse than native speakers in speech recognition studies that provided with background noise or reverberation. But when listening conditions were more favorable, non-natives and natives performed alike (see, for instance, Nábelek and Donahue, 1984; Takata and Nábelek, 1990; Mayo et al., 1997; Meador et al., 2000; Rogers et al., 2006). This poorer performance could be explained by the lower experience of the non-native at any level of language (Bradlow & Alexander, 2007). If the lower experience of non-natives jeopardized their speech comprehension, the pragmatic contribution of attenuation might be irrelevant as long as the listener is not able to decode the words.

Therefore, the question that arises at this point is: what are the role of the pragmatic contribution and the intelligibility loss of attenuation when a native speaker interacts with a non-native listener? We consider three possibilities. First, in case that tracking the informational status of words was more relevant to comprehend the message that keeping a clear signal, native speakers should attenuate to the same extent or even to a bigger extent when talking to non-natives than when talking to natives in order to facilitate their comprehension. Second, if intelligibility loss has a larger impact on the understanding of the non-native than the signaling of informational status, native speakers should either not to attenuate or attenuating less for non-natives than when talking to a native. The third possibility is that attenuation of information and audience design/foreigner talk co-occurred. That is, native speakers would perform foreigner talk to non-native listeners, which would enhance non-natives' overall comprehension, while attenuating predictable words so listeners can also track the informational status of words. This way, the intelligibility loss of attenuation might not be very harmful, as the signal is enhanced in first instance through foreigner talk. As a matter of fact, it is known that attenuation of information and another special speech register as it is *clear speech* interact, at least in the context of

monologue. *Clear speech* refers to a special speech register performed when speakers believe that listeners have perceptual difficulties (see Uchanski, 2005 and Smiljanić and Bradlow, 2009).

Of special relevance is the study of Baker & Bradlow (2009), which assessed how probability factors (such as word frequency and second mention repetition) interacted with speech style (plain or clear speech). The authors frame their work within *Lindblom's hyper- and hypo-articulation theory* (1990), which states that the speaker only needs to articulate clearly enough to ensure that the listener will be able to distinguish his/her intended words from other words. If speakers believe that listeners will understand them without problems, they will likely use a plain speech style and hypo-articulate. But if speakers believe that listeners might not understand them so well, they might hyper-articulate.

Then, attenuation of information promotes hypo-articulation and clear speech promotes hyper-articulation. As the two forces may converge in conversation when the listening conditions are not optimal for the audience, Baker & Bradlow (2009) examined whether attenuation behaves the same or differently in a speech style used when there are no listening problems (plain speech) and when there are listening problems (clear speech). Attenuation for word duration was present in plain and clear speech when speakers read a text. Speakers uttered longer words in clear compared to plain speech, but the size of the attenuation was comparable between speech styles. Therefore, it shows that although clear speech involves overall hyper-articulation, it allows for hypo-articulation of predictable words. Even though the work of Baker & Bradlow (2009) is of crucial relevance for our question of whether attenuation of information and foreigner talk interact in dialogue, it is important to keep in mind that Baker & Bradlow's study (2009) is developed on the context of monologue. Then, it is not immediately obvious that the

same outcome would be observed in our case. In Baker & Bradlow's study (2009), participants read texts that contained predictable words (either frequent or repeated) *as if* they were speaking to a friend (plain speech) or to a person with listening impairments/ non-native listener (clear speech), where our work is developed in face-to-face interactions. Then, in our case, the use of speech enhancements is relevant to the task as participants are really interacting, contrary to Baker & Bradlow's study. Also, Baker & Bradlow (2009) limit their study to attenuation for duration, where we extend it to intensity and to pitch-related measures. Relevantly, we believe that intensity might be useful to assess the social component of foreigner talk and attenuation, as it has been proved to be discourse-relevant (Watson 2008). Taking together the findings of Baker & Bradlow (2009) supporting the interaction between special speech registers and attenuation, and those from Bradlow & Alexander (2007) showing that non-native speakers are able to use contextual information as natives, we believe that it would be not only possible, but also beneficial, that native speakers attenuated both when speaking to natives and when speaking to non-natives (due to its pragmatic utility) while performed foreigner talk on non-natives to enhance the clarity of the signal.

*Amount of information about the listener and its relation with foreigner talk and attenuation*

The second issue that we aim at exploring in the current work relates to whether the amount of information that speakers have about listeners shape their likelihood to perform foreigner talk and attenuation of information. Studies about audience design typically give simple information to the speaker about the needs of the audience, as for instance, if the listener has access to the mentioned object or not (e.g.: see Bard et al., 2000; Bard & Aylett, 2004) or if the listener knows the story that the speaker is telling or

not (as in Galati & Brennan, 2010). Comparing how having different amounts of information about the needs of the listener impact the design of speakers' utterances would be informative about how much speakers need to know in order to consider the needs of the partner. Also, it would inform us about how easy/costly is for speakers to incorporate that information. As Galati and Brennan pointed out in the final lines of their work from 2010, *"It is not yet clear just how simple the partner-specific information need be in order for audience design to be computationally feasible in spontaneous spoken communication"*.

To address this question, native speakers could interact with two different types of non-native addressees. These two types differed in the amount information and feedback that gave to the native speaker. For the sake of simplicity, we will refer to these groups as *no information* and *information* groups. In the no information group, native participants only knew that the addressee (or instruction receiver) was an English native speaker who spoke Spanish as a second language. This was told by the experimenter to the native speaker right before the study started. In the information group, the participant received more information about the addressee at two points in time. First, when participants were being introduced by the experimenter, she asked to the non-native for how long he lived in Spain (the answer of the addressee was always "for about a year"). Secondly, while dyads were performing the task, there were six items marked by the experimenter and randomly distributed across participants in which the addressee asked for clarification. That is, there were six occasions during the experiment where, once the native participants gave the instruction, the addressee showed confusion through questions like "from where did you say? /to where did you say?".

Our predictions regarding how information might impact the native speaker are the following. If native speakers generate elaborated models of their

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non-native partner, where the more information, the better, foreigner talk would be more likely to be observed for the information group compared to the no information group. Predictions regarding attenuation depend on what is the most optimal outcome for listeners. If it is listening to attenuated forms, more attenuation should be observed in the information compared to the no information group. If attenuated forms mislead non-native listeners, less attenuation should be performed when natives talk to non-natives in the information group. However, if native speakers elaborate simple (rather than complex) models about listeners, just knowing that their addresses are not natives would suffice to perform foreigner talk and to adapt attenuation to the most beneficial outcome for the listeners (this is, to attenuate or not to attenuate). Then, no differences (or minor differences) in foreigner talk and attenuation of information should be observed between no information and information groups.

To sum up, the two main objectives and predictions of the current work are the following. First, to see whether audience design and attenuation of information interact in a communicative context. We contemplated three possibilities. First, that native speakers would attenuate for non-natives to the same extent or even more than when they talked to natives, due to the relevance of signaling the informational status of words. Second, that natives would not attenuate when talking to non-natives in order to preserve intelligibility. Third, that natives would attenuate when talking to non-natives but would also perform foreigner talk to compensate for intelligibility loss. We subscribe to this third possibility due to the numerous evidence supporting foreigner talk (Campbell, 1977; Ferguson, 1971; James, 1986; Lattey, 1981) and the interaction between attenuation of information and clear speech (as Baker & Bradlow, 2009). We hold this prediction especially for the case of word duration (as previous research has focused on this indicator) being less clear whether it would apply for intensity and pitch-

related measures (as this is the first time that intensity, pitch, pitch excursion and pitch range are investigated in this context). Secondly, we aim at seeing whether the amount of information that native speakers have about the non-native listener shapes foreigner talk and attenuation of information. As most research has simply manipulated "either/or" cues (as "the listener can see what I am doing, or can not" (Brennan, 2005; Nadig & Sedivy, 2002) or "the addressee is currently gazing at this object or, is not" (Hanna & Brennan, 2007), we can not be sure about the impact that providing with a larger amount of information would have on attenuation and its interaction with foreigner talk. Nevertheless, we hypothesize that, at least for what concerns foreigner talk, native speakers would perform more foreigner talk enhancements (in the shape, for instance, of longer durations or higher intensities) for the information group than for the no information group.

METHOD

*Participants*

Natives talking to natives

15 Spanish native speakers (mean age: 25.4 years, sd: 4.2; 9 female, 6 male) took part in the experiment. They received 7 euro for their participation. All participants had normal or corrected-to-normal vision and none of the participants reported having any speech or hearing impairments. Participants were recruited from the Universitat Pompeu Fabra subjects' data base.

Natives talking to non-natives

28 Spanish native speakers (mean age: 30.66 years, sd: 7.42; 15 female, 13 male) took part in the experiment. They received 7 euro for their

participation. All participants had normal or corrected-to-normal vision and none of the participants reported having any speech or hearing impairments. Participants were recruited from the Universitat Pompeu Fabra subjects' data base. 14 participants were assigned to the no information group, and 13 to the information group (originally, there were 14 participants in the information group, but one participant was removed due to deviant speech rate). Original distributions of gender and age were even between the no information and information groups.

*Materials & Method*

In order to examine participants' utterances regarding attenuation for duration, intensity, pitch, pitch excursion and pitch range from first to second mention of words, we adapted Fraundorf, Watson and Benjamin's (under review) collaborative map task. In this task, the participant acted as the instruction giver, and a confederate as the instruction receiver.

The instruction giver was presented with a sequence of 6 maps (plus a practice map) displayed on a computer screen using DMDX (Forster & Forster, 2003). In each map, there were two arrays of four objects, four displayed in a string in the upper part of the map and four in the lower part, where two objects were linked in eight consecutive steps per map. Each object was involved in two different links, whose direction could be horizontal (two objects in the same string in the upper or lower part of the screen), vertical (two objects in the same axis in different strings from the upper to the lower or from the lower to the upper part of the screen) or diagonal (two objects in different axis in different strings from the upper to the lower or from the lower to the upper part of the screen).
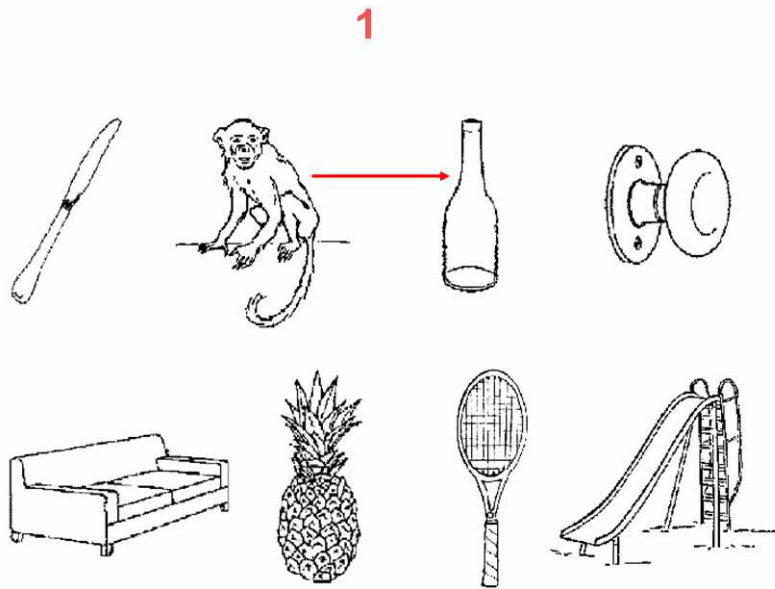
**Figure 7.** Example of the instruction giver's map.

The instruction receiver (confederate) had exactly the same 6 maps (plus the practice map) as the instruction giver, printed on paper and with no links between the objects. The task of the instruction giver was to tell the instruction receiver which were the two linked objects and in which direction, giving instructions aloud of the type "go from the monkey (object 1) to the bottle (object 2)". The task of the instruction receiver was, after hearing each instruction, to draw an arrow linking the two mentioned objects. Each step in the map remained on the screen until the instruction giver pressed the spacebar once the instruction was uttered. Participants were seated face to face in a soundproof booth. The instruction giver could not see the instruction receiver's map and the instruction receiver could not see the instruction giver's screen (the screen of the laptop acted as a visual barrier which allowed participants to see their faces but not each other's

screen or map).

Items consisted of 48 Spanish words which were mentioned twice. Items were randomly distributed regarding 1) to which map did the words/objects belong; 2) in which order the objects were displayed in the map's arrays; 3) the order in which they were mentioned and 4) the item they were paired with. Those items that were mentioned in first place within the sentence of instruction were uttered in second place for the half of the participants (this is, half said "from the monkey to the bottle" and the other half "from the bottle to the monkey"). In addition, repetitions were not immediate but there were between 1 and 13 intervening words between mentions, depending on the randomization in the mention order. Drawings were selected from several sources (including the Snodgrass database (Snodgrass & Vanderwart, 1980) and the International Picture Naming Project (Szekely et al., 2004).

Utterances were recorded, labeled and analyzed using Praat version 5.3.15 (Boersma & Weenink, 2008), obtaining duration (milliseconds), intensity (decibels), pitch (hertz), pitch excursion (hertz) and pitch range (hertz) values for each utterance. Analyses of utterances were blind to the experimenter. There were a total of 96 utterances per participant (6 maps x 8 objects per map x 2 mentions per object). The task lasted approximately 20 minutes.

## RESULTS

*Data analyses*

Utterances were extracted, labeled and analyzed using Praat version 5.3.15 (Boersma & Weenink, 2008). Each instruction was saved in an audio-file, there being a total of 48 audio-files per participant (each one containing two utterances of different objects). At the time of extracting the duration (in milliseconds), intensity (in decibels), pitch (in hertz), pitch excursion (in

hertz) and pitch range (in hertz, subtracting maximum minus minimum pitch) values for each utterance, the order in which audio-files were analyzed was randomized. This way it was ensured that the experimenter was blind to the number of mention of the item. Duration values were extracted manually using both the waveform and the spectrogram. Word boundaries were placed at the nearest zero-crossing on the waveform. Intensity and pitch-related values for each word were automatically provided by the software once duration was selected.

Utterances that contained disfluencies or occurred after disfluencies, had background noise or contained speech errors were eliminated along with their mention-pairs.

*Results*

The aim of the present work is to examine 1) whether both natives talking to native addressees and natives talking to non-native addressees in the no information and information groups show attenuation of information and 2) whether the amount of performed foreigner talk and attenuation (if any) varies depending on the linguistic status of the addressee and to the membership to the no information or information group. Repeated measures ANOVAs were conducted for duration, intensity, pitch, pitch excursion and pitch range, with *mention* (first or second) as a within-subjects variable and *group* (natives talking to natives, natives talking to non-natives in the no information group and natives talking to non-natives in the information group) as a between- subjects variable.

*Duration*

Results revealed a main effect of mention ($F_1(1, 39) : 72.418$, $p < .001$; $F_2(1, 141) : 80.226$, $p < .001$), showing that first mentions had longer durations than second mentions, then finding attenuation of information for duration

(see Figure 8). There was also a main effect of group ($F_1$(2, 39) : 12.415, $p$ < .001; $F_2$(2, 141) : 33.870, $p$ < .001), where Bonferroni post-hoc analyses showed that natives talking to natives significantly differed in their duration values from natives talking to non-natives in both the no information ($p_1$ : .002; $p_2$ : < .001) and the information groups ( $p$ < .001 by item and by mention). Concretely, natives, when talking to non-natives either in the no information or in the information group, spoke slower than when talking to a native, being an indicator of foreigner talk (see Table 5). There were no differences in duration between the no information and the information groups. Finally, the mention x group interaction was not significant, revealing that attenuation was not affected by the audience towards which the speaker uttered the instructions (natives, non-natives in the no information group or natives in the information group).
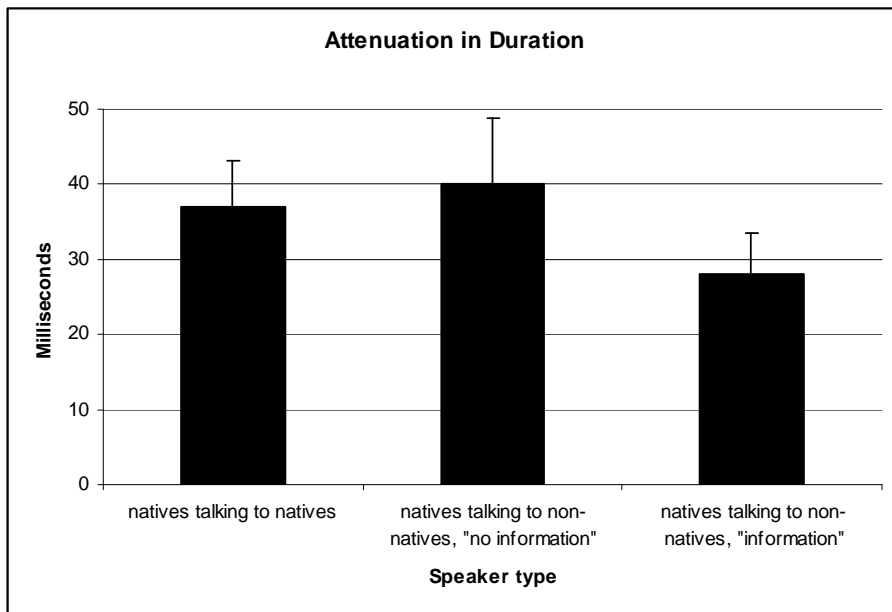


**Figure 8.** Size of the attenuation in word duration by speaker type. Error bars represent standard errors of the mean.

*Intensity*

Results showed a main effect of mention ($F_1(1, 39) : 104.229$, $p < .001$; $F_2(1, 141) : 147.113$, $p < .001$), where first mentions were uttered with higher intensity than second mentions, thus revealing attenuation for intensity (see Figure 9). The main effect of group ($F_1(2, 39) : 6.399$, $p: .004$; $F_2(2, 141) : 232.433$, $p < .001$) indicated, through Bonferroni post-hoc comparisons, that natives talking to non-natives either in the no information ($p_1 : .007$; $p_2 : <.001$) or in the information ($p_1 : .021$; $p_2 : <.001$) group, spoke with higher intensity than when talking to natives. This constitutes an indicator of foreigner talk (see Table 5). The mention x group interaction was significant ($F_1(2, 39) : 4.765$, $p : .014$; $F_2(2, 141) : 5.371$, $p : .006$), showing that foreigner talk enhancements were present in both first and second mentions (natives speaking to non-natives in the no information group for first mentions ($p_1 : .009$; $p_2 : <.001$) and for second mentions ($p_1 : .006$; $p_2 : <.001$); natives speaking to non-natives in the information group for first mentions ($p_1 : .027$; $p_2 : <.001$) and for second mentions ($p_1 : .017$; $p_2 : <.001$). However, in order to see whether natives differed in the amount of attenuation performed depending on the audience, t-tests were run comparing attenuation sizes for natives talking to natives, natives talking to non-natives in the no information group and natives talking to non-natives in the information group. Results revealed that native speakers attenuated less when talking to non-natives regardless of whether they belonged to the no information or to the information group (natives versus non-natives in the no information group, $t_1(27) : 2.754$, $p : .010$; $t_2(47) : 3.142$, $p : .003$; natives versus non-natives in the information group, $t_1(26) : 2.697$, $p : .012$; $t_2(47) : 2.480$, $p : .017$). No information and information groups did not differ between them.
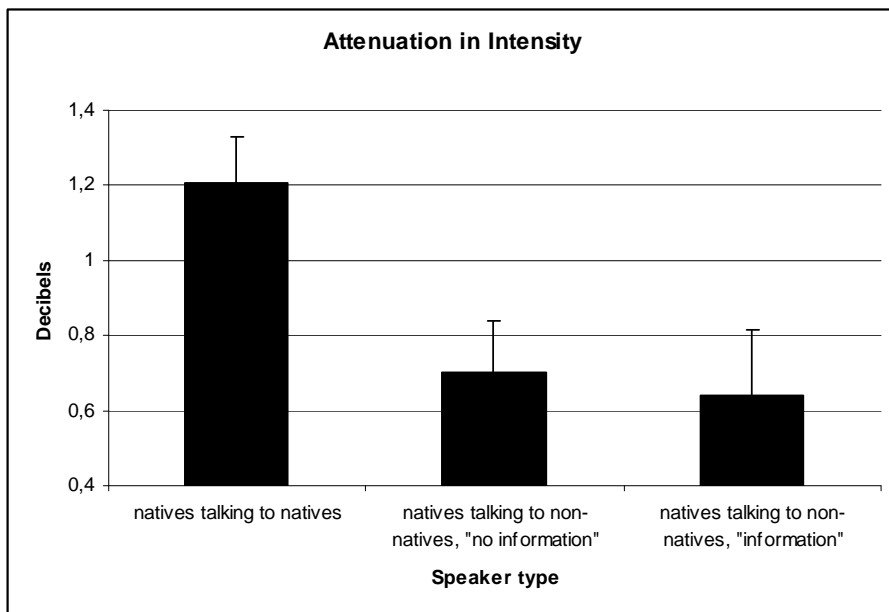
**Figure 9.** Size of the attenuation in word intensity by speaker type. Error bars represent standard errors of the mean.

*Pitch*

There was a main effect of mention ($F_1(1, 39) : 425.382$, $p < .001$; $F_2(1, 141) : 60.229$, $p < .001$), where first mentions had higher pitch values than second mentions, showing attenuation of information for pitch (see Figure 10). There was no effect of group by subjects, but there was by item ($F_2(2, 141) : 22.218$, $p < .001$) being an indicative of foreigner talk for pitch (see Table 5). Finally, there was no mention x group interaction, so attenuation for pitch did not vary depending on the audience.
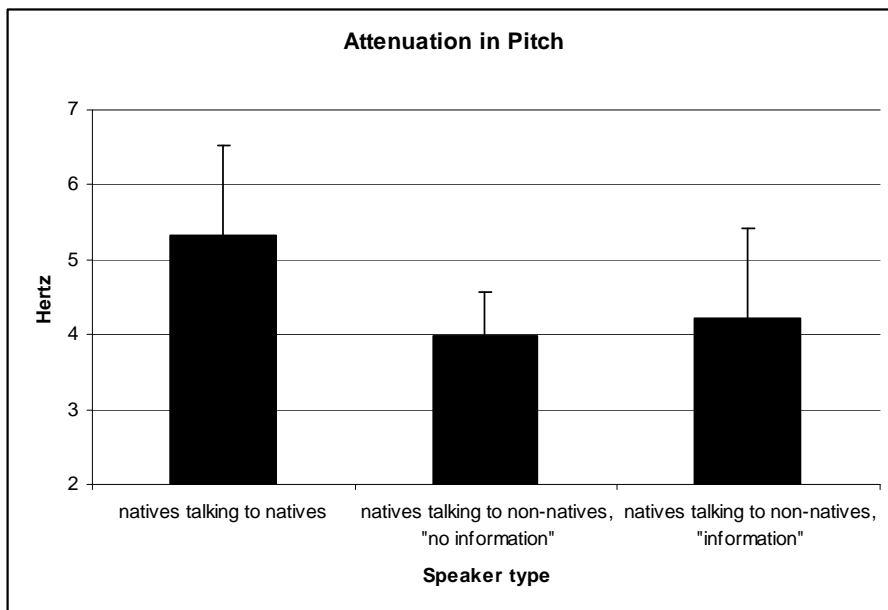
**Figure 10.** Size of the attenuation in word pitch by speaker type. Error bars represent standard errors of the mean.

*Pitch excursion*

Results showed a main effect of mention ($F_1(1, 39) : 25.293$, $p < .001$; $F_2(1, 141) : 28.541$, $p < .001$), where first mentions had higher pitch excursion values than second mentions, revealing attenuation in pitch excursion (see Figure 11). There was no main effect of group by subject, but there was by item ($F_2(2, 141) : 43.206$, $p < .001$), so foreigner talk effects were observed for pitch excursion (by item only; see Table 5). The mention x group interaction was not significant, therefore, attenuation effects for pitch excursion did not vary depending on the audience.
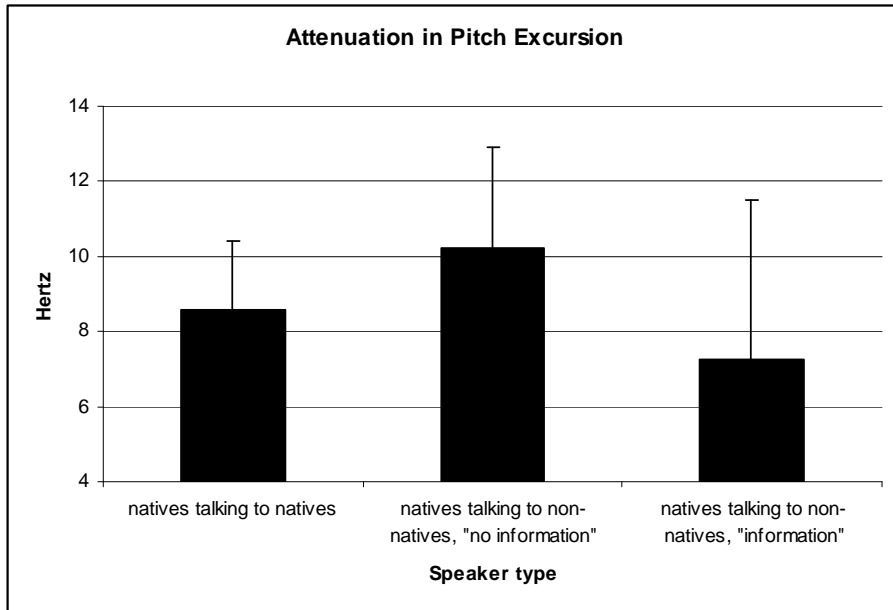
**Figure 11.** Size of the attenuation in word pitch excursion by speaker type. Error bars represent standard errors of the mean.

*Pitch range*

The main effect of mention was significant ($F_1$(1, 39) : 13.940, $p$ : .001; $F_2$(1, 141) : 15.261, $p < .001$), indicating that first mentions had higher pitch range values than second mentions, thus showing attenuation for pitch range (see Figure 12). There was a main effect of group ($F_1$ (2, 39) : 13.951, $p < .001$; $F_2$ (2, 141) : 48.817, $p < .001$), which indicated, through Bonferroni post-hoc comparisons, that natives when talking to non-natives displayed significantly wider pitch ranges, regardless of whether they belong to the no information ($p_1$ : .002; $p_2$ : < .001) or to the information ($p_1$ : < .001; $p_2$ : < .001) group. This reveals foreigner talk effects for pitch range (see Table 5). Finally, there was no mention x group interaction, so attenuation in pitch range did not vary depending on the audience towards which native speakers addressed the instructions.
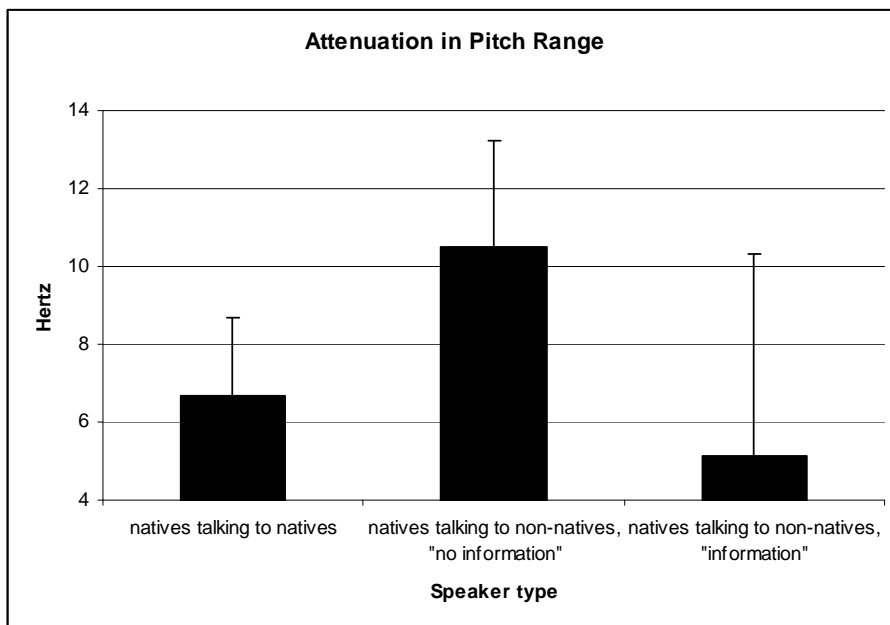
**Figure 12.** Size of the attenuation in word pitch range by speaker type. Error bars represent standard errors of the mean.

| | natives to natives | | natives to non-natives ("no information") | | natives to non-natives (" information") | |
|---|---|---|---|---|---|---|
| | 1st mention | 2nd mention | 1st mention | 2nd mention | 1st mention | 2nd mention |
| **Duration** | 421 (15) | 384 (13) | 513 (17) | 473 (17) | 533 (20) | 505 (23) |
| **Intensity** | 48.77 (.55) | 47.56 (.58) | 59.19 (2.89) | 58.49 (2.89) | 57.98 (3.04) | 57.34 (3.04) |
| **Pitch** | 172 (11.25) | 167 (11.20) | 184 (10.61) | 180 (10.40) | 189 (13.63) | 185 (12.84) |
| **Pitch excursion** | 208 (12.39) | 200 (12.73) | 236 (9.86) | 226 (10.46) | 248 (17.03) | 241 (13.22) |
| **Pitch range** | 66 (4.25) | 60 (4.65) | 94 (4.51) | 83 (4.62) | 102 (8.62) | 97 (5.13) |

**Table 5.** Summary of attenuation of information results for across groups and measures. Standard deviations are shown into brackets.

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DISCUSSION

In this study, we aimed at answering two questions. First, whether foreigner talk and attenuation of information interact in a communicative scenario. Secondly, if the information that native speakers have about the non-native listener shapes foreigner talk and attenuation of information. We did so by asking participants to perform a collaborative referential map task, in which a native speaker gave directions aloud to a native or to a non-native confederate. Certain properties known to be subjected to the effects of predictability by repetition were examined, such as duration, intensity, pitch, pitch excursion and pitch range. Concretely, the task was completed by three different groups of participants: natives talking to natives, natives talking to non-natives with little information about the listener, and natives talking to non-natives with information and feedback about the listener. The main results reported in this article are the following. First, native speakers attenuated second mentions of words for all the considered measures when talking to another native, but when natives talked to non-natives, there was attenuation for duration and pitch-related values, but not for intensity. Secondly, native speakers performed foreigner talk for non-natives across all indicators (but for duration, intensity and pitch-range in the analysis by subjects). Finally, the information that the native speaker had about the non-native did not shape neither foreigner talk nor attenuation of information.

*Do audience design and attenuation of information interact in communicative scenario?*

The presence of foreigner talk (as a means of audience design) indicates that native speakers took into consideration the linguistic status of listeners. When native speakers talked to non-natives, words were longer, higher in intensity, higher in pitch and in pitch excursion and had wider pitch range than when they talked to natives. That is, native speakers acknowledged the

non-native status of listeners speaking slower, louder, with a higher tone and more animatedly than when they spoke to non-natives. This evidence goes along with previous findings on foreigner talk for duration and intensity (Chaudron, 1979; Henzl, 1979; Nelson, 1992; Ramamurti, 1980). Importantly, attenuation of information was present for all the indicators. That is, native speakers reduced the duration, intensity, pitch, pitch excursion and pitch range of words when these were repeated.

Regarding whether attenuation of information and audience design interact, starting with duration, results showed that attenuation was performed regardless of the audience. This is, native speakers performed foreigner talk for non-natives but attenuated in duration both for natives and for non-natives. In the case of intensity, it was showed that native speakers attenuated less for intensity when speaking to non-natives than when speaking to natives. We believe that native speakers signaled the informational status of words through other indicators as duration, and that the lack of attenuation in intensity served to highlight the importance of the object for the correct performance of the task. This way, native speakers may ensure that non-native listeners understand their message while following the task. For pitch-related measures, as in duration, natives performed foreigner talk for non-natives but attenuated as when talking to natives.


Therefore, it can be stated that native speakers consider the needs of addressees through the performance of foreigner talk on first instance. Also, attenuation in intensity is prevented, so the relevance of the items is kept constant while marking given status through indicators more related to production than to social variables (such as duration and pitch-related variables). This would suggest that non-natives could also benefit from the signaling of informational status, and, although there is a loss of intelligibility, it would not hamper communication. Nevertheless, to be more confident about this affirmation, real participants acting as instruction

followers would be needed. This would allow to check non-native's comprehensibility along the task employing different measures: for instance, checking how well non-native listeners performed the task, the number of clarifications asked, or obtaining reports from the participants about how easy/hard was for them to follow the native speaker's instructions. We believe this would be an informative step to be taken in order to get to a better understanding about how attenuation affects to the non-native audience.

Our results replicate the attenuation of information effect in a communicative scenario across all the considered measures in both native/native and in native/non-native interactions. This constitutes, to our knowledge, the first evidence showing that native speakers perform attenuation for non-native speakers while enhancing the clarity of the signal through foreigner talk. Furthermore, it shows that for that indicators being more under the speaker's control (this is, not only related to production processes as it is intensity), speakers modulate attenuation for non-natives.

But, why is there a dissociation between intensity and duration and pitch-related measures? A possibility is that intensity is linked to discourse-related factors (see Fraundorf, Watson & Benjamin, under review, or Watson et al., 2008) and thus it would be more susceptible to be modified socially. *Watson's Multi-Components model* (2008) acknowledges that different factors might contribute to attenuation, some of a more articulatory and some of a more discoursive nature. For instance, Watson and collaborators (2008) disentangled the role that predictability and importance have in attenuation through a Tic Tac Toe game, where important movements (those which block or win the game) are also very predictable. Watson et al. (2008) found that duration and pitch-related variables were related to how predictable the movement was (predictable words were shorter and had lower pitch than unpredictable words), and intensity to how important the movement was

(unimportant words had lower intensity than important words). Then, intensity was used to signal importance in a task, being reasonable to believe that this is the case when native speakers address instructions to non-native listeners. As duration and pitch-related variables were linked to production processes, it suggests that articulation would be more under the influence of egocentric forces. Also, as intensity was not related to disfluencies or intonational boundaries, it would serve as a cue for assisting the listener (for more evidence in support of the Multi-Components model, see Fraundorf, Watson & Benjamin, under review; Galati & Brennan, 2010; Isaacs & Watson, 2009, 2010; Lam & Watson, 2010). For pitch-related measures, no interaction was observed between attenuation of information and foreigner talk. This matches the proposal of Watson and collaborators (2008) for which duration and pitch-related measures would be more linked to production processes and then, harder to control and to modulate for the listener. Then, attenuation for duration and pitch-related measures could be somehow unavoidable regardless of whether native speakers interacted with another native or with a non-native speaker.

*Does amount of information matters?*

The question of whether the information that the speaker has about the non-native listener impacts production is approached in two ways. First, through examining whether the no information or the information group was more susceptible to receive foreigner talk modifications than the native listeners' group across duration, intensity and pitch-related variables. Second, through examining whether the interaction between foreigner talk and attenuation of information is larger for one non-native group than for the other (this is, no information and information groups). This can only be investigated for intensity, as it is the only measure in which foreigner talk and attenuation interacted. Starting with foreigner talk, there were no differences

between the no information and the information groups for any of the measures. Thus, at least to what concerns foreigner talk, just knowing that the listener was a non-native sufficed to natives for tailoring their utterances in a more understandable manner. To what concerns the interaction between attenuation and foreigner talk, there was no difference between the no information and the information groups, indicating that, as in the case of foreigner talk, a single bit of information (this is, being native or non-native) sufficed to perform the pertinent speech modifications. This result is in line with a number of evidence showing that as long as the needs of the audience are clear, just a bit of information is enough to perform audience design (Brennan, 2005; Galati & Brennan, 2010; Hanna & Brennan, 2007; Hanna & Tanenhaus, 2004; Nadig & Sedivy, 2002; Rosa et al., under review). Then, incorporating information about the listener would not necessarily be a costly endeavor.

Even though the results of this study indicate that our paradigm is appropriate to study foreigner talk, attenuation of information and the interaction between these two, we would like to consider two facts that could affect the results in one way or another. Especially, we can not be sure that the lack of differences between the no information and the information groups are due just to the fact that speakers actually do not need more than a bit of information to make their judgments, or to some aspects of our setting. On first place, our experimental setting was designed with the purpose of encouraging an interaction between the speaker and the listener, which, although being more similar to a normal communicative situation than monologue, might be still far from grasping the naturalness of everyday conversations (while also limiting the contributions of the listener). One optimal paradigm to generate spontaneous and balanced dialogue is the DIAPIX task (Bradlow et al., 2007). It consists in a "spot the difference" game in which dyads of participants are encouraged to work together to find

the differences between their scenes. While it provides with obvious advantages (as spontaneous language and equal contributions), it might not be the best option to research into attenuation of information. This is because it can not be ensured that words will be repeated, contrary to our paradigm in which objects are named twice as a requirement of the task. Also, it is almost impossible to ensure that each mention would be said in a constant position within a phrase, in order to make fair comparisons between first and second mentions. Then, it seems very hard to find an adequate paradigm which encourages dialogue in a natural context and which elicits enough repeated target words.

A second aspect that we would like to mention is the issue of employing confederates in psycholinguistics research. In our study, instruction receivers were always confederates. As inquired after the task was completed, none of our participants suspected that the listener was a confederate. However, Lockridge & Brennan (2002) point out that "*although experiments using confederate addressees can be carefully staged so that speakers do not catch on, this by no means guarantees that speakers' utterances are not shaped by factors outside of their awareness*". Therefore, the two aforementioned issues just point to an old problem: the difficulty in finding the right balance between internal and external validity in psycholinguistics research.

In spite of these potential problems, we believe that examining both foreigner talk and attenuation of information in a task designed to encourage attenuation in an interactive context constitutes a novel and informative approach. To conclude, our study provides with strong evidence showing that speakers take into consideration who their listeners are when designing speech. This fact interacted with attenuation when factors supports it, as it was found for intensity and not for variables mostly tied to articulation.

CONCLUSIONS

This study addresses how foreigner talk and attenuation of information interact when native speakers give aloud instructions to non-natives. Through the performance of a collaborative map task, it was showed that native speakers design utterances for listeners speaking slower, lower in volume, with a higher tone and wider pitch range than when talking to native listeners, thus constituting evidence for the presence of foreigner talk. Also, native speakers performed attenuation of information in second mentions of words when talking to natives and to non-natives. However, attenuation for intensity was prevented when natives talked to non-natives. Being a variable more under control than duration and pitch-related measures, the lack of attenuation for intensity served to signal the relevance of the task for those who could have more comprehension problems, this is, non-native speakers. Our study replicates and extends previous findings on foreigner talk and attenuation of information and it is the first, to our knowledge, to assess how these two factors interact in a context of communicative relevance.

| Word | English word | #Letters | #Syllables | Log Frequency |
|---|---|---|---|---|
| balanza | balance | 7 | 3 | 1,806 |
| bandera | flag | 7 | 3 | 2,286 |
| bate | bat | 4 | 2 | 0,699 |
| bigote | moustache | 6 | 3 | 2,107 |
| bolsa | bag | 5 | 2 | 2,354 |
| botella | bottle | 7 | 3 | 2,248 |
| botón | button | 5 | 2 | 1,875 |
| brújula | compass | 7 | 3 | 1,146 |
| cactus | cactus | 6 | 2 | 1,000 |
| cámara | camera | 6 | 3 | 2,348 |
| candado | locker | 7 | 3 | 1,041 |
| cañón | cannon | 6 | 2 | 1,826 |
| casco | helmet | 5 | 2 | 1,991 |
| castillo | castle | 8 | 3 | 2,045 |
| corona | crown | 6 | 3 | 2,152 |
| corsé | corset | 5 | 2 | 1,041 |
| cuchillo | knife | 8 | 3 | 1,934 |
| dentista | dentist | 8 | 3 | 1,279 |
| fresa | strawberry | 5 | 2 | 1,204 |
| gamba | shrimp | 5 | 2 | 0,301 |
| gato | cat | 4 | 2 | 2,324 |
| gota | drop | 4 | 2 | 2,029 |
| guitarra | guitar | 8 | 3 | 1,857 |

| jirafa | giraffe | 6 | 3 | 0,778 |
|---|---|---|---|---|
| maleta | suitcase | 6 | 3 | 1,991 |
| melón | watermelon | 5 | 2 | 1,255 |
| mono | monkey | 4 | 2 | 2,009 |
| palmera | palm tree | 7 | 3 | 0,477 |
| pañal | nappy | 5 | 2 | 0,778 |
| patín | roller | 5 | 2 | 0,602 |
| pecera | fish bowl | 6 | 3 | 0,602 |
| peonza | spinning top | 6 | 3 | 0,602 |
| piano | piano | 5 | 3 | 2,274 |
| pingüino | penguin | 8 | 3 | 1,041 |
| piña | pineapple | 4 | 2 | 1,146 |
| pizza | pizza | 5 | 2 | 0,699 |
| plato | plate | 5 | 2 | 2,238 |
| pomo | knob | 4 | 2 | 0,954 |
| pulpo | octopus | 5 | 2 | 0,954 |
| raqueta | racket | 7 | 3 | 1,079 |
| rueda | wheel | 5 | 2 | 2,107 |
| silbato | whistle | 7 | 3 | 0,954 |
| sofá | sofa | 4 | 2 | 1,996 |
| tobogán | slide | 7 | 3 | 0,778 |
| trompeta | trumpet | 7 | 3 | 1,079 |
| túnel | tunnel | 5 | 2 | 1,944 |
| vaso | glass | 4 | 2 | 2,320 |
| vestido | dress | 7 | 3 | 2,505 |

**Table 6.** Lexical values of the map words.

| Word | Word (English) | #Letters | #Syllables | Log Frequency |
|---|---|---|---|---|
| bombilla | light bulb | 8 | 3 | 0.8 |
| bufanda | scarf | 7 | 3 | 0.71 |
| cohete | rocket | 6 | 3 | 0.87 |
| globo | balloon | 5 | 2 | 1.05 |
| gorra | cap | 5 | 2 | 0.94 |
| manzana | apple | 7 | 3 | 1.08 |
| muelle | spring | 6 | 3 | 1.12 |
| vaca | cow | 4 | 2 | 1.08 |

**Table 7.** Lexical values of the practice items for the map task.

## 2.2 Attenuation of information in non-native speakers during spoken interactions

# Attenuation of information in non-native speakers during spoken interactions

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The attenuation of information phenomenon shows that when words are predictable, they get reduced in a number of ways, such as word duration, intensity or pitch-related values. Attenuation has been pervasively found in monologue and dialogue contexts for native speakers, but little is known about how attenuation works in non-natives. Due to the difficulties of second language production, it is not obvious that non-natives would be susceptible to the attenuation of information phenomenon, especially when they are engaged in a real interaction. In the current study we examine attenuation of information in non-native speakers both in dialogue and in monologue. Pairs of speakers were engaged in a collaborative map task in which objects were mentioned twice, where either non-native or native speakers of Spanish talked to another native. Additionally, native and non-native speakers read a text which contained repeated words. Results showed that non-natives were under the influence of attenuation as much as natives, both in monologue and in dialogue contexts for duration and intensity, although non-natives reduced more for pitch-related measures. This study constitutes the first evidence showing that non-natives perform attenuation when involved in a real interactive situation and extends our knowledge about attenuation and non-native speech production.

# INTRODUCTION

The use of a non-native language in conversations is becoming rather common (see, for instance, Eurobarometer surveys from 2006 and 2012). There are many properties of non-native speech that can compromise certain aspects of a conversation. Just to name a few, the non-native speaker has less experience with the phonological repertoire of the foreign language than the native speaker. Non-natives might also have problems in word pronunciation or syntax, or show an atypical speech rate compared to the native's. Also, non-native's speech can be affected by the differences between the linguistic systems of his/her native and non-native languages, such as the belonging to the same language family or the proportion of cognates across languages (see Costa et al., 2008). Also, the lexical features of the native and the non-native language might be different, for example, concerning word frequency or rates of content and function words (see Baker et al., 2011). A better understanding of how non-native speech in conversational settings departs form the standard native speech can help us to design better second language acquisition protocols. In this article, we explore one property of speech observed in conversational settings, namely the attenuation of certain speech properties when information is repeated, called *attenuation of information*. In particular, we assess whether such property is present (and to what extent) when non-native speakers interact with native speakers. As we will argue, there are reasons to believe that this phenomenon may be reduced in non-native speech.

Attenuation of information refers to how some speech features of identical utterances change depending on whether words are predictable

or not. Words can be predictable by a variety of reasons. The one assessed in the current work is repetition, meaning that words that have been already presented are likely to be attenuated. Also, words that are highly frequent, predictable by sentence context or predictable by conditional and joint word probabilities, are also attenuated in comparison to less predictable words (Aylett & Turk, 2004; Baker & Bradlow, 2009; Baker et al., 2011; Bell et al., 2001, 2002; Fidelholtz, 1975; Fowler, 1987; Hunnicutt, 1985; Jespersen, O., 1923; Jurafsky et al., 1998, 2001; Ladd, 2008; Lieberman, 1963; Prince, 1981; Zipf, 1929). Attenuation of information is manifested, amongst others, in the reduction of word duration, intensity and pitch-related values, and also in a range of phenomena such as consonant deletion, vowel reduction or shortening of referential expressions (Ariel, 1990; Baker & Bradlow, 2009; Bell et al., 2002, 2003; Bybee, 2000; Chafe, 1976; Clark & Haviland, 1977; Fowler & Housum, 1987; Galati & Brennan, 2010; Gregory et al., 1999; Grosz et al. 1995; Gundel et al., 1993; Jurafsky et al., 2001; Lieberman, 1963; Samuel & Troicki, 1998; Watson et al., 2008; for attenuation in affixes see Pluymaekers, 2005).

Very relevantly, attenuating information also implies a loss the intelligibility of words (e.g.: Bard et al., 2000; Galati & Brennan, 2010; Lieberman, 1963), as reducing the acoustic properties of words leads to a poorer signal. Finally, attenuation aids listeners to keep track of the informational status of words, indexing that the speaker is referring to the same entity than previously. This suggests that at least one of the origins of attenuation would be to promote understanding during conversations. Fowler & Housum (1987) presented first and second mentions of words to listeners who had to guess whether the utterance was new or old. Participants guessed the new/old status of words

correctly, indicating that they were able to track their informational status. Also, as new information tends to be accented and old information tends to be deaccented, Birch & Clifton (1995) found that utterances in which new information was accented and given information was deaccented were understood quicker by listeners than those utterances in which new information was unaccented and old information was accented. On the same lines, Terken & Noteboom (1987) showed that accenting given information and deaccenting new information slowed down reaction times. Finally, in the study of Dahan (2002), listeners' eye fixations were faster for given referents than for old referents in a moving objects task. This evidence suggests that it would be beneficial for communication that non-native speakers attenuated second mentions of words when interacting with natives.

Attenuation of information seems to be under the influence of two main processes. First, *priming*, and second, *audience design*. Priming takes place when a word has been previously (and recently) activated, as when mentioning a referent for the second time. This previous activation facilitates word production and, as a consequence, leads to attenuation of word/referents in several forms (e.g.: Bard & Aylett, 2004; Bell et al., 2009; Lindblom, 1990). On second place, attenuation of information can be driven by audience design. Audience design refers to adjusting our behavior to facilitate the interaction with another person (Clark & Carlson, 1982; Clark & Murphy, 1982). Attenuating because of audience design means that speakers perform attenuation because it enhances the comprehension of the listener (for reasons such as the signaling of informational status). It implies that the speaker somehow infers the needs and characteristics of the listener and adjusts her speech accordingly.

The aim of the present research is to explore to what extent the attenuation of information phenomenon is present when non-native speakers are set in a conversation, and whether such attenuation is comparable to that of native speakers. We identify at least two reasons to believe that non-natives' attenuation may depart from natives' attenuation. On first place, the contribution of articulatory priming (the first force that we contemplate for attenuation) to the attenuation phenomenon might be different for non-natives than for natives. The reason is that non-native speakers might have some language difficulties that could hamper production jeopardizing the chances of repetition effects to happen. This is, even though the non-native speaker identified items as given, this might not guarantee that he/she would produce an attenuated utterance. The second reason why non-native speakers might not display attenuation is because it carries intelligibility loss. Due to the implicit intelligibility loss of attenuation, it is reasonable to think that non-native speakers might be reluctant to attenuate their productions in order to make themselves understandable for the listener. This way, non-natives would perform some sort of "clear speech" along the task, trying to keep the signal clear (for more on non-native speakers and clear speech in monologue, see Smiljanić & Bradlow, 2011). This strategy may then limit the effect of words' predictability. Note that non-natives' potential speech difficulties and desire for clarity may have contrastive effects of different magnitude. Therefore, it is difficult to make a strong prediction regarding whether the size of attenuation will be comparable between non-native and native speakers in conversational settings.

As far as we know, there is only one study that has addressed a similar issue. Baker and collaborators (2011) examined whether repeated words in a reading task were attenuated when read by non-native speakers. Their

results revealed that non-native speakers attenuated their second productions (measured only by duration) to the same extent than native speakers. This result is very interesting as it suggests that the articulatory priming component of attenuation seems to be similar for native and non-native speech. However, it does not inform us much about whether attenuation of information would be present in conversational settings involving non-native speakers. This is important, since as argued above, non-native speakers may adopt the strategy of speaking clearer to help the intelligibility of their messages, probably reducing the presence of attenuation.

To address our question, we employed the map task of Fraundorf, Watson and Benjamin (under review). The task involves a pair of speakers, one being the instruction giver and the other being the instruction receiver. As it will be explained in detail in the methods section, the participant (or instruction giver) has pairs of objects linked by an arrow in a display of eight elements. The task of the instruction giver is to tell the instruction receiver which objects are linked and in which manner (that is, following the direction of the arrow). Objects are mentioned twice to investigate attenuation of information effects through repetition for duration, intensity, pitch, pitch excursion and pitch range. Moreover, a group of Spanish native speakers performed the map task with a Spanish instruction receiver. The comparison of native's and non-native's performance provides with a direct indicator of the effects of attenuation and non-nativeness. In addition, as a means to establish a baseline for the map task and as a replication of Baker et al.'s work (2011), participants (both natives and non-natives) read aloud a text inspired in the "Gina's pizza paragraph" by Baker & Bradlow (2009). The inclusion of a text task allows comparing attenuation effects across

communicative contexts. In the study of Garnier and collaborators (2010, study 2), authors researched how the performance of Lombard speech (this is, the tendency of speakers to increase their vocal effort when speaking in noise, Lombard, 1911) varied depending on whether speakers performed a speech task alone or with a partner. Garnier et al. (2010) found that speaker's speech modifications in noise were greater in the presence of a partner, showing that communicative intent contributes to speech adaptation in noise. Although we are dealing with a different issue than Lombard speech, this reveals how the presence of a listener may impact speech production.

Our task extends Baker et al's (2011) work in two respects. One is through the inclusion of a communicative task in addition to the text task, as we have just explained. The second way is through considering a broader scope of indicators than word duration, concretely intensity, pitch, pitch excursion and pitch range (and also duration). Considering these measures makes this study more informative. This is because, as acknowledged by Watson's *Multi-Components model* (2008), different factors contribute in diverse ways to acoustic prominence. For instance, word duration and word pitch are argued to be solely related to articulatory processes, while intensity mainly to discourse processes. Also, pitch range seems to have a more social component, as it is used as a means of emphasis in language (see Pierrehumbert & Hirschberg, 1990).

Due to the speech difficulties that non-native speakers might experience, and to their potential clarity enhancements when speaking to a native, it is not obvious how attenuation would behave for non-natives engaged in a relevant communicative situation. This makes the current experiment necessary for the field of attenuation and non-nativeness.

## METHOD

*Participants*

Native speakers

15 Spanish Native speakers (mean age: 25.4 years, sd: 4.2; 9 female, 6 male) took part in the experiment. Two were excluded from the text task analyses due to deviant pitch values, leaving 13 participants. They received 7 euro for their participation. All participants had normal or corrected-to-normal vision and none of the participants reported having any speech or hearing impairments. Participants were recruited from the Universitat Pompeu Fabra subjects' data base.

Non-native speakers

19 English Native speakers, proficient in Spanish as a second language, took part in the experiment (mean age: 35.52 years, sd: 13.48; 11 female, 8 male). Two were excluded from both the text and map task analyses due to deviant pitch values, leaving 17 participants. They received 10 euro for their participation. All participants had normal or corrected-to-normal vision and none of the participants reported having any speech or hearing impairments. Participants were recruited through contact with English Academies and by word of mouth.

MAP TASK

In order to examine participants' utterances regarding attenuation for duration, intensity, pitch, pitch excursion and pitch range from first to second mention of words, we made use of Fraundorf, Watson and Benjamin's (under review) collaborative map task. In this task, the participant acted as the instruction giver, and a confederate as the instruction receiver. The instruction giver was presented with a sequence of 6 maps (plus a practice map) displayed on a computer screen using DMDX (Forster & Forster, 2003). In each map, there were two arrays of four objects, four displayed in a string in the upper part of the map and four in the lower part, where two objects were linked in eight consecutive steps per map. Each object was involved in two different links, whose direction could be horizontal (two objects in the same string in the upper or in the lower part of the screen), vertical (two objects in the same axis in different strings from the upper to the lower or from the lower to the upper part of the screen) or diagonal (two objects in different axis in different strings from the upper to the lower or from the lower to the upper part of the screen).

**Figure 13.** Example of the instruction giver's map.

The instruction receiver (confederate) had exactly the same 6 maps (plus the practice map) as the instruction giver, printed on paper and with no links between the objects. The task of the instruction giver was to tell the instruction receiver which were the two linked objects and in which direction, giving instructions aloud of the type "go from the monkey (object 1) to the bottle (object 2)". The task of the instruction receiver was, after hearing each instruction, to draw an arrow linking the two mentioned objects. Each step in the map remained in the screen until the instruction giver pressed the spacebar once the instruction was uttered. Participants were seated face to face in a soundproof booth. The instruction giver could not see the instruction receiver's map and the instruction receiver could not see the instruction giver's screen, as laptop's screen acted as a visual barrier which allowed participants to see their

faces but not each other's screen or map.

Items consisted of 48 Spanish words which were mentioned twice. Items were randomly distributed regarding 1) to which map did the words/objects belong; 2) in which order the objects were displayed in the map's arrays; 3) the order in which they were mentioned and 4) the item they were paired with. Those items that were mentioned in first place within the sentence of instruction were uttered in second place for half of the participants (this is, half of the participants said "from the monkey to the bottle" and the other half said "from the bottle to the monkey").

In addition, repetitions were not immediate but there were between 1 and 13 intervening words between mentions (depending on the randomization in the mention order). Drawings were selected from several sources (including the Snodgrass database (Snodgrass & Vanderwart, 1980) and the International Picture Naming Project (Szekely et al., 2004).

Utterances were recorded, labeled and analyzed using Praat version 5.3.15 (Boersma & Weenink, 2008), obtaining duration (milliseconds), intensity (decibels), pitch (hertz), pitch excursion (hertz) and pitch range (hertz) values for each utterance. Analyses of utterances were blind to the experimenter. There were a total of 96 utterances per participant (6 maps x 8 objects per map x 2 mentions per object). The map task lasted approximately 20 minutes.

TEXT TASK

After performing the map task, participants read aloud a text inspired in the "Gina's pizza paragraph" (see appendix) by Baker & Bradlow (2009),

either in their first or in their second language. The text task was administered both as a baseline for assessing attenuation of information in non-native speakers when engaged in dialogue through the map task, and as a replication of Baker et al.'s study (2011). Participants were instructed to read the text aloud naturally. It contained 12 critical words (half high frequent and half low frequent; half cognates and half non-cognates) which were repeated twice along the text. Following the recommendations of Baker & Bradlow (2009), we kept constant the position within a phrase in which every mention of each target word appeared. There were between 3 and 122 intervening words between each critical word's mentions. Critical utterances were recorded, labeled and analyzed using Praat version 5.3.15 (Boersma and Weenink, 2008), obtaining duration (milliseconds), intensity (decibels), pitch (hertz), pitch excursion (hertz) and pitch range (hertz) values for each utterance. The text task lasted approximately 5 minutes.

THE LANGUAGE HISTORY QUESTIONNAIRE (non-native participants only)

Non-native participants filled an adapted version of the "Language History Questionnaire for L2 Research" (LHQ) by Li, Sepanski and Zhao (2006) before starting the experimental session (see Table 8 in the appendix). This questionnaire is helpful to see whether the differences that non-native speakers might have in second language background and competence influence attenuation of information in both the map and the text task. Filling the questionnaire lasted approximately 10 minutes.

## RESULTS

*Data analyses*

Utterances were extracted, labeled and analyzed using Praat version 5.3.15 (Boersma and Weenink, 2008). For the map task, each pair of linked objects was saved in an audio-file, there being a total of 48 audio-files per participant (each one containing two utterances of different objects). At the time of extracting the duration (in milliseconds), intensity (in decibels), pitch (in hertz), pitch excursion (in hertz) and pitch range (in hertz) values for each utterance, the order in which audio-files were analyzed was randomized. For the text task, the whole read text was saved in a single audio-file where target words were measured. Duration values were extracted manually using both the waveform and the spectrogram. Word boundaries were placed at the nearest zero-crossing on the waveform. Intensity, pitch and pitch excursion values for each word are automatically provided by the software. In the case of pitch range, it was calculated manually with maximum and minimum pitch values).

Utterances that contained disfluencies or occurred after disfluencies, had background noise or contained speech errors were eliminated along with their mention-pairs. Repeated measures analyses of variance (RM ANOVAs) were run for duration, intensity, pitch, pitch excursion and pitch range in both the text and map tasks.

*Results*

*Text Data*

Native and non-native participants read aloud the same text in Spanish after taking part in the map task. Although the text was read after performing the map task, text results are reported first as it is constitutes the baseline for the attenuation of information effect. Repeated measures ANOVAs including *mention* (first or second) as a within-subjects variable, and *speaker type* (native or non-native) as a between- subjects variable were run for duration, intensity, pitch, pitch excursion and pitch range.

Duration

Analyses showed a significant main effect of mention ($F_1$(1, 29) : 31.131, $p$ : .006; $F_2$(1, 21) : 9.403, $p$ : .006), where first mentions were longer than second mentions in text reading (see Figure 13), revealing attenuation for duration. There was also a main effect of speaker type ($F_1$(1, 29) : 55.766, $p < .001$; $F_2$(1, 21) : 5.642, $p$ : .027), where non-natives had longer durations than natives, which could be a indicative of second language speech difficulties (see Figure 14). Finally, there was no mention x speaker type interaction, suggesting that attenuation for duration in text reading does not depend on the linguistic background of the speaker.
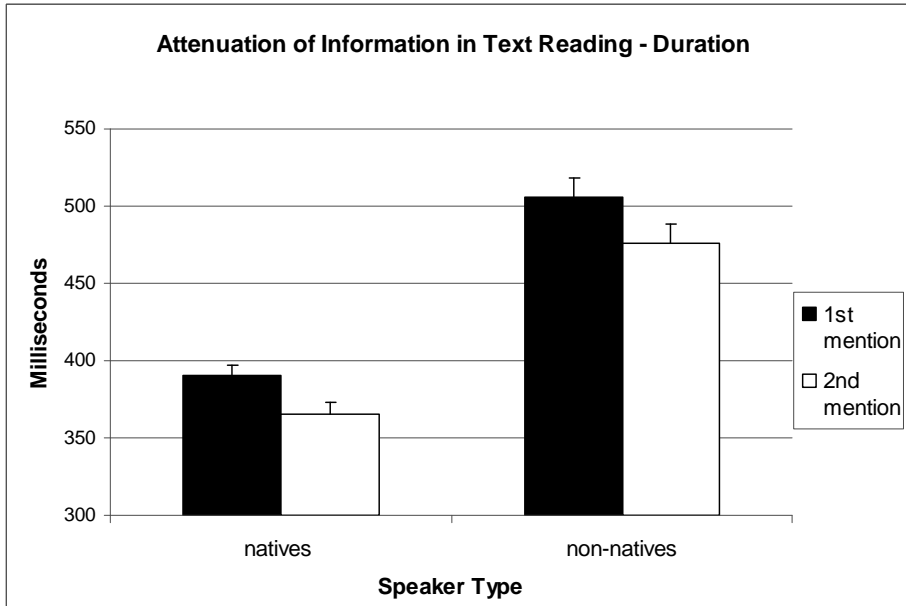
**Figure 14.** Attenuation of information depending on speaker type for duration in the text task. Error bars represent standard errors of the mean.

Intensity

There was a significant main effect of mention by subjects but not by items ($F_1$(1, 29) : 7.652, $p$ : .010), where first mentions had higher intensity than second mentions in text reading (see Figure 15), indicating attenuation of information for intensity. There was no main effect of speaker type, so natives and non-natives did not differ in their intensity values. Finally, the lack of mention x speaker type interaction showed that attenuation for intensity in text reading does not vary depending on the linguistic background of the speaker.

**Figure 15.** Attenuation of information depending on speaker type for intensity in the text task. Error bars represent standard errors of the mean.

Pitch

The significant main effect of mention by subjects but not by items ($F_1(1, 29) : 36.612, p : .001$) showed that first mentions had higher pitch values than second mentions in text reading (see Figure 16), revealing attenuation for pitch. There was no main effect of speaker type, so natives and non-natives had comparable pitch values. Finally, there was no mention x speaker type interaction, showing that attenuation for pitch is no different between natives and non-natives when engaged in text reading.

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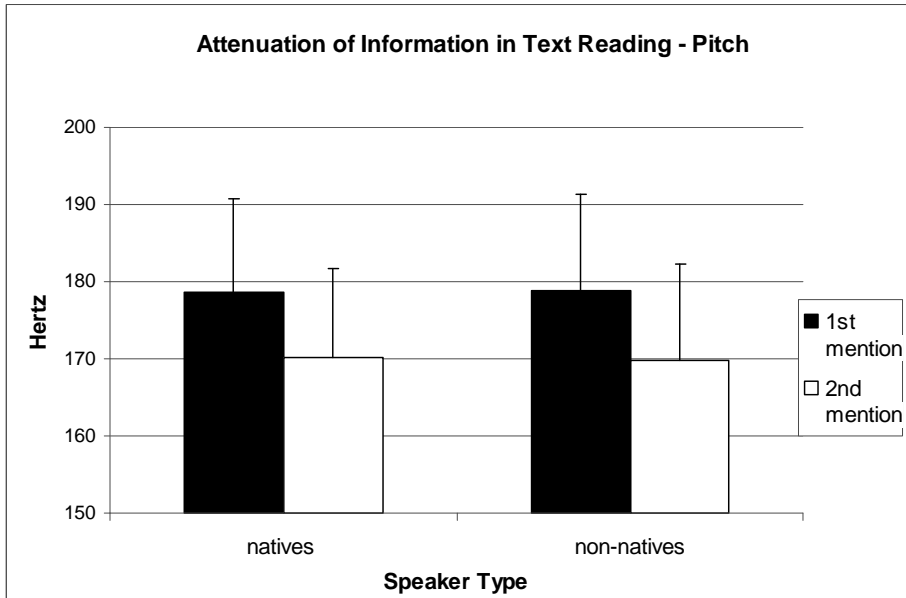
**Figure 16.** Attenuation of information depending on speaker type for pitch in the text task. Error bars represent standard errors of the mean.

Pitch excursion

There was a main effect of mention by subjects but not by items ($F_1$(1, 29) : 13.186, $p$ : .001), where first mentions had higher pitch excursion than second mentions (see Figure 17), showing attenuation for pitch excursion. There was no speaker type effect, so natives and non-natives did not differ in pitch excursion when reading a text. Finally, there was no mention x speaker type interaction, so attenuation for pitch excursion did not vary between natives and non-natives in text reading.

**Figure 17.** Attenuation of information depending on speaker type for pitch excursion in the text task. Error bars represent standard errors of the mean.

Pitch range

No significant effects for mention, speaker type or the mention x speaker type interaction were found regarding pitch range in text reading (see Figure 18).

**Figure 18.** Attenuation of information depending on speaker type for pitch range in the text task. Error bars represent standard errors of the mean.

*Map Data*

In order to see whether both native and non-native speakers perform attenuation of information when engaged in dialogue with a native listener, RM ANOVAs including *mention* (first or second) as a within-subjects variable, and *speaker type* (native or non-native) as a between-subjects variable were run for duration, intensity, pitch, pitch excursion and pitch range.

Duration

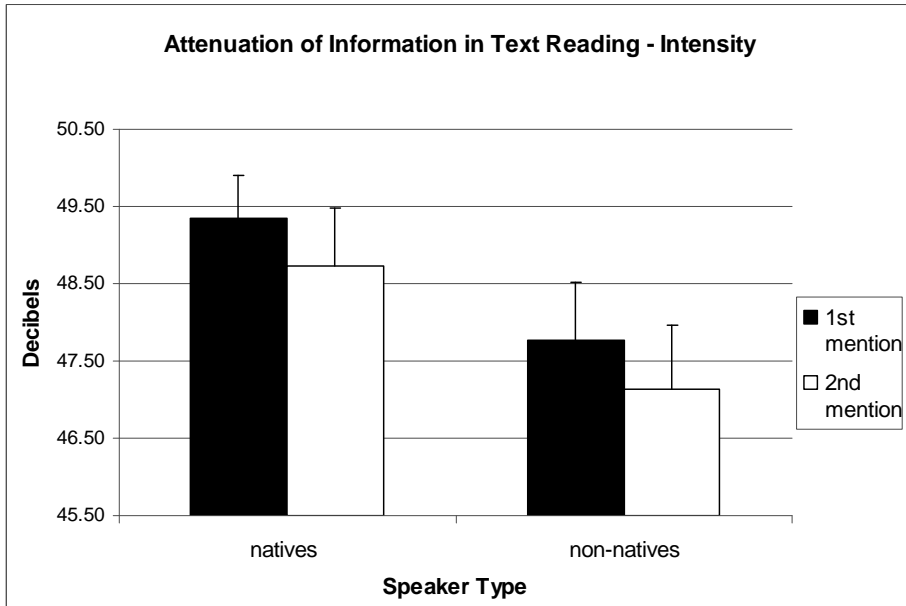Analyses showed a significant main effect of mention ($F_1(1, 32) : 34.774$, $p < .001$; $F_2(1, 93) : 38.227$, $p < .001$), indicating that first mentions have

longer durations than second mentions, and then revealing attenuation when speakers are engaged in a collaborative task (see Figure 19). There was also a main effect of speaker type ($F_1$(1, 32) : 34.462, $p <$ .001; $F_2$(1, 93) : 71.325, $p <$ .001), as non-natives' utterances were longer than those of natives. This could be an indicative, as observed when non-natives read the text, of the speech problems that the non-native might face in his/her second language (see Figure 19). Finally, there was no mention x speaker type interaction, which indicates that although natives and non-natives differed in their overall values for duration, they did not differ regarding attenuation when engaged in a collaborative task.
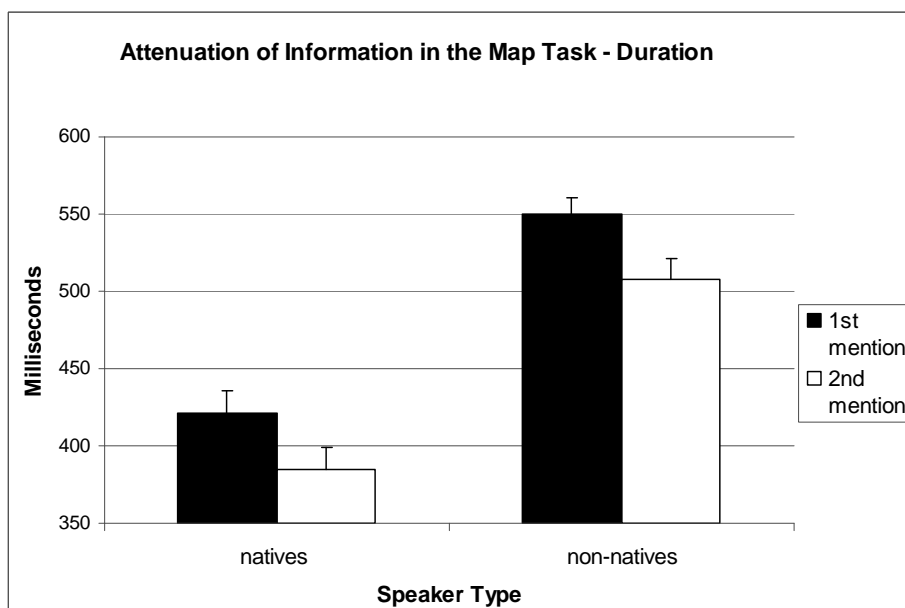


**Figure 19.** Attenuation of information depending on speaker type for duration in the map task. Error bars represent standard errors of the mean.

Intensity

The significant main effect of mention ($F_1(1, 32) : 55.430, p < .001; F_2(1, 93) : 122.819, p < .001$) indicated that first mentions were uttered with higher intensity than second mentions (see Figure 20), showing attenuation for intensity. There was a main effect of speaker type ($F_1(1, 32) : 3.502, p : .070; F_2(1, 93) : 13.899, p < .001$), where native speakers spoke louder than non-natives. There was no mention x speaker type interaction by subject but there was by item ($F_2(1, 93) : 9.605, p : .003$). Bonferroni post-hoc comparisons showed that natives and non-natives tended to differ on first mentions ($p_2 : .006$) and significantly differed on second mentions ($p_2 < .001$), where non-natives spoke lower in intensity than natives. However, in order to see whether natives and non-natives actually vary in the size of their attenuation for intensity, a t-test was performed. Results showed ($t_2(46) : -3.094, p : .003$) that non-natives attenuated more for intensity than natives.
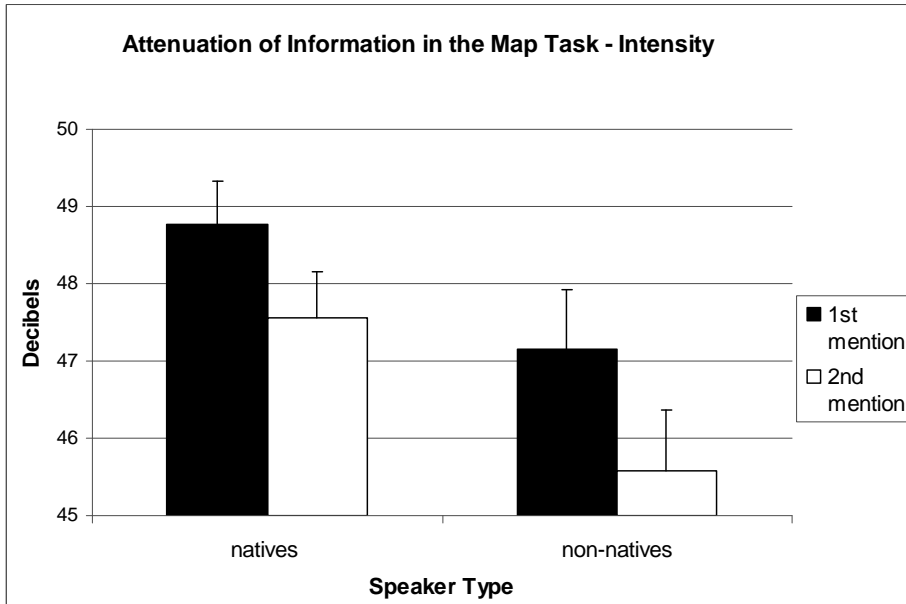
**Figure 20.** Attenuation of information depending speaker type for intensity in the map task. Error bars represent standard errors of the mean.

Pitch

Analyses revealed a significant main effect of mention ($F_1$(1, 32) : 45.779, $p <$ .001; $F_2$ (1, 93) : 71.612, $p <$ .001), where first mentions had higher pitch values than second mentions (see Figure 21), showing attenuation for pitch in the collaborative task. There was no main effect of speaker type, so natives and non-natives did not differ in their pitch values. The significant mention x speaker type interaction ($F_1$(1, 32) : 6.112, $p$ : .019; $F_2$ (1, 93) : 11.972, $p$ : .001), however, indicated that both natives talking to natives ($p_1$ : .009; $p_2$: .001) and non-natives talking to natives ($p_1 <$ .001; $p_2 <$ .001) went through attenuation. In order to see whether natives and non-natives attenuated in pitch to the same extent, their attenuation sizes were compared in an independent samples t-test. Results showed ($t_1$(32) : -2.59, $p$ : .003; $t_2$(46) : -3.27, $p$ : .002) that although both natives and non-

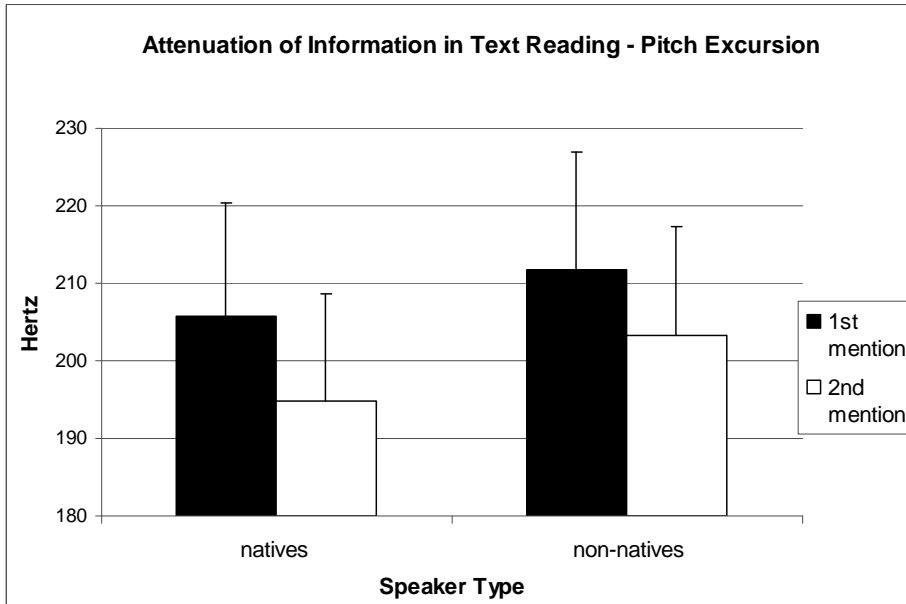natives attenuated for pitch, non-natives attenuated more than natives.
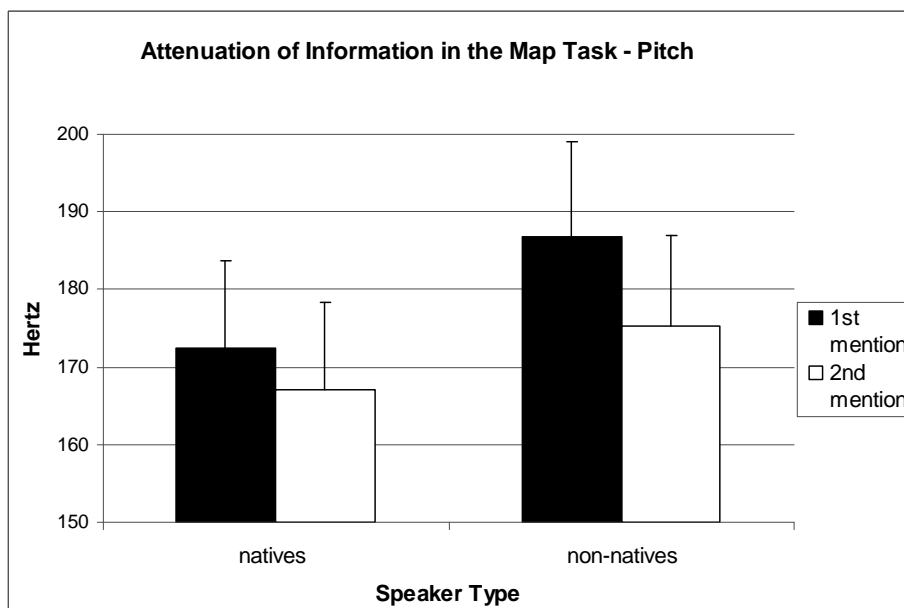


**Figure 21.** Attenuation of information depending on speaker type for pitch in the map task. Error bars represent standard errors of the mean.

Pitch excursion

The significant main effect of mention ($F_1$(1, 32) : 45.779, $p$ < .001; $F_2$(1, 93) : 90.103, $p$ < .001), showed that first mentions had higher pitch excursion values than second mentions (see Figure 22), which revealed attenuation for pitch excursion. There was no effect of speaker type, so pitch excursion values for natives and non-natives did not differ. The mention x speaker type interaction ($F_1$(1, 32) : 18.467, $p$ < .001; $F_2$(1, 93) : 27.158, $p$ < .001) showed that both natives talking to natives ($p_1$ : .020; $p_2$ : .003) and non-natives talking to natives ($p_1$ < .001; $p_2$ < .001) attenuated in pitch excursion. To see whether the size of their attenuation varied, a t-test was run, obtaining that natives and non-natives differed in the

amount of second mention reduction for pitch excursion ($t_1$ (32) : -4.64, $p$ : .004; $t_2$ (46) : -5.08, $p$ < .001), where non-natives attenuated more than natives.
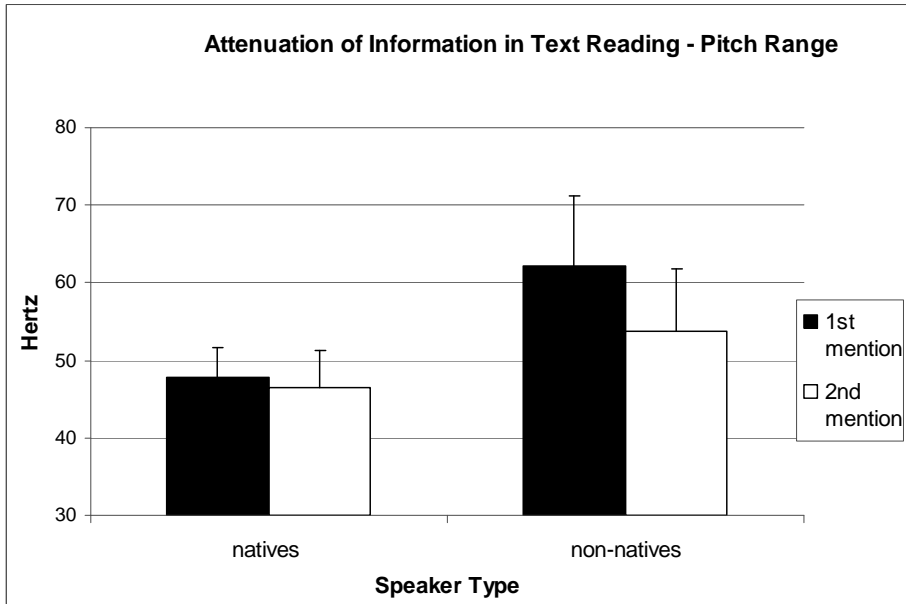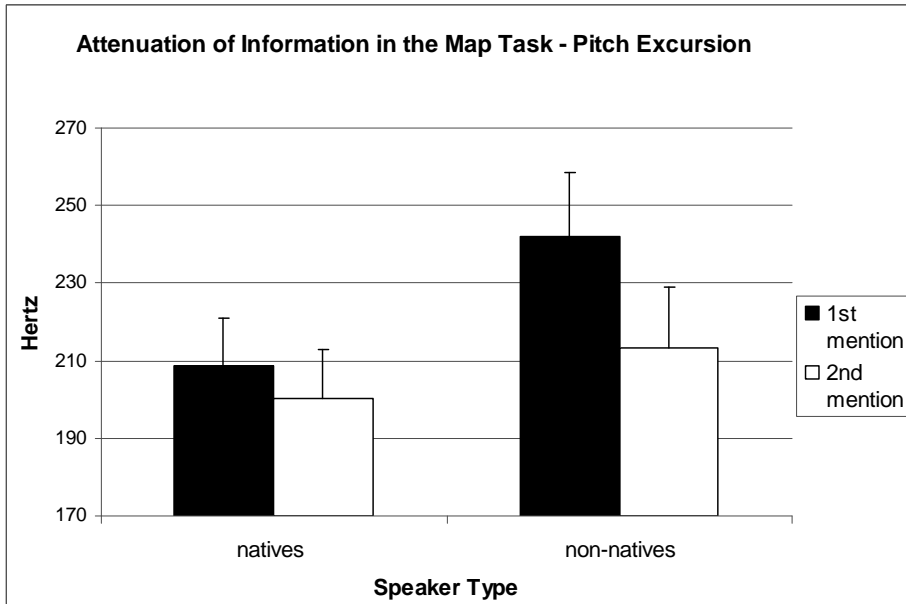


**Figure 22.** Attenuation of information depending on speaker type for pitch excursion in the map task. Error bars represent standard errors of the mean.

Pitch range

Results showed a significant main effect of mention ($F_1$(1, 32) : 35.811, $p$ < .001; $F_2$(1, 93) : 67.131, $p$ < .001), where first mentions had higher pitch range values than second mentions (see Figure 23), there being attenuation for pitch range. The main effect of speaker type ($F_1$(1, 32) : 4.450, $p$ : .043; $F_2$(1, 93) : 22.611, $p$ < .001) showed that non-natives had significantly wider pitch range than natives (see Figure 23). Finally, the mention x speaker type interaction ($F_1$(1, 32) : 11.125, $p$ : .002; $F_2$(1, 93) : 24.077, $p$ < .001) revealed that non-natives attenuated on pitch range

when engaged in a conversation ($p < .001$ both by subject and by item) where natives showed a tendency in by subjects analysis ($p_1 : .094$) and attenuated in by item analysis ($p_2 : .002$). Congruently, the size of their attenuations was different ($t_1 (32) : -3.75$, $p: .002$; $t_2 (46) : -4.96$, $p < .001$), were non-natives narrowed their pitch range in second mentions more than natives.
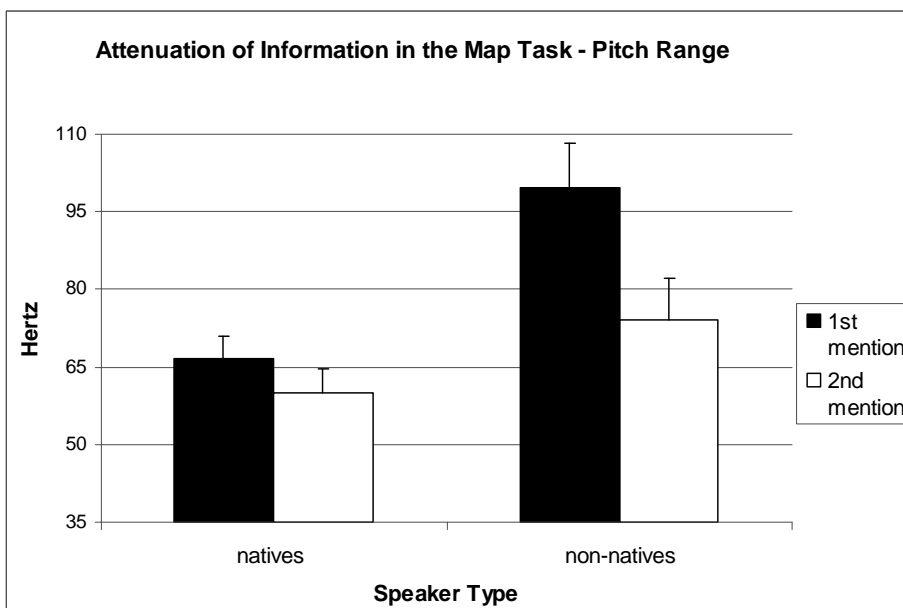


**Figure 23.** Attenuation of information depending on speaker type for pitch range in the map task. Error bars represent standard errors of the mean.

|  | natives to natives | | non- natives to natives | |
|---|---|---|---|---|
| **TEXT** | **1st mention** | **2nd mention** | **1st mention** | **2nd mention** |
| **Duration** | 391 (7) | 365 (8) | 505 (13) | 476 (13) |
| **Intensity** | 49.35 (.55) | 48.72 (.75) | 47.76 (.76) | 47.14 (.83) |

| | | | | |
|---|---|---|---|---|
| **Pitch** | 179 (12) | 170 (12) | 179 (13) | 170 (13) |
| **Pitch excursion** | 206 (14) | 195 (14) | 212 (15) | 203 (14) |
| **Pitch range** | 48 (4) | 47 (5) | 62 (9) | 54 (8) |

**Table 9.** Summary of attenuation of information results across groups and measures for the text task. Standard deviations are shown into brackets.

| | natives to natives | | non- natives to natives | |
|---|---|---|---|---|
| **MAP** | 1st mention | 2nd mention | 1st mention | 2nd mention |
| **Duration** | 421 (15) | 385 (14) | 550 (11) | 508 (13) |
| **Intensity** | 48.77 (.55) | 47.57 (.58) | 47.15 (.77) | 45.58 (.79) |
| **Pitch** | 172 (11) | 167 (11) | 187 (12) | 175 (12) |
| **Pitch excursion** | 209 (12) | 200 (13) | 242 (16) | 213 (15) |
| **Pitch range** | 67 (4) | 60 (4) | 100 (8) | 74 (8) |

**Table 10.** Summary of attenuation of information results across groups and measures for the map task. Standard deviations are shown into brackets.

*Tasks comparison*

In order to see whether communicative context influences 1) overall speech values and attenuation of information, and 2) their plausible interaction with nativeness, two MANOVAs (multivariate analysis of variance) were run. The first MANOVA looked at *task* and *speaker type* effects in "overall values", this is, considering first mentions only and thus free of the attenuation effect. It included *measure* (duration, intensity, pitch, pitch excursion and pitch range) as a within-subjects

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variable, and *task* (map or text) and *speaker type* (native or non-native) as between-subjects variables. The second MANOVA investigated *task* and *speaker type* effects in attenuation, including *measure* as a within-subjects variable (including the size of the attenuation (this is, first minus second mentions) for duration, intensity, pitch, pitch excursion and pitch range), and *task* and *speaker type* as a between-subjects variables.

Starting with overall acoustic values (this is, effects on first mentions), the significant main effect of task ($F_1(4, 244) : 1212.181$, $p < .001$; $F_2(1, 114) : 4.783$, $p : .031$) revealed that speakers uttered words with higher acoustic values in the map task than in the text task. The significant measure x task interaction ($F_1(4, 244) : 2.998$, $p : .019$; $F_2(4, 456) : 2.550$, $p : .039$) showed that overall higher acoustic values for the map versus the text task were present for duration in analyses by subjects ($p_1 : .003$) and for pitch range both by subjects and by items ($p < .001$ in both analyses). There was also a main effect of speaker type ($F_1(1, 61) : 27.138$, $p < .001$; $F_2(1, 114) : 31.502$, $p < .001$), showing that overall values were higher in the case of non-natives than in the case of natives. The measure x speaker type interaction ($F_1(4, 244) : 26.952$, $p < .001$; $F_2(4, 456) : 30.508$, $p < .001$) revealed that this difference between natives and non-natives was present for duration ($p_1 < .001$ for both by subjects and by items analyses), intensity ($p_1 : .027$; $p_2 : .011$) and pitch range ($p_1 : .002$; $p_2 < .001$). Concretely, non-natives spoke slower, with lower intensity and with wider pitch range than natives. Finally, no triple measure x task x speaker type interaction was found.

Secondly, we investigated whether attenuation effects were modulated by task and speaker type. Analyses revealed a main effect of task ($F_1(4, 244) : 31.139$, $p < .001$; $F_2(4, 456) : 15.031$, $p < .001$), showing that attenuation

is more likely to be observed in the map task, this is, in an interactive context. The measure x task interaction was not significant. A main effect of speaker type was found by subjects only ($F_1(1, 61) : 6.259$, $p : .015$), where non-natives went through larger attenuation effects than natives. The measure x speaker interaction was not significant. Finally, there was no triple measure x task x speaker type interaction.

*Language History Questionnaire*

Several correlations and ANOVAs were run in order to see if any of the linguistic background and competence variables included in the adapted version of the LHQ was related to attenuation in both the text and the map tasks for duration, intensity, pitch, pitch range and pitch excursion. Nonetheless, no significant interactions between the variables of interest from the LHQ and attenuation across measures and tasks were observed.

## DISCUSSION

In the current study, we aimed at answering whether non-native speakers are sensitive to a phenomenon commonly observed in native speech, namely attenuation of information. Also, we were interested in whether overall speech values and attenuation for both native and non-native speakers was affected by communicative context (text reading versus collaborative map task). To address our questions, native and non-native speakers of Spanish performed two different tasks. The first task was an adaptation of the collaborative map task by Fraundorf, Watson and Benjamin's (under review), in which the participant (or instruction giver) gave directions aloud to a confederate (or instruction receiver) about two

objects that had to be linked. Objects were named twice, and certain acoustic properties known to be subjected to the effects of predictability by repetition were examined, such as duration, intensity, pitch, pitch excursion and pitch range. This allowed us to assess whether non-native speakers were under the influence of attenuation in the context of dialogue. The second task was a repetition text task (adapted from the "Gina's pizza paragraph" by Baker & Bradlow, 2009). The text task served two purposes. First, it acted as an anchor point and as a replication of the attenuation of information phenomenon in non-natives as found by Baker and collaborators (2011). In second place, as a means to compare how communicative contexts shapes overall acoustic values and attenuation of information.

In a nutshell, both native and non-native speakers attenuated from first to second mention of words both in the text and in the map tasks (but there was no attenuation effect for pitch range in the text). The size of attenuation for natives and non-natives was comparably the same across all the measures in the text. However, non-native speakers attenuated more than native speakers in intensity (only in by items analysis), pitch, pitch excursion and pitch range when engaged in the collaborative map task. Natives and non-natives also differed in their overall acoustic values. Non-native speakers spoke slower than natives for both the text and the map tasks. They also spoke lower (in intensity) and had wider pitch range than natives for the map task. About whether the map and the text task yielded comparable results, higher acoustic values were found for the map than for the text task, concretely for word duration and for pitch range. Also, attenuation was more likely to be observed in the map task. We would like to add that even though the items in our study were half high frequent and half low frequent, and half cognates and half non-cognates,

we did not observe any effect of these variables neither in attenuation nor in overall values. Now we will discuss our findings in more depth.

Our first question was whether non-native speakers were under the influence of attenuation of information in a collaborative scenario. Results showed that non-native speakers attenuated from first to second mentions of words in both the text and the map task. This outcome goes along with the evidence of Baker et al. (2011), and also extends it to an interactive situation employing more acoustic values such as intensity and pitch-related measures. Although attenuation of information for intensity and pitch-related measures has been previously reported in the monolingual literature (see, for instance, Watson, 2008), this is, to our knowledge, the first time that attenuation for these measures is found in non-native speech. In the introduction, we acknowledged two main factors that could influence the performance of attenuation of information.

First, the speech problems that the non-native might face, especially at the articulatory level. Secondly, the desire of the non-native to speak efficiently in a situation of communicative relevance, which could lead non-natives to enhance their speech across the task. Our results showed that even though non-natives showed speech problems, these problems did not interact with attenuation. Concretely, non-natives spoke slower both in the map and in the text task. Finding slower durations both in the text and in the map indicates that this issue would be mostly related to articulation. If it were to be a phenomenon tied to the situation (e.g.: as non-native speech departing from natives' speech as a consequence, for instance, of feeling shy or under pressure due to the presence of a listener, see Costa et al., 2008), longer durations should have been present only during the performance of the map task and not for the text task.

Natives and non-natives also differed in their overall intensity. Nevertheless, non-natives spoke lower in volume than natives only during the map task. As intensity is related to discourse-level factors (Watson et al., 2008) rather than to articulatory, one possibility is that showing lower intensity during the map task answers to aspects related to the presence of a listener. Also, non- natives displayed higher pitch range values than natives. Pitch range encodes the difference between the maximum and the minimum pitch values within a word, thus reflecting voice inflections and it acts as a means to emphasize information (Ladd and Morton, 1997). Our data shows that non-native speakers talked with a very animated voice when introducing referents in an interactive situation (see Figure 23). This difference was only present for the map task (as in the case of intensity), supporting the social component of pitch range. But, why would non-natives display higher pitch range values than natives in the map task? We suggest that non-natives tried to compensate their production difficulties (as evidenced by longer durations) through widening pitch range, which would make items salient for the correct development of the task by the native listener (as information in focus is realized with a wider pitch-range that information out of focus, see Xu & Xu, 2005).

Then, it was showed that the potential difficulties that the non-native might have were not evidenced in different amounts of attenuation, but in overall values. Also, the larger pitch range showed by non-natives can be considered as some sort of audience design, this is, as a strategy to clarify speech.

Therefore, articulatory problems *per se* did not affect attenuation. We showed that non-native speakers behaved as native speakers in a situation of little communicative relevance, this is, the text task. However, when

engaged in the collaborative task, while non-natives attenuated as natives for duration (replicating and extending Baker et al.'s (2011) results to a communicative context), non-natives attenuated more for pitch-related measures than natives (see Figures 21, 22 and 23). Regarding intensity, results point to a bigger attenuation by non-natives compared to natives. This pattern was significant in the analysis by items and showed a tendency in the analysis by subjects. Although the pattern is not completely clear due to the tendency in the analysis by subjects, we believe that simply by incrementing the number of participants, results would turn to be significant in both analyses. That is, results indicate that even though non-native speakers spoke lower in volume than natives to start with, they also attenuated more. One potential explanation is that as natives did not show any problem in understanding non-natives during the task, non-natives felt free to speak low (for reasons as being embarrassed of mispronunciations, as discussed above) while emphasizing information through other tools such as pitch-related measures.

Non-native speakers displayed higher values on first mentions of pitch-related measures than natives, having a larger space to attenuate. Big attenuation sizes would be more suitable to highlight the given status of the referents and to allow for the correct following of the task. However, this result reached significance for pitch range only. Again, this pattern of results suggests that non-native speakers emphasized first mentions of words to help native listeners to perform the task, but once the item was mentioned, they attenuated their productions presumably guided by the same forces that drive natives to attenuate predictable instances. Baker et al. (2011) stated that the fact that non-native speakers were under the influence of attenuation as natives when reading a text indicates that at least some of the processes leading to attenuation for the native also

operate for the non-native. This statement could be also applied to our case: non-natives behaved largely as natives regarding attenuation, but departed from them for overall values. Thus, non-natives performed enhanced pitch range for first mentions that dramatically decreased on second mentions because interlocutors (which were confederates) did not show any sign of misunderstanding, not needing any particularly clear signal.

This is in line with Lindblom's theory of *hyper and hypo-articulation* (1990). Lindblom's claim is that the signal that the speaker emits varies in relation to the informational requirements of the listener. If listeners have trouble to understand what the speaker is saying, speakers would hyper-articulate. However, as long as the listener understands the message, speakers will hypo-articulate. In the study of Hazan & Baker (2011) it was showed that clear speech enhancements in a collaborative task were reduced if the comprehension of the listener looked appropriate, but clear speech was increased when a communication problem appeared. Hazan & Baker's (2011) result is in line with the possibility that non-native speakers in our study were aware of their potential limitations, and tried to compensate it with wider pitch ranges. However, as natives showed that they were following the task without apparent trouble, non-natives allowed themselves to attenuate their second productions.


Concerning our second question, this is, whether task type/ communicative context influence overall acoustic properties and attenuation, our study showed that it does. Communicative context affected both the word's overall values and attenuation effects. When speakers performed the map task (irrespectively of whether they were natives or non-natives), words were longer and had wider pitch range than when they read the text. We believe that this reflects the social

component of speech. If no social influence was at play, acoustic values should be comparably the same across tasks. Also, attenuation was larger for the map than for the text task regardless of the indicator. Again, we believe that this difference across tasks could reflect social influences. Speakers marked more given status through larger reduction when attenuation was useful not only for themselves, but for an audience (so speakers would be able to follow the task tracking the informational status of words). Therefore, it can be stated that communicative context, and then, communicative intent influences linguistic forms and choices. Our finding goes along with the study of Garnier and collaborators (2010), where Lombard speech enhancements were greater in an interactive context (see also Amazi & Garber (1982) and Junqua et al. (1999), supporting that communicative intent contributes to speech adaptation in noise).

To conclude, this study constitutes the first evidence of attenuation of information performed by non-native speakers in a relevant communicative situation. It also replicates and extends Baker and collaborator's (2011) work, supporting that although non-native speakers may face some language difficulties, which were observed at the general level, these difficulties do not prevent them to be under the influence of attenuation, and then, to carry conversations with success.

# APPENDIX

"En el *episodio* de hoy aprenderemos cómo hacer una *sopa* con *espinacas* y *sésamo* para calmar tu *apetito* entre horas. El primer paso es lavar y mezclar las *espinacas* y el *sésamo*. Después fríe los *cebollinos* y echa un *trozo* de en el *cazo*. Asegúrate de que el *trozo* de *guindilla* no sea demasiado grande, o su fuerte *sabor* podría tapar el suave *sabor* de las espinacas. Cuando los *cebollinos* estén dorados, mézclalo todo y echa el *caldo* en el *cazo*. El que mejor va es el de *ostra*, pero como la *ostra* es bastante cara, cualquier *caldo* ligero irá bien. Deja que se enfríe durante una hora y verás como con esta *sopa* te será más fácil controlar tu *apetito*. En el *episodio* de mañana les mostraremos una nueva receta."

**Text read by native and non-native speakers.** Repeated words are in italics.

"In today's *episode*, we will learn how to make a *spinach* and *sesame soup* to calm down your *appetite* between meals. The first step is to wash and mix the *spinach* and the *sesame*. Then, fry the *spring onions* and throw a *piece* of *chilli* in the *saucepan*. Make sure that the *piece* of *chilli* is not too big, or its strong *flavor* could mask the spinach's smooth *flavor*. Once the *spring onions* are golden-brown, mix everything and pour the *broth* into the *saucepan*. The best one is *oyster's*, but as the *oyster* is quite expensive, any light *broth* will do. Let it cool for one hour and you'll see as, with this *soup*, it will be easier for you to control your *appetite*. In tomorrow's *episode* we will show you a new recipe."

**Text read by native and non-native speakers (English version).** Repeated words are in italics.

| *Background Questions* |
| --- |
| Age |
| Sex |

| Education |
|---|
| Country of origin |
| Number of years living in a Spanish speaking country |
| Age of Learning L2 |
| How was L2 learnt (interacting with people, classroom, mixture of both) |
| L2 proficiency (mean of reading and writing proficiency, speaking fluency and listening ability values |
| Number of years learning the language |
| Presence of a native accent |
| *Language environment and use* |
| Percentage of L1 use (and percentage of L2 use) |
| General language preference |

**Table 8.** List of questions from the LHQ included in our experiment

| Word | Word (English) | #Letters | #Syllables | Log Frequency |
|---|---|---|---|---|
| balanza | balance | 7 | 3 | 1,806 |
| bandera | flag | 7 | 3 | 2,286 |
| bate | bat | 4 | 2 | 0,699 |
| bigote | moustache | 6 | 3 | 2,107 |
| bolsa | bag | 5 | 2 | 2,354 |
| botella | bottle | 7 | 3 | 2,248 |
| botón | button | 5 | 2 | 1,875 |
| brújula | compass | 7 | 3 | 1,146 |

| | | | | |
|---|---|---|---|---|
| cactus | cactus | 6 | 2 | 1,000 |
| cámara | camera | 6 | 3 | 2,348 |
| candado | locker | 7 | 3 | 1,041 |
| cañón | cannon | 6 | 2 | 1,826 |
| casco | helmet | 5 | 2 | 1,991 |
| castillo | castle | 8 | 3 | 2,045 |
| corona | crown | 6 | 3 | 2,152 |
| corsé | corset | 5 | 2 | 1,041 |
| cuchillo | knife | 8 | 3 | 1,934 |
| dentista | dentist | 8 | 3 | 1,279 |
| fresa | strawberry | 5 | 2 | 1,204 |
| gamba | shrimp | 5 | 2 | 0,301 |
| gato | cat | 4 | 2 | 2,324 |
| gota | drop | 4 | 2 | 2,029 |
| guitarra | guitar | 8 | 3 | 1,857 |
| jirafa | giraffe | 6 | 3 | 0,778 |
| maleta | suitcase | 6 | 3 | 1,991 |
| melón | watermelon | 5 | 2 | 1,255 |
| mono | monkey | 4 | 2 | 2,009 |
| palmera | palm tree | 7 | 3 | 0,477 |
| pañal | nappy | 5 | 2 | 0,778 |
| patín | roller | 5 | 2 | 0,602 |
| pecera | fish bowl | 6 | 3 | 0,602 |
| peonza | spinning top | 6 | 3 | 0,602 |
| piano | piano | 5 | 3 | 2,274 |
| pingüino | penguin | 8 | 3 | 1,041 |

| piña | pineapple | 4 | 2 | 1,146 |
|------|-----------|---|---|-------|
| pizza | pizza | 5 | 2 | 0,699 |
| plato | plate | 5 | 2 | 2,238 |
| pomo | knob | 4 | 2 | 0,954 |
| pulpo | octopus | 5 | 2 | 0,954 |
| raqueta | racket | 7 | 3 | 1,079 |
| rueda | wheel | 5 | 2 | 2,107 |
| silbato | whistle | 7 | 3 | 0,954 |
| sofá | sofa | 4 | 2 | 1,996 |
| tobogán | slide | 7 | 3 | 0,778 |
| trompeta | trumpet | 7 | 3 | 1,079 |
| túnel | tunnel | 5 | 2 | 1,944 |
| vaso | glass | 4 | 2 | 2,320 |
| vestido | dress | 7 | 3 | 2,505 |

**Table 11.** Lexical values of the map words.

| Word | Word (English) | #Letters | #Syllables | Log Frequency |
|------|----------------|----------|------------|---------------|
| bombilla | light bulb | 8 | 3 | 0.8 |
| bufanda | scarf | 7 | 3 | 0.71 |
| cohete | rocket | 6 | 3 | 0.87 |
| globo | balloon | 5 | 2 | 1.05 |
| gorra | cap | 5 | 2 | 0.94 |
| manzana | apple | 7 | 3 | 1.08 |
| muelle | spring | 6 | 3 | 1.12 |
| vaca | cow | 4 | 2 | 1.08 |

**Table 12.** Lexical values of the practice items for the map task.

| Word | Word (English) | #Letters | #Syllables | Log Frequency |
|---|---|---|---|---|
| apetito | appetite | 7 | 4 | 1.94 |
| caldo | broth | 5 | 2 | 1.79 |
| cazo | saucepan | 4 | 2 | 1 |
| cebollinos | spring onions | 10 | 4 | 0.30 |
| episodio | episode | 8 | 4 | 1.98 |
| espinacas | spinach | 9 | 4 | 0 |
| guindilla | chilli | 9 | 3 | 0.3 |
| ostra | oyster | 5 | 2 | 0.9 |
| sabor | flavor | 5 | 2 | 2.14 |
| sésamo | sesame | 6 | 3 | 0.48 |
| sopa | soup | 4 | 2 | 1.92 |
| trozo | piece | 5 | 2 | 2.05 |

**Table 13.** Lexical values of the text words.

## 2.3 On the conceptual and articulatory nature of the attenuation of information phenomenon: the contribution of bilingualism

Rodríguez-Cuadrado, S. (in preparation). On the conceptual and articulatory nature of the attenuation of information phenomenon: the contribution of bilingualism.

# On the conceptual and articulatory nature of the attenuation of information phenomenon: the contribution of bilingualism

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The attenuation of information phenomenon shows that when words are predictable there is a decrease in their duration, intensity and pitch-related values. However, the nature of the phenomenon is unclear. Do speakers attenuate information because it is the second time that the concept is evoked or that the word is uttered? If attenuation answers to semantics, it would be irrelevant whether the same referent is repeated with a different word; but if it answers to articulation, uttering different words for the same referent would make an impact in attenuation. I use bilingualism to compare attenuation where both mentions of a referent were uttered in the same language with cases in which there was a language switch between mentions. Dyads completed collaborative maps in which words were uttered twice in Catalan or in Spanish, either repeating or switching the language between mentions. Results showed that words were attenuated for duration, intensity and pitch to the same extent when both mentions were uttered in the same or in a different language. However, pitch excursion was only attenuated in the repetition condition. Overall, this results support that attenuation of information is a phenomenon of conceptual nature, and acknowledges how articulation can also contribute to its realization.

# INTRODUCTION

When words are predictable, they are likely to be attenuated in a variety of ways, being this phenomenon called *attenuation of information*. Also, words can be predictable due to several factors. For instance, the predictability of a word can be determined by its frequency, context, or previous mention in a discourse, implying that the word would have shorter duration and/or lower intensity. In the present work, I am interested in the roots of the attenuation of information phenomenon, considering conceptual and articulatory modulations. That attenuation is modulated by semantics would imply that predictable words are attenuated because of facilitation in the access to the conceptual form of a word. Articulatory modulations would entail that predictable words are shortened because the word is easier to articulate. While I do not believe that conceptual and articulatory modulations are exclusionary, my question is about which is the most relevant, driving force, of the attenuation of information phenomenon.

Although there are a number of studies which indirectly showed evidence giving more weight to semantics or to articulation, no study up to date has been designed to examine the role that these two factors might have in a straightforward manner. In my study, participants completed a collaborative map with a confederate inspired in Fraundorf, Watson and Benjamin's task (under review), where items in the map appeared twice in order to elicit attenuation through repetition. Furthermore, the same item could be named with two different words, either with a Spanish or with a Catalan word. The language in which items were named was signalled to the participant with a flag in the screen. The rationale is that if attenuation is mainly driven by the predictability of the referent, it would be irrelevant how the object is labelled as long as it is referred twice. However, if attenuation answers to the predictability of a word's articulatory form, how the object is labelled

matters. This is, if articulation drives attenuation, it should not be present in cross-language mentions, or at least, it should be smaller than when the two mentions of an object are named in the same language, either in Spanish or in Catalan. Attenuation is measured through duration, intensity, pitch, pitch excursion and pitch range.

*The attenuation of information phenomenon: predictability sources and manifestations.*

Attenuation of information depends on the predictability of a word. One way in which attenuation is achieved is through word frequency: high frequency words have attenuated pronunciations compared to low frequency words (see Bell, 2002, 2009; Jurafksy et al., 2001). Another mean is "repetition", meaning that repeated words are attenuated compared to newly introduced words (Chafe, 1976; Fowler & Housum, 1987; Gundel, 1988; Prince, 1992; Robertson & Kirsner, 2000). Sentence context also influences predictability. In the classic example of Lieberman (1963), when analyzing the duration of the word "nine" from speakers' utterances in a highly predictable context (e.g.: "a stitch in time saves _____") or in a low predictable context (e.g.: "the number that you will hear is _____"), it was found that words in the predictable context were shorter and less intelligible than their unpredictable counterparts (see also Bell et al., 2002; Hunnicutt, 1985; Jespersen, 1923; Jurafsky et al., 2001). Finally, attenuation depends on the predictability given surrounding words, such as *joint* and *conditional* probabilities. Joint probability refers to the prior probability of two words taken together and conditional probability to the probability of a word given another word (see Bell et al., 2002; Gregory, 1999).

Attenuation of information is manifested in several ways. For instance, predictable information leads to shorter durations and lower intensities (Baker & Bradlow, 2009; Bell et al., 2002, 2003; Clark & Haviland, 1977;

Fowler & Housum, 1987; Gregory et al., 1999; Lieberman, 1963; Samuel & Troicki, 1998; Watson et al., 2008). Also, when information is predictable, mean pitch and pitch excursion decrease, and the pitch range of words is narrowed (see Watson et al., 2008). Referential expressions are also shortened, meaning that referents that have been introduced previously in the discourse tend to be shorter and less explicit (e.g.: *the red car* vs. *the car* vs. *it*) than newly introduced referents (Ariel, 1990; Chafe, 1976; Galati & Brennan, 2010; Grosz et al. 1995; Gundel et al., 1993). Finally, attenuation is manifested in a loss of intelligibility: when information is predictable, speakers produce less intelligible utterances than when information is unpredictable (see Bard & Aylett, 1999; Fowler & Housum, 1987; Galati & Brennan, 2010).

*Attenuation of information, is it conceptual or articulatory?*

There are a number of studies which indirectly have provided with evidence about the weight of conceptual and articulatory forces on the elicitation of the attenuation of information phenomenon (Bard et al., 2000; Bard & Aylett, 2004; Bell et al., 2001; Fowler, 1988; Fowler et al., 1997; Jurafsky et al., 2001; Kahn & Arnold, 2012; Trón, 2008). Nevertheless, a study directly addressing the issue of the roots of attenuation is needed.

Starting with those studies that speak in support of a conceptual weight in attenuation, Fowler (1988) found that when repeated words were read in a list their duration was not reduced. However, the same words were attenuated when appeared into meaningful prose. In addition, homophones do not lead to attenuation. This evidence suggests that attenuation is not driven by the mere repetition of articulatory forms, but that it is something related to the meaning of the word itself. Secondly, in the study of Fowler et al. (1997), participants engaged in a scene description task of a television

show. Words were repeated, belonging either to the same or to a different television scene. Fowler and collaborators (1997) found that attenuation was only present when the target word and its repetition belonged to the same scene. If the repetition belonged to a different scene, there was no attenuation.

The last piece of evidence in support of the role of semantics in attenuation is the dissociation between content and function words. Content words are defined as meaningful words, such as nouns, adjectives, verbs or adverbs. Function words have the role of structuring sentences, as made by pronouns, prepositions, articles and conjunctions. If attenuation is mainly driven by articulation, both content and function words should be reduced, presumably to the same extent. However, if attenuation is driven by meaning, content words should go through higher attenuation as content words are more meaningful than function words. In the regression analysis performed by Bell and collaborators (2009) in the Switchboard corpus (Greenberg et al., 1996), authors found that content words were attenuated for duration, but function words were not. Word frequency (being frequency another predictability factor) also influenced content words but barely affected function words. Also, in the study of Jurafsky et al. (2001), regression analyses were performed on two different datasets drawn from the Switchboard corpus (Greenberg et al. 1996) for content and function words separately. The duration of function words was mainly affected by the conditional probability of the preceding and following words, but it was not affected by word repetition. Content words showed a different pattern, where frequency and repetition were the two main sources of predictability that affected word duration. I believe that the findings of these two studies support the view of attenuation being mainly driven by meaning. This is because function words, which have a grammatical purpose rather than a semantic purpose, were either not reduced or their reduction was affected by

different means than for content words.

Considering those studies supporting the weight of articulation, while they do not neglect that semantics affect attenuation, they believe that articulation would have a higher impact. Articulation would act as an extra facilitator step in the production of attenuated utterances. The study of Bard and collaborators (2000) looked at the attenuation of word duration and referential expressions through a collaborative map task in which several landmarks were repeated under different conditions (as, for instance, landmarks being visible to both speakers or not, or the listener being present in both mentions or not). Concretely, in study 4, first and second mentions of landmarks could be either visible to both conversational partners or not visible to the listener. Listeners assigned given status to the word if they heard it twice, even though they only saw the landmark once. This suggests that linguistic giveness, rather than visual giveness, is crucial for attenuation, where the effect of visual giveness was only additive. However, Bard et al.'s (2000) study was not designed with the purpose of researching on the origins of attenuation, and the two mentions of the landmarks were cross-repeated (each participant uttered one mention) instead of self-repeated. Then, the issue of linguistic/visual giveness and self-/cross-repetitions (which will be outlined in the next section) could be confounded in this particular case.

Kahn & Arnold's study (2012) dealt with how attenuation was influenced by linguistically given and by visually given information. The task of participants was to address listeners about moving objects that were either linguistically and visually primed (this is, objects that were spoken aloud through speakers and flashed in the screen; I will refer to this type as "linguistically given" for the sake of simplicity) or just visually primed (control trials were also included). It was found that both linguistic and visual

giveness led to attenuation, but linguistically given items were more reduced than visually given items. This suggests that while both articulation and semantics would be at play when attenuating, linguistic giveness leads to more reduction. Kahn & Arnold's findings are framed within the *Facilitation-Based Reduction Hypothesis* (Kahn & Arnold, 2012). This hypothesis assumes that speakers attenuate because speech is facilitated, where more facilitation leads to more reduction. Linguistically given information would be more accessible because articulation primes one extra step (the articulatory levels) in speech production than non-linguistically given information.

Finally, I would like to outline the issue of self- and cross-repetitions. It relates to whether attenuation is affected by the identity of the speaker who utters the second mention. This is, in a task in which speaker A and speaker B participate, and speaker A utters the first instance of a word, would it matter for attenuation if the second mention is uttered by speaker A (this is, "self-repetition condition") or by speaker B (this is, "cross-repetition condition")? Or, as long as both speakers listened to the first mention together, attenuation would occur? Whether self and cross repetitions lead to different amounts of reduction can be helpful to disentangle the weight of conceptual and articulatory influences on attenuation. This is, if the nature of attenuation is mainly conceptual, the identity of who utters the second mention would be irrelevant as the item is given for both participants. But if articulation plays a role, reduction should be higher when both mentions are uttered by the same speaker, due possibly to articulatory priming. However, literature in this issue is not clear. Bard & Aylett (2004, Experiment 3) found through the performance of a map task that attenuation was unaffected by who uttered the first mention. On the contrary, Trón (2008) analysed recordings from the Edinburgh Maptask Corpus finding that self-repetitions were more attenuated than cross-repetitions.

In this study, predictability is manipulated through repetition and attenuation is measured for duration, intensity, pitch, pitch excursion and pitch range. The role that semantics and word articulation have in attenuation is examined through the use of bilingualism, comparing utterances in which both mentions are articulated in the same language (repeat condition) versus utterances in which there is a change of language between the first and the second mention (switch condition).

*Predictions for current research*

As it was stated a few lines ago, evidence up to date does not suffice to assess the roots of attenuation. This is because studies were not designed with this purpose and because the available evidence supports both semantics and articulation. Due to this reason, I believe that the need of providing with evidence on the nature of the phenomenon is indubitable.

I predict that repeated words will be shortened both when the two mentions of an item are uttered in the same language and when there is a language switch, due to the multiple evidences in the literature supporting the presence of conceptual modulations. Regarding whether attenuation would work in the same way for repeat and for switch trials, predictions are not that straightforward. This is, although some reduction is expected in any case due to the presence of conceptual modulations, it is plausible that articulation facilitates attenuation. According to Kahn & Arnold's Facilitation-Based Reduction Hypothesis (Kahn & Arnold, 2012), the bigger the facilitation in speech production, the larger the attenuation. Then, articulatory priming should boost attenuation, expecting bigger attenuation in conditions in which both mentions are uttered in the same language compared to when there is a language switch. This idea would be further explored by the inclusion of cognates, words belonging to different languages which share an

etymological origin. Congruently with the Facilitation-Based Reduction Hypothesis, even though less attenuation would be expected for mentions in the switch condition, those mentions involving cognates would be benefited regarding attenuation compared to non-cognates (as it implies priming of articulatory forms). Also, as the task is performed by balanced bilinguals, I do not expect differences in attenuation depending on the language. This is, if bilinguals were more proficient in one language than in another, it could be expected that attenuation worked differently in their second than in their first language (although evidence in text reading shows that unbalanced bilinguals also attenuate in their second language, see Baker et al., 2011). Having balanced leads to the hypothesis that attenuation would not differ between Spanish and Catalan.

Therefore, predictions are:

- Both repeat and switch second mentions will be attenuated in comparison with first mentions.

- Due to a plausible larger amount of facilitation, second mentions in the repeat condition are susceptible to be more attenuated than second mentions in the switch condition.

- Attenuation in the switch condition might be benefited by the presence of cognates, compared to non-cognates.

- As the task will be performed by balanced bilinguals, no differences in attenuation depending on language are expected.

METHOD

*Participants*

31 balanced Spanish-Catalan bilinguals (12 male, 19 female, mean age: 26.51 years, sd: 8.22) took part in the experiment. All participants reported speaking Spanish and Catalan from an early age and felt equally proficient in both languages. They received 7 euro for their participation. All participants had normal or corrected-to-normal vision and none of the participants reported having any speech or hearing impairments. Participants were recruited from the Universitat Pompeu Fabra subjects' data base.

*Materials & Method*

In order to examine the duration, intensity, pitch, pitch excursion and pitch range of first and second mentions in the repeat and switch conditions, I made use of the collaborative map task of Fraundorf, Watson and Benjamin (under review). In this task, a Spanish-Catalan participant acted as the instruction giver, and a Spanish-Catalan confederate as the instruction receiver. The instruction giver had a sequence of 6 maps (plus a practice map) displayed on a computer screen using DMDX (Forster & Forster, 2003). Each map consisted in two arrays of four objects, four displayed in a string in the upper part of the map and four in the lower part, where two objects were linked in eight consecutive steps per map. Each object appeared in two different links, which could be horizontal (two objects in the same string in the upper or in the lower part of the screen), vertical (two objects in the same axis in different strings from the upper to the lower or from the lower to the upper part of the screen) or diagonal (two objects in different axis in different strings from the upper to the lower or from the lower to the upper part of the screen). In addition, on the top left of the screen, either a

Spanish or Catalan flag cued to the instruction giver the language required to utter the instruction (see Figure 24).

The instruction receiver (confederate) had exactly the same 6 maps (plus the practice map) as the instruction giver printed on paper, with no links between the objects and without the flag. The task of the instruction giver was to tell the instruction receiver which were the two linked objects and in which manner, giving instructions aloud of the type "go from the skittle (object 1) to the piggy bank (object 2)", always following the arrow's direction and uttering the instruction in the language cued by the flag. The task of the instruction receiver was, after hearing the instruction, to draw an arrow between the corresponding objects in paper. Each step in the map remained on the screen until the instruction giver pressed the spacebar once he/she uttered the instruction. Participants were seated face to face in a soundproof booth. The screen of the instruction giver's laptop prevented both the instruction giver and the instruction receiver to see each other's screen/paper map.
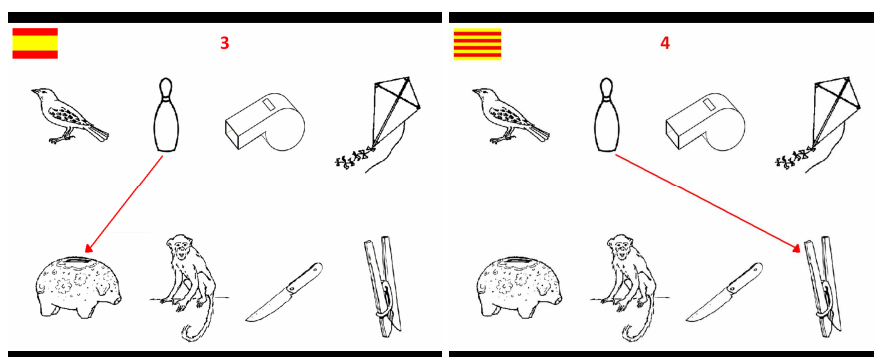


**Figure 24.** Example of the map task. The repetition of "skittle" from step 3 (to be named in Spanish) to step 4 (to be named in Catalan) constitutes a switch trial.

Items consisted of 48 black and white line drawings selected from several

sources (including the Snodgrass database (Snodgrass & Vanderwart, 1980) and the International Picture Naming Project (Szekely et al., 2004). Drawings corresponded to 48 Spanish and 48 Catalan words equated in number of letters and logarithmic frequency. Frequency values for both Spanish and Catalan words were obtained through the NIM software (Guasch et al., 2012). Half of the items were cognates, where Spanish cognates and non-cognates and Catalan cognates and non-cognates did not differ in terms of logarithmic frequency or number of letters. Items were randomly distributed in the following respects: 1) the map (from 1 to 6) to which the item belonged, 2) the order (from 1 to 8, 1-4 above, 5-8 below) in which items were displayed in the maps' arrays, 3) the order in which they were mentioned (from 1st to 16th place, including 1st and 2nd mentions) and 4) the item with which words were paired (there being two different randomizations). In order to answer to the question about to what extent attenuation of information's nature is related to conceptual or articulatory forces, half of the second mentions were uttered in the same language as first mentions (repeat trials) whereas in the other half there was a language switch (switch trials):
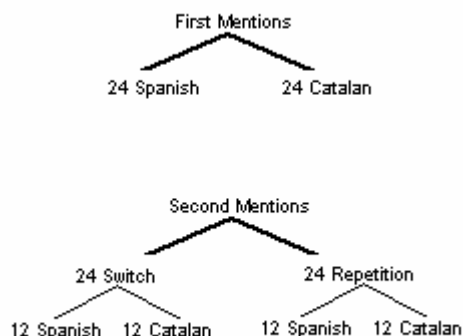


**Figure 25.** Distribution of trials for first and second mentions.

Once randomization order and distribution of items were made, 4 different lists were created (for a detailed example of the lists for a map, see Table 16 (in English) or 17 (in Spanish and Catalan) in the Appendix). Each list contained, for each map, two items whose second mention was a repetition in Spanish (e.g.: "knife" and "kite" in List 1), two items whose second mention was a repetition in Catalan (e.g.: "whistle" and "bird" in List 1), two items whose second mention was a switch trial, being the first mention in Spanish and the second mention in Catalan (e.g.: "skittle" and "piggy bank" in List 1), and finally, two items whose second mention was a switch trial, being the first mention in Catalan and the second mention in Spanish (e.g.: "monkey" and "pin" in List 1). Furthermore, it was ensured that those words that were presented at the beginning of the sentence of instruction (e.g.: "skittle" in "go from the skittle to the piggy bank"), were presented at the end for the half of participants (thus, "skittle" in "go from the piggy bank to the skittle"). Thus, there were a total of eight lists as a result of multiplying the original four lists with the two possibilities for item position within a sentence. Additionally, the two mentions of an object were not immediate, but there were between 1 and 13 intervening words between mentions, depending on the randomization in the mention order.

A total of 96 mentions were uttered per participant, 48 first mentions and 48 second mentions. Out of the 48 first mentions, 24 were named in Spanish, and 24 were named in Catalan. The same distribution applies for second mentions.

Utterances were recorded, labeled and analyzed using Praat version 5.3.15 (Boersma & Weenink, 2008), obtaining duration (milliseconds), intensity (decibels), pitch (hertz), pitch excursion (hertz) and pitch range (hertz) values for each utterance. Analyses of utterances were blind to the experimenter. The task lasted approximately 20 minutes.

RESULTS

*Data analysis*

Analyses were performed as follows. *First mentions* included all mentions which were uttered for the first time, regardless of whether the second mention of that word was uttered in the same or in a different language. Second mentions could be of two types. *Repeat mentions* were those second mentions uttered in the same language than first mentions. *Switch mentions* were those second mentions uttered in a different language than first mentions. As the four possible combinations per each item (two mentions in Spanish, two mentions in Catalan, first mention in Spanish and second in Catalan or first mention in Catalan and second in Spanish) were distributed in quartets of participants, analyses are reported by subject and not by item.

*General analysis*

A Repeated Measures ANOVA was run for every measure of interest (duration, intensity, pitch, pitch excursion and pitch range) with *trial type* (first mention, second mention repeat and second mention switch) as a within-subjects variable.

Duration

There was a main effect of trial type ($F_1$ (2, 60) : 12.246, $p < .001$). Bonferroni post-hoc comparisons showed that first mentions were significantly longer than both repeat ($p < .001$) and switch ($p : .006$) second mentions, but repeat and switch trials were no different.
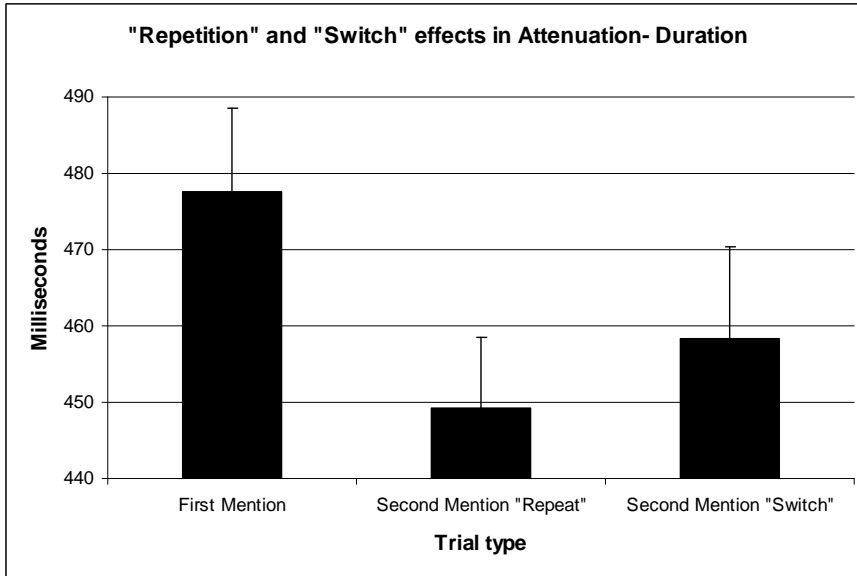
**Figure 26.** Attenuation of information depending on trial type for duration. Error bars represent standard errors of the mean.

Intensity

There was a main effect of trial type ($F_1$ (2, 60) : 8.856, $p$ < .001). Bonferroni post-hoc comparisons showed that first mentions had significantly higher intensity than both repeat ($p$ < .001) and switch ($p$ : .032) second mentions, but repeat and switch trials were no different.
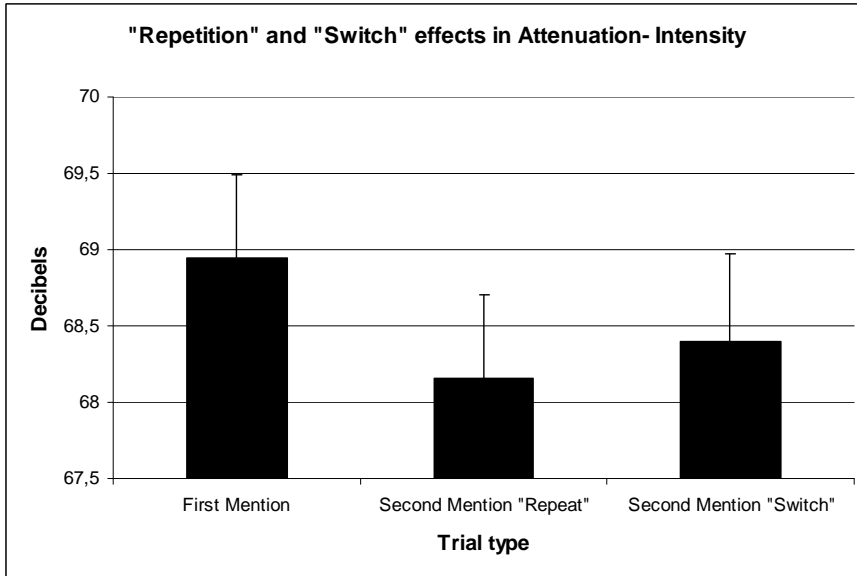
**Figure 27.** Attenuation of information depending on trial type for intensity. Error bars represent standard errors of the mean.

Pitch

There was a main effect of trial type ($F_1$ (2, 60) : 12.640, $p < .001$). Bonferroni post-hoc comparisons showed that first mentions had significantly higher pitch than both repeat ($p < .001$) and switch ($p : .003$) second mentions, but repeat and switch trials were no different.
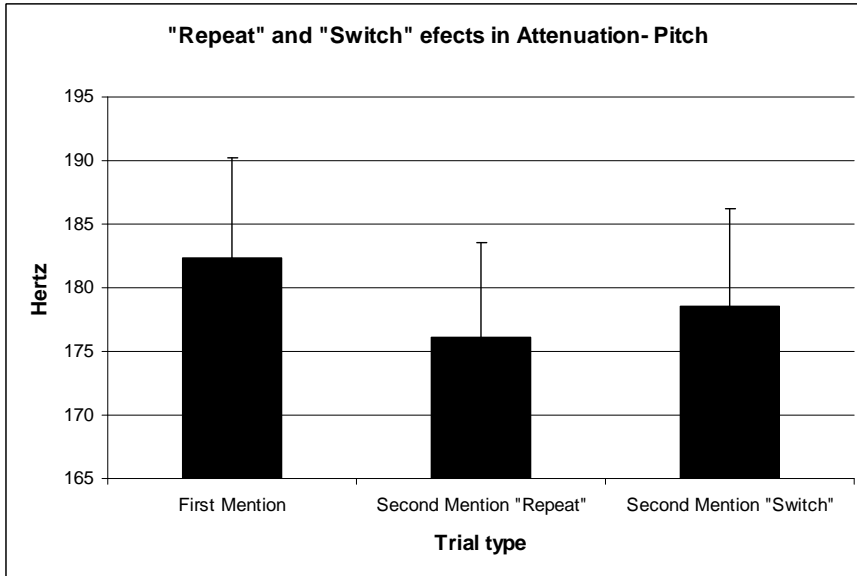
**Figure 28.** Attenuation of information depending on trial type for pitch. Error bars represent standard errors of the mean.

Pitch excursion

There was a main effect of trial type ($F_1$ (2, 60) : 5.162, $p$ : .009). Bonferroni post-hoc comparisons showed that first mentions significantly differed from repeat second mentions ($p$ : .024) but not from switch second mentions.
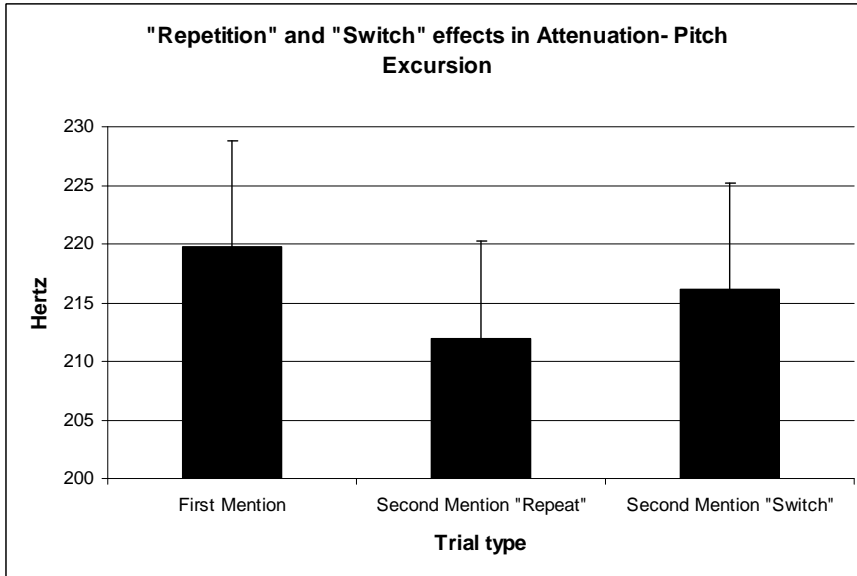
**Figure 29.** Attenuation of information depending on trial type for pitch excursion. Error bars represent standard errors of the mean.

Pitch range

There was no main effect of trial type for pitch range.
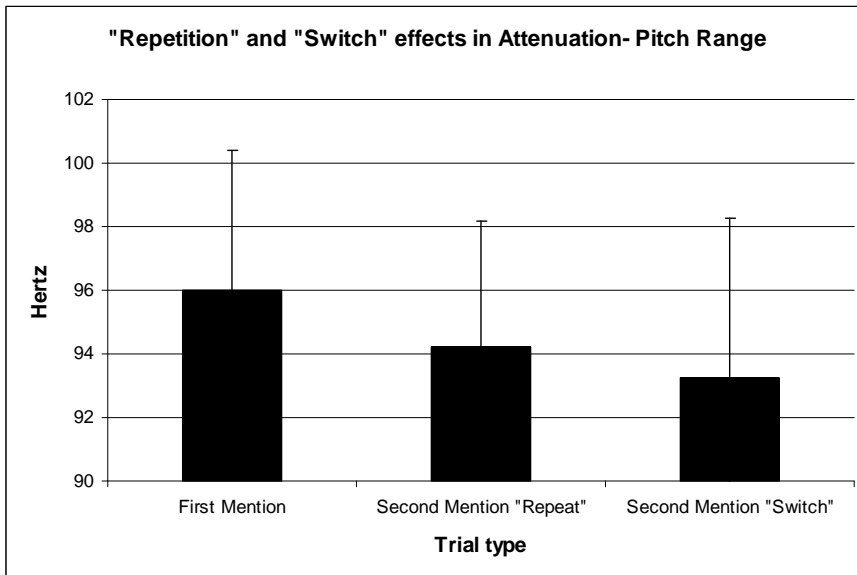
**Figure 30.** Attenuation of information depending on trial type for pitch excursion. Error bars represent standard errors of the mean.

| | First mention | Second mention "repeat" | Second mention "switch" |
|---|---|---|---|
| **Duration** | 477 (60) | 449 (52) | 458 (67) |
| **Intensity** | 68.9 (3.07) | 68.2 (3.03) | 68.4 (3.2) |
| **Pitch** | 182 (43.72) | 176 (41.52) | 179 (42.71) |
| **Pitch excursion** | 220 (50) | 212 (46) | 217 (51) |
| **Pitch range** | 96 (24) | 94 (22) | 93 (28) |

**Table 14.** Summary of attenuation of information results across trial types and measures. Standard deviations are shown into brackets.

*Cognate effect*

In order to address whether the cognate status of words modulated attenuation of information between first mentions and switch second mentions, several ANOVAs were run with *trial type* (this is, first mentions and second mentions in the switch condition) as a within-subjects variable and *cognate status* (cognate or non-cognate) as a between-subjects variable for duration, intensity, pitch, pitch excursion and pitch range. No effect of cognate status was found for any of the measures (duration, intensity, pitch, pitch excursion or pitch range) in attenuation of information. This result indicated that the presence of cognates did not affect attenuation.

*Language effect*

In order to see whether attenuation exhibited a different pattern depending of the language of the utterance (Spanish or Catalan), and whether switch

trials varied depending on the directionality of the switch (this is, from Spanish to Catalan or from Catalan to Spanish), five RM ANOVAs were run, one per measure of interest. RM ANOVAs included *trial type (*first mentions, second mentions in the repeat condition and second mentions in the switch condition) as a within-subjects variable and *language* (Spanish or Catalan) as a between-subjects variable. Results revealed no effect of language for any of the measures.

## DISCUSSION

The aim of the current work was to research into the conceptual and articulatory roots of the attenuation of information phenomenon, asking whether attenuation is driven by the second evocation of a concept or by the second articulation of a word. In order to approach this issue, pairs of participants (one participant and one confederate) engaged in a collaborative map task in which 48 items were mentioned twice to check for attenuation effects by repetition in duration, intensity, pitch, pitch excursion and pitch range. Crucially, second mentions could be uttered in the same or in a different language than first mentions (this is, either in Spanish or in Catalan, where the language of instruction was cued by a flag). This way, attenuation could be elicited within languages (repeat trials) or between languages (switch trials). If attenuation answered to a conceptual modulation, it would be irrelevant whether the second mention of an item was uttered in the same or in a different language than the first mention, as the concept is evoked twice. On the contrary, if attenuation was a phenomenon of a more articulatory nature, it would be more likely to be observed when both mentions were uttered in the same language than when each mention is uttered in one language, due to reasons as articulatory facilitation. A further way to explore the role of conceptual and articulatory modulations in attenuation was to include cognate words for switch trials. Due to the similarity of cognates

from an articulatory point of view, if articulation shapes attenuation, attenuation would be expected to be higher in those switch mentions containing cognates compared to those with non-cognates.

Four predictions were made in the introduction. First, I hypothesized that both repeat and switch second mentions would be attenuated in comparison to first mentions. The data confirmed this prediction for duration, intensity, pitch and pitch excursion, replicating previous findings in which speakers attenuated information along several indicators when involved in a collaborative task with a partner (e.g.: Bard et al., 2000; Bard & Aylett, 2004; Galati & Brennan, 2010; Watson et al., 2008). Attenuation was not found for pitch range.

The second prediction was that second mentions in the repeat condition would be more susceptible to be attenuated than second mentions in the switch condition, due to a larger amount of facilitation. This was only true for pitch excursion, as duration, intensity and mean pitch were attenuated in comparable amounts both in repeat and in switch trials. This result suggests that attenuation would be mainly modulated by semantics, where articulatory facilitation was only found for pitch excursion. As pitch excursion is the most extreme pitch value, it is likely that the differences between repeat and switch trials are maximized for pitch excursion. Although the Facilitation-Based Reduction Hypothesis (Kahn & Arnold, 2012) assumes the speaker's experience with the word facilitates pronunciation over and above the activation of the concept, in this case it was only evidenced in pitch excursion.

The third prediction was that in case articulation facilitates attenuation, cognates in the switch condition should be more attenuated than non-cognates. Results, however, showed that this prediction was wrong, as attenuation in switch trials was present regardless of whether the words in

the two languages were cognates or non-cognates (this is, cognates and non-cognates were no different concerning attenuation). This further supports the superior role of conceptual modulations in attenuation, as if articulation was fundamental for attenuation, switch mentions including cognates should have been more reduced than those without cognates. Therefore, without denying the aid of articulation in generating the phenomenon, I believe that concept evocation would be the main motivation for attenuation. Finally, as the task was carried by balanced bilinguals, I did not expect any differences in attenuation depending on the language. The results supported this prediction as no differences in attenuation were observed depending on language for duration, intensity and pitch-related measures.

This pattern of results supports that attenuation can not be reduced to articulatory priming. This goes in line with previous data. For instance, if speakers read repeated words on a list or if the target word has been primed by a homophone, reduction is not observed (Fowler, 1988). Also, attenuation has been found when the two repetitions of an item have different articulatory forms, for instance, when second mentions are anaphors of the target word (Fowler & Housum, 1987; McKoon & Ratcliff, 1980). Lam & Watson (2010) suggest that the aforementioned evidence indicates that the attenuation can not be realized at the phonological level.

Now, I would like to address why pitch range was not attenuated. Pitch range is measured as the difference between maximum and minimum pitch values within a word. It refers to voice inflections and it is used to emphasize information (e.g.: Ladd and Morton, 1997; Pierrehumbert & Hirschberg, 1990). That is, while duration or mean pitch have been linked to processes of a more articulatory nature (Watson et al., 2008), pitch range serves a discursive function, as it is emphasizing. In addition, Xu & Xu (2005) found that information out of focus has a reduced pitch-range compared to

information in focus. Therefore, I believe that it is possible that speakers emphasized both mentions of the object as a means of giving relevance to the task, aiding speakers to follow them in a language-switching task. This is, participants might want to keep the names of items in focus to guarantee success in the task, while signalling given status through indicators as duration.

This study also provides evidence to the field of bilingual speech production. Extra analyses were performed to elucidate whether the Spanish-Catalan balanced bilinguals went through an overall switch cost. The switch cost refers to the difference in performance between switch and repeat trials. In the present study, some sentences were uttered in Catalan and some in Spanish. Then, in some cases, two (or more) sentences in a row were uttered in the same language, and in other cases there was a language switch from Spanish to Catalan or from Catalan to Spanish. I ran a MANOVA with *measure* (duration, intensity, pitch, pitch excursion and pitch range) as a within-subjects variable, and *trial type* (repeat or switch) for first mentions only (as I was interested in the switch from one sentence to another, but not from one mention to another). Results showed that Spanish-Catalan bilinguals switched from one language to another with ease, as no switch costs were found for duration, intensity, pitch, pitch excursion or pitch range. What remains unsolved is whether switch costs could be observed in other indicators out of the scope of the present research, for instance, at planning regions as onset to speak (this is, the time between a stimulus is presented and a word is uttered).

These results also show that when a concept is accessed, representations in both languages are activated, as no switch costs are observed between different language trials and attenuation occurs overall for repeat and for switch trials. This is in line with numerous previous evidence showing

activation for the two lexicons of a bilingual, as the lexical nodes of both languages receive activation from the semantic system when one language gets lexicalized (see, for instance, Colomé, 2001; Costa, et al., 2000; Costa, et al., 2003; De Bot, 1992; Gollan & Kroll, 2001).

Finally, I would like to address a question that the current study opens: how would conceptual and articulatory influences would work if participants were less proficient in one of the target languages? An obvious prediction would be that the language in which repeat and switch trials were uttered would matter. Some of the problems related to second language production involve deviant speech rate compared to the native's (or their L1) or difficulties in word pronunciation or syntax. Also, non-native speakers might feel embarrassed of their pronunciations (see Costa et al., 2008). As a consequence, I adventure that in overall terms those mentions involving the less proficient language would be longer in duration than those uttered in the dominant language. It is also plausible that the "fear" of making mistakes lead non-proficient bilinguals to speak lower in volume. What is hard to predict, however, is whether this unbalance between the first and second language of a non-proficient bilingual would affect attenuation of information and the weight that conceptual and articulatory modulations might have. A number of possibilities arise. First, as results in this study showed that conceptual influences seem to dominate attenuation, second language speech problems could be observed at overall (as speaking slower in general) but not specifically for attenuation. This is, for instance, first and second mentions could be longer in their second than in their first language, but the size of their attenuations or more accurately, their percentage of reduction, does not have to be different.

However, on second place, there is also the possibility that semantic modulations diminish when speakers experience articulatory problems. If unbalanced bilinguals experience trouble in producing second language

words, those repeat trials uttered in their second language could go through less attenuation. For switch mentions, if the first mention was in the native language and the second mention in the non-native language, attenuation could disappear due to articulatory trouble. However, if attenuation in the first mention is in the non-native language and in the second mention is in the native language, attenuation could be maximized. Combining these two situations could generate an attenuation size comparable to those of balanced bilinguals.

To conclude, the current study suggests that attenuation of information is mainly and primarily modulated by semantics, as speakers attenuated second production of words even when they were uttered in different languages. The influence of articulatory priming on attenuation is also acknowledged, but it was probed to be relevant only for pitch excursion, which constitutes an extreme pitch value. This way, this study directly elucidates, for the first time, that attenuation is mainly driven by semantics, rather than by articulatory modulations.

APPENDIX

| Spanish Word | Catalan Word | English Word | LFreq Spanish | LFreq Catalan | #Letters Spanish | #Letters Catalan | Cognate Status |
|---|---|---|---|---|---|---|---|
| aguja | agulla | needle | 0,995 | 1,38 | 5 | 6 | cognate |
| alfombra | catifa | carpet | 1,23 | 0,921 | 8 | 6 | non-cognate |
| anillo | anell | ring | 1,197 | 1,255 | 6 | 5 | cognate |
| arco | arc | arc | 1,375 | 1,555 | 4 | 3 | cognate |
| balanza | balança | balance | 1,092 | 1,062 | 7 | 7 | cognate |
| ballena | balena | whale | 0,604 | 0,484 | 7 | 6 | cognate |
| banco | banc | bench | 1,679 | 1,612 | 5 | 4 | cognate |
| bastón | bastó | walking stick | 1,105 | 1,399 | 6 | 5 | cognate |
| biberón | biberó | bottle | 0,604 | 0,143 | 7 | 6 | cognate |
| bolo | bitlla | skittle | 0,186 | 0,105 | 4 | 6 | non-cognate |
| búho | mussol | owl | 0,736 | 0,844 | 4 | 6 | non-cognate |
| caja | caixa | box | 1,661 | 1,743 | 4 | 5 | cognate |
| cama | llit | bed | 2,136 | 2,188 | 4 | 4 | non-cognate |
| cangrejo | cranc | crab | 0,384 | 0,719 | 8 | 5 | non-cognate |
| casco | casc | helmet | 1,265 | 0,998 | 5 | 4 | cognate |
| cepillo | raspall | brush | 0,789 | 0,625 | 7 | 7 | non-cognate |
| cerilla | llumí | match | 0,658 | 0,556 | 7 | 5 | non-cognate |
| cesta | cistella | basket | 0,889 | 0,712 | 5 | 8 | cognate |
| cinturón | cinturó | belt | 1,192 | 0,837 | 8 | 7 | cognate |
| cometa | estel | kite | 0,927 | 1,298 | 6 | 5 | non-cognate |
| cruz | creu | cross | 1,401 | 2,248 | 4 | 4 | cognate |
| cubo | galleda | bucket | 0,848 | 0,738 | 4 | 7 | non-cognate |
| cuchillo | ganivet | knife | 1,212 | 1,353 | 8 | 7 | non-cognate |
| cuna | bressol | cradle | 1,122 | 1,098 | 4 | 6 | non-cognate |
| espejo | mirall | mirror | 1,822 | 1,587 | 6 | 6 | non-cognate |
| gafas | ulleres | glasses | 1,53 | 1,266 | 5 | 7 | non- |

| | | | | | | | cognate |
|---|---|---|---|---|---|---|---|
| hacha | destral | ax | 0,858 | 1,038 | 5 | 7 | non-cognate |
| hucha | guardiola | piggy bank | 0,233 | 0,388 | 5 | 9 | non-cognate |
| imán | imant | magnet | 0,776 | 0,363 | 4 | 5 | cognate |
| jarrón | gerro | vase | 0,691 | 0,79 | 6 | 5 | non-cognate |
| jirafa | girafa | giraffe | 0,315 | 0,137 | 6 | 6 | cognate |
| martillo | martell | hammer | 0,801 | 0,987 | 8 | 7 | cognate |
| mono | mico | monkey | 1,281 | 0,544 | 4 | 4 | non-cognate |
| oreja | orella | ear | 1,359 | 1,724 | 5 | 6 | cognate |
| pájaro | ocell | bird | 1,335 | 1,564 | 6 | 5 | non-cognate |
| pecera | peixera | fishbowl | 0,233 | 0,359 | 6 | 7 | cognate |
| perro | gos | dog | 1,787 | 1,786 | 5 | 3 | non-cognate |
| pie | peu | foot | 2,124 | 2,246 | 3 | 3 | cognate |
| pinza | pinça | pin | 0,47 | 0,283 | 5 | 5 | cognate |
| piña | pinya | pineapple | 0,542 | 0,633 | 4 | 5 | cognate |
| plato | plat | dish | 1,502 | 1,639 | 5 | 4 | cognate |
| ratón | ratolí | mouse | 0,927 | 0,755 | 5 | 6 | cognate |
| silbato | xiulet | whistle | 0,415 | 0,949 | 7 | 6 | non-cognate |
| silla | cadira | chair | 1,69 | 1,726 | 5 | 6 | non-cognate |
| sombrero | barret | hat | 1,497 | 1,538 | 8 | 6 | non-cognate |
| tiburón | tauró | shark | 0,564 | 0,296 | 7 | 5 | non-cognate |
| tronco | tronc | log | 1,161 | 1,436 | 6 | 5 | cognate |
| ventana | finestra | window | 1,975 | 1,89 | 7 | 8 | non-cognate |

**Table15.** List of experimental stimuli

| Cond 1a | | Cond 1b | | Cond 2a | | Cond 2b | |
|---|---|---|---|---|---|---|---|
| 1st object | 2nd object | 1st object | 2nd object | 1st object | 2nd object | 1st object | 2nd object |
| whistle (cat) | bird (cat) | bird (cat) | whistle (cat) | whistle (sp) | bird (sp) | bird (sp) | whistle (sp) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| knife (sp) | kite (sp) | kite (sp) | knife (sp) | knife (cat) | kite (cat) | kite (cat) | knife (cat) |
| skittle (sp) | piggy bank (sp) | piggy bank (sp) | skittle (sp) | skittle (cat) | piggy bank (cat) | piggy bank (cat) | skittle (cat) |
| skittle (cat) | pin (cat) | pin (cat) | skittle (cat) | skittle (sp) | pin (sp) | pin (sp) | skittle (sp) |
| knife (sp) | pin (sp) | pin (sp) | knife (sp) | knife (cat) | pin (cat) | pin (cat) | knife (cat) |
| monkey (cat) | bird (cat) | bird (cat) | monkey (cat) | monkey (sp) | bird (sp) | bird (sp) | monkey (sp) |
| monkey (sp) | kite (sp) | kite (sp) | monkey (sp) | monkey (cat) | kite (cat) | kite (cat) | monkey (cat) |
| whistle (cat) | piggy bank (cat) | piggy bank (cat) | whistle (cat) | whistle (sp) | piggy bank (sp) | piggy bank (sp) | whistle (sp) |
| **Cond 3a** | | **Cond 3b** | | **Cond 4a** | | **Cond 4b** | |
| **1st object** | **2nd object** | **1st object** | **2nd object** | **1st object** | **2nd object** | **1st object** | **2nd object** |
| knife (sp) | kite (sp) | kite (sp) | knife (sp) | knife (cat) | kite (cat) | kite (cat) | knife (cat) |
| skittle (cat) | piggy bank (cat) | piggy bank (cat) | skittle (cat) | skittle (sp) | piggy bank (sp) | piggy bank (sp) | skittle (sp) |
| skittle (cat) | bird (cat) | bird (cat) | skittle (cat) | skittle (sp) | bird (sp) | bird (sp) | skittle (sp) |
| knife (cat) | piggy bank (cat) | piggy bank (cat) | knife (cat) | knife (sp) | piggy bank (sp) | piggy bank (sp) | knife (sp) |
| monkey (sp) | pin (sp) | pin (sp) | monkey (sp) | monkey (cat) | pin (cat) | pin (cat) | monkey (cat) |
| monkey (sp) | bird (sp) | bird (sp) | monkey (sp) | monkey (cat) | bird (cat) | bird (cat) | monkey (cat) |
| whistle (cat) | kite (cat) | kite (cat) | whistle (cat) | whistle (sp) | kite (sp) | kite (sp) | whistle (sp) |
| whistle (sp) | pin (sp) | pin (sp) | whistle (sp) | whistle (cat) | pin (cat) | pin (cat) | whistle (cat) |

**Table 16. Example of items distributions across lists in a map**. Numbers 1, 2, 3, 4 refer to the different list combinations for having 2 repeat Spanish, 2 repeat Catalan, 2 switch Spanish-Catalan and 2 Catalan-Spanish items per list. Letters *a* and *b* refer to the order in which critical words were uttered within a sentence (meaning that those uttered at the beginning for condition a were uttered at the end for condition b and vice-versa).

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| Cond 1a | | Cond 1b | | Cond 2a | | Cond 2b | |
|---|---|---|---|---|---|---|---|
| 1st object | 2nd object | 1st object | 2nd object | 1st object | 2nd object | 1st object | 2nd object |
| xiulet | ocell | ocell | xiulet | silbato | pájaro | pájaro | silbato |
| cuchillo | cometa | cometa | cuchillo | ganivet | estel | estel | ganivet |
| bolo | hucha | hucha | bolo | bitlla | guardiola | guardiola | bitlla |
| bitlla | pinça | pinça | bitlla | bolo | pinza | pinza | bolo |
| cuchillo | pinza | pinza | cuchillo | ganivet | pinça | pinça | cuchillo |
| mico | ocell | ocell | mico | mono | pájaro | pájaro | mono |
| mono | cometa | cometa | mono | mico | estel | estel | mico |
| xiulet | guardiola | guardiola | xiulet | silbato | hucha | hucha | silbato |

| Cond 3a | | Cond 3b | | Cond 4a | | Cond 4b | |
|---|---|---|---|---|---|---|---|
| 1st object | 2nd object | 1st object | 2nd object | 1st object | 2nd object | 1st object | 2nd object |
| cuchillo | cometa | cometa | cuchillo | ganivet | estel | estel | ganivet |
| bitlla | guardiola | guardiola | bitlla | bolo | hucha | hucha | bolo |
| bitlla | ocell | ocell | bitlla | bolo | pájaro | pájaro | bolo |
| ganivet | guardiola | guardiola | ganivet | cuchillo | hucha | hucha | cuchillo |
| hucha | pinza | pinza | hucha | mico | pinça | pinça | mico |
| mono | pájaro | pájaro | mono | mico | ocell | ocell | mico |
| xiulet | estel | estel | xiulet | silbato | cometa | cometa | silbato |
| silbato | pinza | pinza | silbato | xiulet | pinça | pinça | xiulet |

**Table 17**. Example of items distributions across lists in a map in their original language (Spanish or Catalan)

| Spanish Word | Catalan Word | English Word | LFreq Spanish | LFreq Catalan | #Letters Spanish | #Letters Catalan | Cognate Status |
|---|---|---|---|---|---|---|---|
| árbol | arbre | tree | 1.55 | 1.99 | 5 | 5 | cognate |
| bombilla | bombeta | light bulb | 0.8 | 0.94 | 8 | 7 | cognate |
| cohete | cohet | rocket | 0.87 | .1 | 6 | 5 | cognate |
| globo | globus | balloon | 1.05 | 1.03 | 5 | 6 | cognate |
| manzana | poma | apple | 1.08 | 1.13 | 7 | 4 | non-cognate |
| seta | bolet | mushroom | 0.13 | .95 | 4 | 5 | non-cognate |
| tenedor | forquilla | fork | 0.67 | .73 | 7 | 9 | non-cognate |
| vaso | got | glass | 1.58 | 1.12 | 4 | 3 | non-cognate |

**Table 18.** List of practice stimuli.

# 3 General discussion

## 3.1   Summary of results

This dissertation had two general aims. First, to explore how attenuation of information works in situations in which non-native speakers are involved both as producers and as listeners. Second, to explore the conceptual and articulatory roots of the attenuation of information phenomenon.

Performing *audience design* means to tailor our message to the characteristics and needs of the listener (Clark & Carlson, 1982; Clark & Murphy, 1982). If the message is tailored to non-native speakers, it is called *foreigner talk* (see Campbell, 1977; Ferguson, 1971; James, 1986; Lattey, 1981 or Wenk, 1978).

In the current dissertation we address three main questions. First, focusing on the non-native speaker acting as the listener, we were interested in whether and how foreigner talk interacted with attenuation of information. As attenuating information conveys both a pragmatic benefit and an intelligibility drawback, we were interested in how these forces are at play when natives talk to non-natives; also, our interest lied in how the pragmatic benefit and the intelligibility drawback of attenuation interact with foreigner talk in order to maximize the comprehension of the non-native (see Experimental Section 1).

The second main question focused on the non-native as the speaker. Concretely, we addressed whether non-native speakers were under the influence of the attenuation of information phenomenon both in monologue and in dialogue scenarios. This is because it is not immediately obvious that non-native speakers would perform attenuation due to the difficulties that they may have in second language production (see

Experimental Section 2).

Our third question departed from the two previous questions as it was not related to the interaction between attenuation of information and non-nativeness. Rather, it focused on the origins of the attenuation of information phenomenon, namely, on the role that conceptual and articulatory modulations have in its realization (see Experimental Section 3).

The findings of the current dissertation can be summarized as follows.
The first relevant result is that native speakers talking to non-native listeners performed foreigner talk and attenuation of information. Regarding foreigner talk, natives spoke to non-natives slower, with louder volume and with more intonation and emphasis than when talking to natives. Attenuation was present for duration and for pitch-related measures, which was kept constant across repetitions. This result suggests that native speakers do what is most beneficial for non-native listeners. This is, 1) enhancing the overall intelligibility of words through foreigner talk and 2) attenuating repeated words to signal informational status for duration and pitch-related measures while keeping the relevance of the task constant through intensity. In addition, native speakers performed foreigner talk and attenuation of information regardless of whether the non-native listeners belonged to the "no information" or to the "information" groups. Just as a reminder, for the "no information" group, native speakers only knew that the listeners were not Spanish natives. In the "information" group, the experimenter asked to the non-native listener for how long he lived in Spain. Also, during the task, non-natives showed difficulties to follow the native's instructions at six points in time. Therefore, our results indicate that the quantity and type of information that the native speaker had about the non-native listener did not affect the behavior of the native speaker in a significant manner.

The second relevant finding of the current dissertation is that non-native speakers attenuated second productions of words both in a monologue and in a dialogue context (when speaking to a native listener). This is very relevant as it shows that the potential speech problems that non-native speakers might have do not impair the presence of attenuation. Attenuation by the non-native, then, helps native listener's comprehension of the discourse signaling the given status of words. Our findings extend the results of Baker and collaborators (2011), that showed that non-natives performed attenuation as natives but for word duration only and when no real interaction or communicative needs were present (this is, in the context of monologue). In the case of the current work, attenuation was present when non-native speakers were involved in monologue through text reading, and in dialogue performing a collaborative map task with a native listener. This was true not only for word duration, but also for intensity, mean pitch, pitch excursion and pitch range.

The third relevant finding speaks about the nature of the attenuation of information phenomenon. In order to see whether attenuation has a conceptual or an articulatory origin, dyads of balanced Spanish-Catalan bilinguals performed a collaborative map task in which first and second mentions could be uttered either in the same language, being both in Spanish or both in Catalan ("repeat" condition) or the first mention could be uttered in Spanish and the second mention in Catalan or vice-versa ("switch" condition). Our results indicated that attenuation seems to have a conceptual origin, as second mentions in the "switch" condition were as reduced as second mentions in the "repeat" condition. This was true for duration, intensity and pitch, where for pitch excursion attenuation was only present in "repeat" trials. We believe that this suggests that even though conceptual modulations dominate, articulatory modulations are also present in generating the attenuation effect, but more as a complement than as a

requirement.

Furthermore, half of the items were Spanish-Catalan cognates. Attenuation in the switch condition could have been facilitated for cognates compared to non-cognates, which would support the contribution of articulation on attenuation. Results showed that non-cognates were as attenuated as cognates, supporting the larger implication of semantics in the realization of the attenuation phenomenon.

## 3.2 Implications of the current findings

### 3.2.1 Implications for audience design and non-nativeness

Speakers perform audience design when they perceive that their listeners have some special needs or perceptual difficulties. This is called foreigner talk when the listeners are non-natives. It has been extensively reported that native speakers modify their speech in order to enhance clarity for the benefit of the non-native listener (e.g.: Chadron, 1970; Hens, 1979; Ketch, 1985; Long, 1983; Nelson, 1992; Armament, 1980). This dissertation replicates and extends previous results. To start with, this is the first time, to our knowledge, that the same study investigates (and finds) speech modifications for word duration, intensity, pitch, pitch excursion and pitch range.

In addition, we address the interaction of foreigner talk and attenuation of information. Finding that intensity is not attenuated when native speakers talk to non-natives shows how foreigner talk permeates into attenuation, where native speakers did what is most beneficial for listeners: overall enhancing speech through foreigner talk, signaling informational status of words through attenuation in duration and pitch-related measures, plus

giving relevance to the task keeping intensity constant (compared to when natives talk to natives).

Results from Experimental Section 1 also speak on whether speakers create elaborated or simple models of their listeners when designing utterances. Within the "elaborated view" (Anderson & Hearth, 2002; Bard et al., 2000, 2004), creating a model of the listener implies to consider both what the speaker knows and what the speaker believes that the listener knows. This process would be resource-consuming, requiring constant monitoring and attention to generate detailed and precise models. Due to the demands of model elaboration, it can not be guaranteed that speakers would actually generate any model and may behave selfishly. However, there is numerous evidence suggesting that elaborated models might be wrong. The "simple view" of models' elaboration (see, for instance, Galati & Brennan, 2010) supports that as long as information about the listener is clear and available early enough in the conversation, just one bit of information would suffice for speakers to adapt their speech. With "one bit of information" we refer to dichotomies such as "the listener is a non-native or a native" in our case, "the listener is naïve or familiar to my story" (Galatia & Brennan, 2010) or "the listener is distracted or attentive" (Rosa et al., under review). Just needing a single either/or cue to assess the needs of the listeners makes model elaboration rather simple and cheap. Native speakers talking to non-natives adapted to listeners performing foreigner talk and preventing attenuation for intensity. The amount and type of information that speakers had about listeners (remember that there was a "no information" and a "information" group) did not affect speakers' utterances (see Experimental Section 1).

Even though our evidence indicates that the amount of information about the non-native listeners did not make any impact on native speakers, as they behaved the same for the no information and the information groups, we

contemplate another possibility. That is, that the information about listeners actually impacted the production of native speakers, but in a way that was not detected by our experimental setting. In the study of Arnold and collaborators (2012), it was examined how addressee's feedback influenced acoustic prominence. Participants performed a collaborative task in which addressees moved objects in pairs of two and put the objects in several locations on a table following the speaker's instructions. There were two feedback conditions that signaled addressee's knowledge. First, the addressee (who was a confederate) could show anticipation by picking up the second object before it was mentioned; in the second condition, the addressee did not perform any action until the speaker uttered the instruction. Arnold et al. (2012) investigated whether this difference in the feedback given by the addressees affected speaker's onset to speak, length and intensity of the determiner and of the target word, and intelligibility. Authors found that when the addressees showed anticipation, the duration of the determiners was shorter. However, feedback did not impact the duration of the target words or its intelligibility.

In our study, we only investigated the impact of listener's information for target words, but not for determiners or for onset to speak. Thus, Arnold et al.'s work (2012) showed that speakers incorporate the characteristics of the listener, as speakers attenuated information when listeners had contextual support (in accordance with Lindblom's theory of "hyper and hypo-articulation", 1990). Following the evidence of Arnold et al. (2012), we have to be cautious when saying that the "no information"/"information" distinction did not impact speaker's behavior. Rather, it is plausible that our method was not sensitive enough to detect facilitation in other places, such as planning regions. Running the same experiment with the same type of participants, in which onset to speak and determiners can be analyzed, is in need to see whether information about the listener impacts attenuation in

planning regions.

Finally, we would like to discuss that audience design was present not only when native speakers spoke to non-natives, but when non-native speakers interacted with native listeners (see Experimental Section 2). Non-native speech production can go through some difficulties. Some of these difficulties are mostly related to articulation (e.g.: slower speech rate), where others are of a more social nature (e.g.: as speaking with a low volume or avoiding the use of some terms because of being embarrassed of making mistakes). Non-native speakers in our study displayed longer durations than natives both when reading a text and when interacting with a native listener, supporting that duration is hard to control (in comparison with other manifestations of attenuation such as intensity or pitch range, as it will be outlined in upcoming lines). Thus, longer durations would be unavoidable for non-native speakers, where slower speech rates in an interactive scenario can jeopardize communication (see Costa et al., 2008). Non- native speakers also displayed different word intensity than natives (concretely, lower intensity). This was true only in a communicative scenario, but not when the non-native read a text. Even though this is speculative, the difference in intensity between non-natives and natives in an interactive context might answer to social issues such as the non-native being embarrassed of mispronunciations (see Costa et al., 2008).

Our data also suggests that non-natives tried to compensate for their production problems (as evidenced in longer durations and lower intensities) through the enhancement of pitch-related values. While pitch and pitch excursion signal whether information is new or old (see Watson et al., 2008), pitch range also encodes whether information is in focus or out of focus (Xu & Xu, 2005). That is, pitch range serves as a means to emphasize information. Non-native speakers interacting with native listeners displayed

higher pitch, higher pitch excursion and wider pitch range than native speakers interacting with native listeners. Therefore, it is likely that non-native speakers attempted to compensate for their language difficulties through the enhancement of pitch-related values. This implies that non-natives performed some sort of audience design/clear speech (as pitch enhancements were not present during text reading) to help natives in the correct following of the instructions.

## 3.2.2    Implications for attenuation of information and non-nativeness

One relevant finding of the current dissertation, in accordance with Watson's multi-components model (2008), is that attenuation does not work in the same way for all acoustic measures. I believe that acknowledging this fact is crucial to understand the nature of attenuation of information.

Concretely, we addressed how duration, intensity, pitch, pitch excursion and pitch range values vary depending on the predictability of words through repetition. Our studies show (mostly in Experimental Sections 1 & 2) that only articulatory influences and influences of a more social and/or discursive nature are at play for attenuation, where some acoustic values subscribe more to one or to another type of influences. Word duration appears to be more resistant to social influences, and its articulation seems harder to control than for other manifestations regarding attenuation (e.g.: as word intensity, evidenced in our case in the Experimental Section 1). This is congruent with a number of previous findings (see, for instance, Baker & Bradlow, 2009; Bell et al., 2002, 2003; Fowler & Housum, 1987; Gregory et al., 1999; Lieberman, 1963; Samuel & Troicki, 1998; Watson et al., 2008) and has been pervasively found in our experiments. When native speakers talked to native listeners in the collaborative map task (Experimental Section 1),

second mentions of words were always shorter than first mentions. If native speakers talked to non-native listeners from which they could have more or less information (see Experimental Section 1), native speakers also attenuated. Audience design did not influence attenuation for duration (as attenuation for duration was always present) but native speakers were able to control the overall duration of their utterances performing foreigner talk (this is, speaking slower).

Intensity, however, seems to be modulated by different forces than duration, where the speaker seems to have more room in controlling how intense his/her utterances are, and whether attenuation is present for intensity or not. Our findings go in line with previous literature showing that intensity can be under the effects of audience design (see, for instance, Fraundorf, Watson & Benjamin (under review) or Watson et al., 2008).

In our case, native speakers who spoke to non-native listeners attenuated for duration, pitch, pitch excursion and pitch range. However, attenuation for word intensity was prevented (see Experimental Section 1). This might work as a strategy adopted by native speakers to signal importance in the task, so listeners can follow the instructions properly. Native speakers performed audience design (in this case, foreigner talk, as listeners were non-natives) when introducing first mentions of words as a means to be clear and to facilitate the comprehension of the non-native. To avoid attenuation across all indicators is not a clever option, as listeners could not follow the informational status of words, being difficult to identify words as new or as given. Preventing attenuation for intensity seems to be the optimal strategy. This is because the importance of the task is constantly highlighted with a measure which is easy to control by speakers, while the informational status of words is signaled too, but through other indicators.

In the case of non-native speakers talking to natives, it was also shown that

intensity has more of a social, rather than articulatory, component (see Experimental Section 2). Non-native speakers spoke with lower intensity than native speakers but only when engaged in the collaborative map task. If lower intensities were related to a production problem, they should have been found both when the non-native read the text and when he/she performed the collaborative map task, and not only when non-natives addressed their speech to an audience. If intensity was only influenced by articulation, it should be lower in both cases. Furthermore, non-native speakers displayed larger attenuation sizes than native speakers, being this difference only present in the map task. Nonetheless, it is unclear why non-native speaker attenuate for intensity to a larger extent than native speakers when involved in an interaction. This is why I believe that it would be interesting to assess the behavior of non-native speakers in interactions where the listener appeared in need of a clearer signal (which was not our case, in which the native listener just followed the non-native's instructions).

Finally, in the scenario of Spanish-Catalan balanced bilingual speakers interacting with balanced bilingual listeners (see Experimental Section 3), speakers attenuated for intensity as they attenuated for articulatory measures such as duration or pitch. However, neither speakers nor listeners in this study had any special characteristic or need that could have affected the presence of attenuation for intensity (contrary to cases as natives talking to non-natives).

Therefore, to sum up, word intensity arises as a variable susceptible to be under the control of the speaker, which can be adjusted depending on the situation in order to guarantee communication.

Moving to pitch-related measures, first of all I would like to remind that mean pitch, pitch excursion and pitch range signal different phenomena.

Mean pitch refers to the speaker's tone of voice and it is interpreted as an indicative of prominence (see Watson et al, 2008b). Pitch excursion, being the maximum pitch value within an utterance, has also been reported as relevant for the perception of prominence (e.g.: see Rietveld & Gussenhovent, 1985). Both mean pitch and pitch excursion have been claimed to be mainly subjected to articulation and not to discoursive/social factors (see, for instance, Watson et al., 2008). Pitch range refers to the difference between maximum and minimum pitch values within an utterance, thus reflecting voice inflections. It is used to emphasize information, where words with wide pitch ranges signal that information is in focus, and words with narrower/decreased pitch ranges signal that information is out of focus (see Xu & Xu, 2005).

When natives spoke to non-natives, they attenuated for pitch, pitch excursion and pitch range. This is, native speakers did not alter attenuation of pitch-related measures for the understanding of the non-native. However, they modified their overall values through the performance of foreigner talk using higher mean pitch, higher pitch excursion and wider pitch range than when talking to a native. We interpreted these enhancements as a compensation for their longer durations and lower intensities. Also, non-natives attenuated more than natives for pitch-related measures. It is likely that the presence of higher attenuations simply answered to the fact that as pitch-related values were higher for first mentions, non-natives had more space to attenuate.

I believe that the data obtained in this dissertation, especially for what concerns non-natives talking to natives (Experimental Section 2) together with some previous literature (see Pierrehumbert & Hirschberg, 1990), suggest that pitch-range departs from mean pitch and pitch excursion, as the former would be related to social/discursive influences, and the latter mainly to articulatory.

Considering the result of 1) natives attenuating in comparable ways when

talking to natives and when talking to non-natives, and 2) non-natives attenuating more than natives when talking to natives, it seems that those measures more under the sole influence of articulation, such as mean pitch and pitch excursion, are harder to control when attenuating. However, these measures seem easier to monitor when speakers perform clear speech enhancements. This is because natives talking to non-natives display foreigner talk, and non-natives talking to natives emphasize the relevance of the task through pitch-related measures.

Spanish-Catalan balanced bilinguals attenuated for pitch in both repeat and switch trials, but for pitch excursion only in repeat trials. However, no attenuation was observed on switch trials or for pitch range. There is the possibility that the acknowledged social component of pitch range made speakers to emphasize the two mentions of the object. This is because it would give relevance to the task and might help listeners to follow them in a language-switch task (which entails higher difficulty than our standard collaborative map task). As argued in Experimental Section 3, participants would like to keep items in focus, while signaling given status through indicators of a more articulatory nature (which speakers are not so able to control, as duration or mean pitch, for instance).

Also, Experimental Section 3 offers relevant insights into the nature of attenuation of information. Balanced bilingual speakers were the key to research into the origins of attenuation through language-switching. Our results point in the direction of attenuation being mainly driven by conceptual influences. This is clearly reflected in duration, intensity and pitch regardless of whether speakers used the same language during the two mentions of an object or whether they changed the language. In the case of pitch excursion, only those trials which were uttered in the same language were reduced. This does not mean that conceptual influences were not at play for pitch excursion (as pitch excursion is a measure directly derived

from the pitch of a word). Rather, this suggests that as pitch excursion is an extreme measure, articulatory effects are easier to detect compared to duration, intensity or pitch. In congruency with the Facilitation-Based Reduction Approach (Kahn & Arnold, 2012; see section 1.3.2. in the introduction), for which the amount of reduction corresponds to the amount of facilitation of the item, articulation would add to giveness. However, articulatory modulations would not be a requisite for attenuation.

Finally, this thesis raises awareness about the relevance of employing actual communicative situations to see how attenuation works (see Experimental Section 2). Putting language in context is essential to get to a better understanding about non-nativeness, attenuation, and language itself. In Experimental Section 2 we directly compared the behavior of non-natives when reading a text and when completing a map with a listener. We demonstrated that those measures more subjected to discursive factors, as intensity or pitch range, were modulated by the presence of a listener. In my opinion, relevant studies for the field such as Baker and collaborators (2011), who investigated non-natives' attenuation during a text reading task, approach attenuation in a decontextualized manner. Using collaborative tasks in which speakers are engaged in accomplishing a goal, allows the researcher to both analyze the transcript and to have physical evidence of what speakers mean and listeners understand in a real communicative situation (see Brennan et al., 2010). Although I would go back to this idea later, I truly believe that the right balance between external validity and experimental control is essential to get to a good knowledge of language in general and of attenuation of information in particular.

## 3.3   Limitations and future directions

The current section is structured as follows. First, I would like to discuss one

issue that, under my opinion, deserves the attention of researchers involved in the study of audience design: the implications of using confederates as addressees. On second place, I would like to discuss the questions that this dissertation opens.

Researchers employ confederates in interactive tasks as it represents a benefit in several aspects. In our case, the use of confederates was motivated by two reasons. First, to reduce variability from the side of the listener (as we focused in the speaker's behavior), and second, to reduce costs (as half of the participants are needed). Also, confederates were especially required for the "information" group in Experimental Section 1, as there were six points in time in which listeners should show misunderstanding (for more reasons motivating the use of confederates see Kuhlen & Brennan, 2013).

A revealing example of how employing confederates might influence experimental results comes from the study of Brown & Dell (1987) and the posterior replication by Lockridge & Brennan (2002). In both studies, the same storytelling/scene descriptions task was employed, there being a crucial difference: Brown & Dell used confederates as addressees, and Lockridge & Brennan used naïve participants. The scenes that speakers described contained typical or atypical instruments where the listener could have pictorial support for the scenes or could not. If the addressees had pictorial support, participants would not need to mention the atypical instruments very explicitly. However, if the addressees did not have pictorial support, speakers would have to highlight the use of atypical instruments for a correct following of the story (which would be an indicative of audience design).
In Lockbridge's experiment, speakers displayed audience design adjustments that were not present in the case of Brown & Dell. The take-home message would be that researchers need to be careful when using confederates as this example shows that when addressees have actual needs, speakers adapt to

them compared to when addressees are confederates.

Considering this example, is it possible that naïve participants could have behaved differently to confederates in our studies? Due to the simplicity of our task, and to the reduced role that the confederate had (who virtually just linked two objects in paper maps), I predict that the impact of using naïve participants would not depart much from the impact of using confederates. For instance, foreigner talk effects were robustly observed even though listeners were confederates. The same applies for pitch-related enhancements from non-native speakers. However, as we did not count with an experimental condition in which naïve participants acted as addressees, we can not be sure about if having confederates impacted the realization of attenuation of information at some point.

Now, I will speak about the questions and new directions that this dissertation opens.
First, in multiple occasions our conversations are not addressed to a single speaker, but we rather interact in larger groups. Thus, it would be interesting to see how the issues addressed in the current dissertation would work in multi-party interactions. This is because exploring the relationship between attenuation of information and audience design beyond two people interactions would expand our understanding about how communicative exchanges really work.
For instance, imagine that speaker A and speaker B, both being native speakers of a certain language, are having their daily coffee break at work. Speaker A initiates a conversation about the recipe of the meal that she brought that day. Probably, the first time that speaker A mentioned the recipe of her meal, she uttered something of the type "Let me tell you about a new recipe that I tried yesterday". The second time that speaker A talks about the recipe, she might say something like "the recipe" or "this". This is

because referential expressions change due to predictability (Ariel, 1990; Chafe, 1976; Galati & Brennan, 2010; Grosz et al. 1995; Gundel et al., 1993), being also likely that the word "recipe" gets attenuated the second time that it is mentioned. Now, imagine that at some point of the conversation speaker C enters in the room. How likely it is that speaker A goes back to the use of full pronunciations? In case speaker A goes back to using full pronunciations to benefit speaker C's comprehensibility, would this occur for some measures and not for others (as attenuating for duration but not for intensity, for instance)? Would speaker A attenuate more for speaker B, who is an old participant in the conversation, than for speaker C? Answering to these questions would fill a gap about how attenuation works in larger interactive settings. The interest, however, would not lie only on three people interactions, but in larger groups. Size of the group would be a factor to consider as some authors have suggested that as group size increases, the degree of interactivity decreases (Borgatta, 1962; Hare, 1981). Also, speakers in small groups align most strongly with their respective predecessors, whereas in large groups speakers only align with the dominant person (Fay et al., 2000).

Previous work using multi-party interactions have mostly dealt with how common ground is achieved and how it differs when people are speakers, addressees, side-participants, so on and so forth (see Clark & Carlson, 1982). Also, research has been conducted in how participants align syntactically (see Branigan et al., 2005), showing that side-participants and addressees align syntactically with a previous speaker, but alignment is higher when participants are addressees rather than side-participants. Nevertheless, to my knowledge, no work has been carried about how attenuation works in larger groups.

On second place, interactions between two non-native speakers of a language are becoming increasingly frequent nowadays. In this scenario, a

number of questions arise. For instance, do non-native speakers perform some sort of foreigner talk when talking to another non-native? Are the same language difficulties faced as when talking to a native, or as both speakers are non-natives and their linguistic status are comparable, communication is easier? Is predictable information attenuated when speaking in a second language to another non-native?

Under some circumstances, two non-native speakers communicate easier than a native and a non-native speaker. This is very much influenced by the proximity of the target languages (see Costa et al., 2008). This means that it would be relatively easy that, for instance, a native speaker of Spanish and a native speaker of Italian communicated successfully in a foreign language. However, the story might be very different if instead of being a Spanish-Italian dyad, it was a German-Spanish dyad. Conversations between close languages would be easier, amongst others, because speakers with similar linguistic backgrounds would go through stronger automatic alignment due to similar phonology, vocabulary, syntax, and speech rate, amongst others (see Bent & Bradlow, 2003 and Costa et al., 2008).

But sharing a similar linguistic background does not necessarily mean that communication between two non-natives would be easier than communication between a native and a non-native. For instance, conversational partners might have different speech rates (see Costa et al., 2008, Ferreira & Bock, 2006 or Wilson & Wilson, 2005), or non-native speakers might need to assess each other's proficiency levels. Although these problems can be present when the conversation involves a native and a non-native speaker (instead of two non-natives), the native speaker would have higher proficiency, flexibility and resources.

I believe that exploring the dynamics of non-native/non-native interactions compared to native/non-native (and of course, of native/native interactions) would provide with valuable and practical insights on the mechanisms of

conversation in a society which is more and more globalized.

Regarding the third suggestion for further research, I believe that there is still a long way to go to make a better connection between language inside and outside the laboratory. The language produced in our everyday interactions is mainly characterized by long and complex utterances that have a communicative intent and serve a communicative purpose. However, most laboratory tasks use single words or sentences lacking a communicative intent.

A more natural way to investigate into attenuation, audience design and non-nativeness is to use tasks as the DIAPIX task (see Bradlow et al., 2007). The DIAPIX task consists in a "spot the difference" game in which pairs of speakers have the same map differing in some object's features or in the presence/absence of some elements. Dyads are encouraged to work together to find those differences and mark it on the scenes only by making use of their voice (as participants are seated back to back).

It has the benefit, amongst others, of allowing speakers to make balanced contributions using spontaneous language in order to reach a common goal (see, for instance, Bradlow et al., 2007; Hazan & Baker, 2010; Van Engen et al., 2010). However, employing the DIAPIX task to research into attenuation of information is not trouble-free. First, it can not be ensured in advance that words will be always repeated to check for attenuation. Second, it is almost impossible to ensure that mentions of each target word would be uttered in a constant position within a phrase. Preliminary results in our laboratory using dyads of Spanish native participants show that during the course of the game, a number of words are repeated. However, the number of repetitions is not as high as in our collaborative task in which 48 words were mentioned twice. Therefore, far more participants would be needed, carrying higher costs. So, up to date, it seems hard to find an adequate

paradigm containing the two ingredients that we need to properly research into attenuation of information in conversation: 1) generating speech in a natural context and 2) eliciting enough repeated target words.

## 3.4   Summary of conclusions

The main conclusions of the current dissertation are the following:

- When native speakers interact with non-native speakers, natives benefit non-natives' comprehension: the overall intelligibility of speech is enhanced through foreigner talk and attenuation is performed to signal informational status through the task. In addition, attenuation for intensity is prevented as a means of keeping the relevance of the task constant.

- The amount and type of information that the native speaker receives about the non-native listener does not impact the behavior of the native concerning foreigner talk and attenuation effects. This supports that speakers generate simple, rather than elaborated, models of the listener. However, it unclear whether the information that the speaker has about the listener influences other aspects of speech not considered in this dissertation, such as onset to speak or determiners.

- Non-native listeners display attenuation of information in spite of their production difficulties (as evidenced by longer durations). This is the case not only in the context of monologue, but also for dialogue. In addition, they try to compensate for their difficulties through the enhancement of pitch-related values.

- Attenuation of information seems to have a conceptual nature. This is showed by attenuation for repeat and switch trials in duration, intensity and mean pitch. The influence of articulation is additive, but not crucial, to the realization of the phenomenon.

- Collaborative tasks look more appropriate to research into attenuation of information, audience design and non-nativeness than monologue tasks as text reading. This is because collaborative tasks put speakers in a position which is closer to "real" language than monologue.

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