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A Comparison between English and Spanish Subjects' Typicality Ratings in Phoneme Categories: A First Report

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ABSTRACT

The purpose of the present study is to report the findings of an experimental task in which both native speakers of English and Spanish learners of English rated different phonetic realisations of the same phoneme (the English vowel / i /) in terms of how good examples of that phoneme those realisations were (i.e. their typicality). Similarities or differences between both groups are also described. This study also investigates the possible determinants of such typicality ratings and differences between the determination of typicality in both groups. Implications of these findings are discussed in relation to the learning of segmental phonological categories by Spanish leamers of English.

KEYWORDS: phoneme category / i /, typicality, typicality ratings.

I. TYPICALITY

A central topic in categorisation research for the last three decades has been the phenomenon of *typicality*. Typicality refers to how "typical" different members of a category are within their

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category (e.g. *robin, sparrow, duck, penguin,* or *ostrich* are members of the category "*bird*"). The typicality of members of a category within that category is a type ofjudgement elicited from subjects. If subjects, for exarnple, are asked to judge how typical members of the category *bird* different types of birds are, they tend to consider *robin* or *sparrow* as more typical birds than *duck,* and *duck* as more typical *thanpenguin* or *ostrich.* In short, typicality refers to a continuum of category representativeness, ranging from the most typical members of a category and continuing through less typical members to the most atypical ones. Researchers have referred to typicality using a wide variety of names: "typicality", "prototypicality", "representativeness", "exemplar goodness", "graded structure", "internal structure", etc. Consequently, in the extensive literature available, typical members of a category are called "typical", "prototypical", "representative", "good", etc. while less typical members are referred to as "atypical", "non-prototypical", "unrepresentative", "bad, etc.

Traditionally, the standard procedure for obtaining subjects' ratings of the typicality of items as members of categories has been Eleanor Rosch's 7-point rating scale technique (e.g. Rosch 1973b, 1975b). When asked to judge to what extent members of a category can be regarded as good examples of that particular category, subjects respond using a 7-point scale ranging from 1 (=very good example), through 4 (=moderately good example), to 7 (=very bad example). What subjects are instructed to do is to write a number next to different members of a specific category listed on a sheet. This number represents the extent to which they feel each member is typical of its category. Perhaps not too surprisingly, people find it a natural and meaningful task to rate the various the typicality of members of a category in rating tasks as statistical reliability guarantees that subjects do not put random crosses on their answer sheets. Therefore, statistically the order in which the items are rated is highly reliable.

Rosch's questionnaire technique and modified versions of it (reductions or increases of the numerical scale or reversals of its direction with higher numbers representing increasingly more typical examples) have been used dozens of times. Tables 1, 2, and 3 illustrate typicality ratings for some members of common semantic categories. Results are somehow equivalent in that people agree on which members are more typical than others despite differences in the rating scales used.[1]

Significantly, every human category studied so far has been shown to possess typicality and the same kind of statistically reliable responses have been obtained. Most studies have involved common semantic categories similar to those of tables 1, 2, and 3 (e.g. Hampton & Gardiner 1983; McCloskey & Glucksberg 1978; Rosch 1973b, 1975b; Uyeda & Mandler 1980). However, other types of categories have been studied. These include perceptual categories like *colours* (Nosofsky 1988b; Rosch 1973a, 1975c), product categories like *candy bars, beers,* etc. (Loken & Ward 1990), goal-derived ad hoc categorieslike *things to eat on a diet, what to get for a birthdaypresent,* etc.[2] (Barsalou 1981, 1983, 1985), mathematical categories like *even number* or *odd number* (Armstrong *et al.* 1983), different geometrical designs like *square* or *triangle* (Boume 1982; Nosofsky 1991), linguistic categories like *simple declarative sentence* (Corrigan

1986), personality trait categories like *helpful*, *sociable, dishonest,* etc. (Buss & Craik 1980; Chaplin *et al.* 1988; Isen *et al.* 1992; Read *et al.* 1990; Wojciszke & Pienkowski 1991), stereotype categories like *politician, clown, comedian,* etc. (Cantor & Mischel 1979; Dahlgren 1985) and other types of categories as heterogeneous as fumiture art styles like *Modern* and *Georgian* (Whitfield & Slatter 1979), psychiatric categories like *schizophrenia* or *affective disorder* (Cantor *et al.* 1980), computer programming categories like *sorting* or *searching* (Adelson 1985), emotion categories like *happiness* or *sadness* (Fehr *el al.* 1982; Shaver *et al.* 1987), etc. This body of research suggests that, when encouraged, typicality ratings are ubiquitous and that typicality is a universal characteristic of categories (Barsalou 1985).

Table 1*: Typicality ratings for the members of the category *bird

Category member	Rosch (1975b)	Hampton & Gardiner (1983)
	Mean typicality ratings	
Sparrow	1.18	1.04
Robin	1.02	1.09
Dove	1.46	1.47
Hawk	1.99	1.69
Raven	2.01	1.74
Parrot	2.07	1.83
Pheasant	2.69	1.93
Swan	3.16	2.00
Duck	3.24	2.15
Chicken	4.02	2.17
Turkey	4.09	2.30
Ostrich	4.12	3.04
Penguin	4.53	3.22

Table 2*: Typicality ratings for the members of the category *fruit

Category Member	Rosch (1975b)	Schwanenflugel & Rey (1983)
	Mean typicality ratings	
apple	1.07	6.82
orange	1.08	6.76
banana	1.15	6.32
peach	1.17	6.30
strawberry	1.61	6.04
cherry	1.86	5.88
melon	2.09	5.74
lemon	2.16	5.34
lime	2.45	5.02
papaya	2.58	4.16
pomegranate	3.05	3.8
coconut	4.50	3.56
avocado	5.37	3.34

Table 3*: Typicality ratings for the members of the category *furniture

Category member	Rosch (1975b)	Malt & Smith (1982)
	Mean typicality ratings	
sofa	1.04	6.79
chair	1.04	6.74
table	1.10	6.74
dresser	1.37	6.21
bed	1.58	6.16
bookcase	2.15	5.37
footstool	2.45	4.74
lamp	2.94	4.52
mirror	4.39	3.47
clock	5.48	2.63
picture	5.75	2.58
closet	5.95	2.00
telephone	6.68	1.74

One of the reasons why typicality has been the focus of so much interest and research is its strong influence on performance in a wide range of experimental tasks or naturally-occurring phenomena of roughly three main kinds: cognitive processing and memory, language use and communication, and finally, category leaming and conceptual development (this last group, as will be seen later, is relevant for our discussion of the leaming of English phonology by Spanish students of English). Typicality is related to virtually all of the major dependent variables used as measures in psychological research. The effects of typicality on those variables are usually called "typicality effects". In addition, subjects also agree with one another significantly on the different tasks.

Typicality effects related to cognitive processing and memory tasks for which there is presently empirical evidence are of at least six types. First, typicality predicts speed of processing. It predicts how long it takes someone to classify an item as a member of a category, with typical members being identified faster than atypical ones.' This finding has been obtained in (speeded) category verification tasks in which subjects are asked to verify category membership propositions as rapidly as possible. Thus, people are faster to verify that "a *robin* is a *bird*" than "a ***duck*** is a *bird*" (e.g. Armstrong *et al.* 1983; Duncan & Kellas 1978; Glass & Meany 1978; McCloskey & Glucksberg 1979; McFarland *et al.* 1978; Rips *et al.* 1973; Rosch 1973b, 1975b, 1975c; Rosch *et al.* 1976; Smith *et al.* 1974). Speed of processing has also been investigated in sentence verification tasks. For example, Keller (1982) found that telegraphic transitive sentences with typical subjects (e.g. "a *rohin* has feathers") are verified faster than sentences with atypical subjects (e.g. "a ***duck*** has feathers").

Second, typicality predicts the direction in similarity judgements between category members varying in typicality. Less typical category members are rated as more similar to typical ones than vice versa (e.g. Tversky & Gati 1978). In a related way, typical members are more likely than atypical members to serve as "cognitive reference points" (Rosch 1975a). When subjects are given sentence frames like "[x] is almost [y]" and two category members varying in typicality, they place the most typical one in the referent [y] slot.

Four additional types of cognitive processing and memory phenomena are also affected by the typicality of a category member in its category. These are: first, strength of inductive (e.g. Osherson *et al.* 1990; Rips 1975) and deductive (Chemiak 1984) inferences about category members, with typical members allowing stronger inductive inferences than less typical members; second, judged probability that instances belong to categories (e.g. Shafir *et al.* 1990), with more typical members of a category more likely to be judged as category members than less typical ones; third, rated degree of truth value of category membership propositions (e.g. Oden 1977) and fourth, ease of encoding items into memory for free recall (e.g. Bjorklund *et al.* 1982; Bjorklund *et al.* 1983; Cantor & Mischel 1979; Greenberg & Bjorklund 1982; Keller & Kellas 1978) with typical members being better recalled after presentation than less typical ones.

Typicality has also been shown to be related to several phenomena related to language

use and communication. First, typicality predicts, for example, acceptance of qualifying terms like "true", "technically", "virtually", etc. It has been shown that a given qualifying term is applicable to only a subset of category exemplars determined by degree of typicality (Lakoff 1973). Second, typicality predicts the extent to which the names of category members can be substituted for their related category name in a sentence (e.g Rosch 1977). Typical members are more likely to occupy the place of the category name than less typical members. In addition, typicality predicts subjects' order and probability of production of category members in a free listing task. When asked to produce (name, draw, etc.) category members, people produce typical instances of categories earlier and more frequently than atypical ones (e.g. Hampton & Gardiner 1983; Mervis ***et al.*** 1976; Rosch & Mervis 1975; Rosch ***et al.*** 1976). Similarly, typicality affects order and probability of category member production in more natural situations (e.g. Kelly ***et al.*** 1986). Also, when superordinate category terms are denoted by a short list of exemplars in American Sign Language, only the more typical exemplars are used (Newport & Bellugi 1978). Finally, typicality predicts which category members will be named with general category names by parental input. Parents or caretakers seldom use category names to refer to atypical instances; instead, they are more likely to label typical instances with a category name (White 1982). Parents are more likely, for example, to call a ***robin*** a "bird" than a ***duck.***

The third main group of variables for which typicality has been shown to be a good predictor of performance is that related to developmental and/or category leaming phenomena. A wide variety of experimental tasks like non-verbal sorting, non-verbal selection, picture-naming, name-recognition, etc. have shown that typicality predicts the order in which category members are learned. Children leam typical category members at an earlier age than atypical ones (e.g. Bauer ***et al.*** 1995; Bjorklund ***et al.*** 1983; Blewitt & Durkin 1982; Carson & Abrahamson 1976; Heider 1971; Lin ***et al.*** 1990; Mervis & Pani 1980; Mulford 1979; Rosch ***et al.*** 1976; White 1982). Thus, children are more apt to consider a ***robin*** as a ***bird*** than a ***chicken.*** Also, adults acquiring a new (artificial) category learn typical members before atypical ones (e.g. Mervis ***et al.*** 1975; Rosch & Mervis 1975; Rosch ***et al.*** 1976). Second, categories are leamed more easily and more accurately if initial exposure to the category is through representative category members (Hupp & Mervis 1981; Mervis & Pani 1980).

To sum up, it seems that typicality effects are as ubiquitous as typicality ratings themselves and that they are found in many different types of experimental tasks and naturalistic phenomena extensively. Furthermore, typicality ratings and effects have been documented not solely in adults but also in children (e.g. Bjorklund & Thompson 1978; Duncan & Kellas 1978; Keller 1982), and, with appropriate experimental techniques, in infants (e.g. Bauer ***et al.*** 1995; Strauss 1979; Younger & Gotlieb 1988). Furthermore, research on comparative animal psychology is beginning to reveal that other species with extensively demonstrated categorisation abilities also show typicality effects in their categories. Pigeons, for example, consider some members of the category ***birds*** as better examples of the category than others (Cook ***et al.*** 1990). Some further research with artificial categories has added strength to the

presence of typicality effects in the categories formed by pigeons (e.g. Aydin & Pearce 1994; Huber & Lenz 1996; Jitsumori 1996).

II. TYPICALITY IN PHONETIC AND PHONOLOGICAL CATEGORIES

Given the ubiquity of typicality ratings and typicality effects, it might be surprising to find people's inability to provide typicality ratings for different members of both phonetic and phonological categories. It might also be surprising to find that, if such ratings were obtained (as might be expected), these ratings should not be related to performance on different experimental tasks. However, a long tradition of research on categorical perception seems to speak against typicality particularly in phonetic categories.

Categorical perception refers to a mode of perception in which changes along a stimulus continuum are not perceived continuously, but in a discrete manner. Categorical perception is in direct opposition to continuous perception, which refers to a relatively continuous relationship between changes in a stimulus and changes in the perceptual experience of that stimulus. Categorical perception studies (e.g. Liberman *eral.* 1957; Studdert-Kennedy *et al.* 1970; see also Repp 1984 for a review) claim that listeners can discriminate stimuli only to the extent that they can recognise them as members of different categories.

However, at present there is substantial evidence that the discrimination of stimuli from a given phonetic category with a relatively high degree of accuracy is not all that limited; under certain experimental conditions, listeners can discriminate stimuli within a category remarkably well (Camey *et al.* 1977; Pisoni & Tash 1974; van Hessen & Schouten 1992). Furthermore, growing evidence suggests that within-category stimuli are not only discriminable from one another but are perceived as varying in typicality, with some members of a phonetic category perceived as more typical than others. In a typical experiment, a speech series is created in which a phonetically relevant acoustic property is varied so as to range from one phonetic segment to another. A typical example is the series / bi / to / pi /, with the / b /-/ p / voicing distinction specified by a change in voice onset time (VOT). Then, listeners are presented randomised sequences of the extended series. Next, they are asked to judge the typicality of each sound as a member of the / p / category using a rating scale similar to the ones used in experiments with semantic categories. Such type of studies have shown that subjects can provide typicality ratings for different within-category speech sounds with statistical reliability (e.g. Davis & Kuhl 1992; Grieser & Kuhl 1989; Kuhl 1991; Massaro & Cohen 1983; Miller & Volaitis 1989; Miller *et al.* 1997; Samuel 1982; Volaitis & Miller 1992; Wayland *et al.* 1994).

In addition, as in the case of other types of categories, several typicality "effects" have been obtained in tasks that assess the functional or differential effectiveness of different members ofphonetic categories in phenomena such as dichotic competition, selective adaptation, discrimination/generalisation, or category verification. It is now known that some stimuli are

more effective adaptors than others in selective adaptation experirnents (Miller 1977; Miller ***et*** al. 1983; Sarnuel 1982), more effective cornpetitors in dichotic cornpetition experirnents (Miller 1977; Repp 1977) or they elicit greater generalisation to other rnernbers of the category when they serve as the referent stirnulus in category learning tasks (Grieser & Kuhl 1983, 1989; Kuhl 1991). Finally, it has been shown that typical stirnuli take less time than less typical ones to be verified as category rnernbers in category verification tasks (e.g. Davis & Kuhl 1992; Massaro 1987).

It has also been suggested that various allophones of the sarne phonerne are more typical of the category than others. Nathan (1986; see also Mornpeán-González 1999) considered the English phonerne categories / t / and / d /, suggesting, for exarnple, that alveolar stops (voiceless ones in / t / and voiced ones in / d /) are more typical than other allophones such as voiced alveolar flaps (i.e. [ɾ]). In this respect, the experimental evidence par excellence was provided by Jaeger (1980, exp. 1 and 2), who showed that people were faster to verify the category rnernbership of typical allophones of the category English / k / (e.g. aspirated allophones) than that of less typical allophones (e.g. unaspirated stops). [4]

To surn up, these studies have evinced that the categoricality of phonetic segrnents in their linguistic function does not irnply that they are also categorical in the way they are perceived.[5] Phonetic (and phonological) categories have more typical and less typical rnernbers, which contradicts initial studies on categorical perception that predicted that, if within-category sounds are not discrirninable, there should not be any differences in typicality between different speech sounds that belonged to the sarne category. Furthermore, as rernarked by Miller (1994), all phonetic categories in which typicality has been investigated so far have yielded reliable ratings and effects. It seerns then that typicality is also a characteristic of phonetic categories as in the case of other types of categories. In fact, typicality and typicality effects seern to be so ubiquitous that they have found even with infant subjects. Recent research has even found typicality effects of typicality norrns previously provided by adults in infants' prelinguistic vowel categories (e.g. Grieser & Kuhl 1983, 1989; Kuhl 1991) and consonant categories (e.g. Miller & Eirnas 1996).

Given current experimental evidence, it rnight then be surprising that typicality ratings and effects should not be obtained for other phonetic or phonological categories. This study atternpted to provide additional support for the generality of typicality with the British English vowel phonerne category / i /, as in the word "flee".

The reason why / i / was chosen is that previous work with infants using / i / (Grieser & Kuhl 1989; Kuhl 1991) has shown that different cornputer-synthesised variants of / i / differ in typicality dernonstrating Kuhl's intuition that, if typicality should be shown to exist at all in vowel categories, as her studies showed, / i / should be an ideal candidate.[6]

The present investigation tried to extend this research in at least three ways: by studying different rnernbers of the phonerne category / i / in naturally-produced stirnuli, by cornparing the

ratings of both native speakers of English and Spanish leamers of English and by investigating the possible determinants of typicality ratings in both groups. This study was originally motivated in part by an interest in knowing whether different realisations of / i / might be perceived as varying in typicality by both cross-cultural and cross-linguistic groups and, if so, on what basis.

The specific research questions this study investigated were four:

1) do different realisations of / i / differ in typicality as rated by native English and Spanish speakers of English?
2) do the typicality ratings generated by both English and Spanish subjects correlate or do they differ?
3) what determines typicality ratings in both groups?
4) are there any differences in the determinants of typicality in both groups?. If so, of what sort and to what extent?

Three experiments were conducted to try to answer these questions. Experiments 1 and 2 were directed at revealing typicality ratings in both cultural-linguistic groups. Experiment 3 examined possible determinants of such ratings and differences in the determination of typicality for both groups.

II.1. Experiment 1

The purpose of this experiment was to determine whether adult native speakers of English can generate similar typicality ratings for several members (i.e. phonetic realisations) of / i / in spoken English words. Based on the results of previous experiments with phonetic and phonological categories, it is hypothesised that they will do so.

II.1.1. Method

II.1.1.a. Subjects

15 adult native English speakers of British English between the ages of 20-32 (mean age 24 yrs) participated in this study. There were 7 men and 8 women. They were all recruited on the University of Murcia campus. They were all undergraduate or graduate students and were phonetically naive. They all had normal hearing.

II.1.1.b. Stimuli and apparatus

60 naturally-produced words containing / i / were digitally recorded using an audio processing

program called DartPro, implemented on a computer and stored in hard disk file. The stimuli were produced by an English native speaker of British English speaking on a microphone at a normal rate.[7] Each stimulus word was preceded by a number corresponding to the order in which the stimulus word appeared on the recording. There were four seconds between the end of a stimulus word and the number preceding the next stimulus word. There was one second between each nurnber and its corresponding stimulus word. These words were later played at a comfortable listening level (approximately 68 dB SPL). The stimuli were presented to subjects binaurally over stereo headphones. The subjects heard the stimuli in a small sound-treated computer room.

The selection of the stimuli was carefully accomplished. Before the specific stimulus list was obtained, a wide range of different stimulus candidates pronounced with / i / were ruled out due to different factors. First, / i / appears in words up to four syllables long (e.g. "beat", "feeling", "tequila", "preconceiving"). Furthermore, / i / may occupy the nucleus of primarily stressed (e.g. "seat"), secondarily stressed (e.g. "preconceive") or totally unstressed syllables (e.g. "phoneme"). In addition, / i / can be spelled in many different ways.[8] To avoid excessive heterogeneity in the sample, the stimuli chosen only included monosyllabic words. As a consequence, / i / appeared exclusively in stressed positions. Also due to the variety of spelling forms -some of which are rather unusual like < ae >, < ay > or < oe >- the stimuli included two of the most common ones, i.e. < e a > (24 items) and < ee > (26 items).[9] In addition, six items did not include any vowel letter in the spelling as they corresponded to the names of letters ("d", "d's", "g's", "p", "v", "v's") and four words contained the spelling < e > (i.e. "e", "e's", "he", "we"). Word length was further controlled by selecting only four syllable structure patterns: V (1 item), CV (8 items), VC (4 items), and CVC (47). Most syllables had a CVC structure, that is, they included both one-consonant heads and codas.[10] Two- or three-consonant clusters were not included in this study either word-initially or word-finally.[11]

The use of stimuli produced by a real native speaker contrasts with those speech-synthesised stimuli of previous experiments investigating typicality in phonetic categories. Certainly, those speech-synthesised stimuli are advantageous in that they allow the experimenter to have precise control over the stimuli the subjects are presented with. Researchers can then study several phenomena without having to worry about other aspects that vary between subjects and that are irrelevant to the hypotheses tested. However, the study of speech sounds in more "naturalistic" contexts (i.e. embedded in real English words and pronounced by real speakers) is also an unavoidable pathway in the study of phonology and with some control may shed light on people's actual perception and categorisation of speech. The type of naturally-produced stimuli used in this study are similar to those used in previous studies (Davis & Kuhl 1992; Jaeger 1980; Jaeger & Ohala 1984).

II.1.1.c. Procedure

Subjects were run individually in this experiment in a session which lasted for approximately twenty minutes. The procedure included a pre-test, a test session and a post-test interview.

In the pre-test phase of the experiment, subjects were seated comfortably in a sound-treated room on a chair in front of a computer. The experimenter (the author of this study) gave each informant four stapled sheets including the instmctions of the experiment (page 1) and the answer sheets (pages 2 to 4). The instructions had been carefully designed to direct subjects' attention to the phenomenon of typicality and were similar to those used in previous studies. The answer sheets contained numbers 1 to 60 arranged along the left-hand side of the sheet corresponding to the words on the recording (e.g. "1" for the first word, "2" for the second, etc.). **A** 7-point scale had been drawn horizontally next to each number. However, following Schwanenflugel and Rey's (1986) or Malt & Smith's (1982) procedure, the poles on Rosch's (1973b, 1975b) typicality scales were reversed. **A** rating of 1 meant a very bad member of the category while a rating of 7 meant a very typical member of the category.

The experimenter asked subjects to read the instmctions carefully. Instructions were as follows:

> This study has to do with how people perceive sounds. However, before explaining the task you have to perform, it is important to tell you that the perception of sounds is, to a great extent, very similar to the perception of other types of stimuli. For example, think of birds. Close your eyes and imagine examples of *birds*. You may think of robin, sparrow, *penguin*, turkey or chicken. However, if you were asked to give an example of bird, you would probably think of robin or sparrow and it is very unlikely that you would use *penguin*, turkey or chicken. Robin and sparrow seem to be better or more characteristic examples of bird than *penguin,* turkey, or chicken. Think now of fruits. You could think of apple, orange, pomegranate, coconut or even avocado. However, if you were asked to indicate a representative, typical, or good example of *fruit* you might probably choose apple or orange. It is less likely that you might considerpomegranate, coconut, or avocado as good examples of "fruits" as apple or orange. Notice that this has nothing to do with how well you like the fruit. It has to do with what is generally considered to be a typical example of fruit. You may prefer coconuts to oranges but still admit that orange is more typical of *fruit* than coconut.
>
> Something similar happens with sounds. For example if you are asked to give good examples of consonantal sounds, you might probably refer to the sound at the beginning of the words "pay" or "tea" as more typical consonants than the initial consonants in "why", or "lie".
>
> In the task you are going to perform, you will be listening to a series of English words. These words contain a type ofsound (a vowel) that people generally perceive as "the same". This type of vowel is the one you find in words like "need", "each", "see", "cheap", "been", "leave", "she", etc. Ifyou close your eyes for a few seconds and think ofhow these words are pronounced you may form an idea of how that sound should be.
>
> However, although each (actually pronounced) vowel in those examples is an example of a type of vowel (just as different types of birds are examples of a type of animal, that is, bird), there are different auditory differences amongst them. As you listen to the words, what you have to do is to decide to what extent each of the vowels you hear is a good example of the type of sound (i.e. vowel) they represent.
>
> After you hear each word you must indicate your decision using a 7-point scale. Here you have an example of the scale you are going to use.

Worst Examples		Rather Bad Examples		Bad Examples		Moderately Bad/God Examples		Good Examples		Quite Good Examples		Best Examples	
1		2		3		4		5		6		7	

As you can see, a 1 means that the vowel you hear in a word one of the worst examples of that type of vowel. A 7 means that it is one of the best examples you could give. Tick one of the seven numbers for each word you hear according to your decisions. For example, ifyou hear the word "bee" and think the vowel in that word is quite a good example of the type of vowel it exemplifies, then tick number 6. If, on the contrary, you think it is a rather bad example, tick number 2. You must repeat the procedure for each of the specific vowels in the words you are going to hear.

Please ***use all the numbers in the scale*** (and not just 1 or 7 for example). You will be listening to 60 words altogether preceded by a number which represents the order in which the words appear (the number is also written on the answer sheets). You'll hear the series twice. If necessary, you can listen to it one more time. Please, pay a lot of attention to the words and remember you mustjudge how good an example each ofthe vowel sounds you hear is of the type of vowel it represents. Finally, remember that the meaning of the words or their spelling is not important, just the sound. If, at any moment during the task you want to stop for any reason, tell the experimenter.

After reading the instructions, the experimenter asked subjects whether they had understood the instructions. All subjects answered affirmatively although a few doubts were solved by the experimenter. Next, when subjects said they were ready, they were instructed to put on headphones and play the recording when the experimenter had sat at a distance of 4 metres from them in order not to influence their decisions. During the overt typicality rating task, subjects behaved as instructed. After the recording was over, the computer stopped automatically. The experimenter approached the subjects in order to check for any possible problems and instructed them to repeat the same procedure again. When this had taken place, the experimenter approached the subjects again and collected the answer sheets.

Finally, in a post-test interview, the experimenter asked subjects "which criterion were you following to decide which vowels were more typical than others?". The experimenter wrote down subjects' answers and, after discussing their strategies, the experimenter thanked them for their co-operation.

II.1.2. Results and Discussion

Rank order of items (R), mean ratings of typicality and their associated standard deviations for all instances of / i / are shown in table 4. As the table shows, the standard deviations of subjects' typicality ratings of the different exarnples of / i / have low variability ($0.50 < SD < 1.18$), which indicates that subjects produced similar responses in the 7-point scale. This confirms the hypothesis of this study. Further confirmation of the hypothesis was obtained by calculating the coefficients of variation for all examples of / i /. As the mean coefficient of variation (19.65%) obtained was relatively low, this also seems to confirm the hypothesis that subjects provided

similar typicality ratings for each realisation of / i /. Figure 1 shows, as an example, the two words for which the highest ("leal": 45.56 %) and the lowest ("need": 8.91 %) coefficients of variation were obtained.

11.2. Experiment 2

The purpose of this experiment was to discover whether Spanish learners of English can also generate statistically reliable typicality ratings for the category / i /. It also tried to determine to what extent these ratings were similar to those provided by the English group in experiment 1.

II.2.1. Method

II.2.1.a. Subjects

Subjects were 15 adult native Spanish speakers (mean age 19 yrs). There were 4 men and 11 women. They were all students of "Filología Inglesa" in their first and (beginning of their) second year at the University of Murcia. They all had normal hearing. The criterion for being selected was their obtaining a very high mark (i.e. "sobresaliente") in a course on English pronunciation they had taken during the first four months of the first year. This was to guarantee that / i / was already a well-established part of their interlanguage segmental phonology. However, before they carried out the typicality rating task, a pre-test checked that they actually knew the category. This little test consisted in presenting randomised words containing either / i / or / ɪ /, conveniently called ***sound "a"*** and ***sound "b"***. They were instructed to indicate whether each word exemplified sound "a" or sound "b". All subjects did pretty well in this task so they all qualified for the present experiment.

II.2.1.b. Stimuli and apparatus

The stimuli were the same as those used in experiment 1 and were arranged in exactly the same order.

II.2.1.c. Procedure

The procedure was the same as that used in experiment 1. However, the session was conducted in Spanish and the instructions subjects received were an adaptation (in Spanish) of the instructions given to the English group (these instructions are available from the author).

II.2.2. Results and Discussion

Table 4: **Rank order of items, mean typicality ratings and associated standard deviations for members of / i /: native speakers of English**

R	Item	MTR	SD	R	Item	MTR	SD	R	Item	MTR	SD
1.	need	6.00	0.53	21.	neat	5.27	0.70	41.	peat	3.87	0.91
2.	seed	5.93	0.70	22.	weave	5.27	0.80	42.	peag	3.73	0.80
3.	e	5.93	0.80	23.	e's	5.27	0.88	43.	beam	3.67	1.04
4.	deep	5.87	0.63	24.	v	5.27	0.88	44.	'neath	3.60	0.63
5.	teeth	5.87	0.74	25.	lea	5.27	1.16	45.	keen	3.60	1.05
6.	deed	5.80	0.77	26.	jeep	5.20	0.86	46.	lean	3.53	0.74
7.	heed	5.67	0.72	27.	reef	5.13	0.74	47.	jean	3.27	0.88
8.	weed	5.67	0.72	28.	heave	5.13	0.83	48.	wean	3.27	0.96
9.	p	5.53	1.06	29.	fee	5.13	0.91	49.	mean	3.27	1.03
10.	seethe	5.47	0.63	30.	he	5.13	1.06	50.	eel	3.07	0.70
11.	leap	5.47	0.83	31.	knees	5.13	1.06	51.	e'en	3.07	0.70
12.	seek	5.40	0.50	32.	g's	5.07	0.70	52.	meal	3.07	0.88
13.	d	5.47	1.18	33.	heath	5.00	0.65	53.	heal	3.00	0.76
14.	eat	5.40	0.99	34.	league	5.00	0.76	54.	peel	2.93	0.70
15	teethe	5.4	1.12	35.	leaf	5.00	0.84	55.	veal	2.93	0.70
16	knee	5.40	1.18	36.	weep	4.87	0.83	56.	reel	2.93	0.80
17.	beef	5.33	0.61	37.	d's	4.87	0.91	57.	keel	2.80	0.77
18.	leave	5.33	0.90	38.	v's	4.87	0.91	58.	sheen	2.80	0.94
19	we	5.33	1.04	39.	feel	4.33	0.81	59.	deal	2.67	0.81
20	heap	5.27	0.59	40.	sheaf	3.87	0.74	60.	leal	2.27	1.03

Table 5: **Rank order of items, mean typicality ratings and associated standard deviations for members of / i /: Spanish learners of English**

R	Item	MTR	SD	R	Item	MTR	SD	R	Item	MTR	SD
1.	knees	6.20	0.77	21.	leal	5.47	1.46	41.	lean	4.40	0.63
2.	e's	6.20	0.86	22.	feel	5.40	1.12	42.	beam	4.33	1.04
3.	d's	6.20	1.08	23.	lea	5.33	1.04	43.	sheen	4.33	1.17
4.	v's	6.13	0.83	24.	weed	5.33	1.17	44.	wean	4.13	1.46
5.	leave	6.00	1.13	25.	heed	5.27	1.28	45.	eat	3.47	0.99
6.	teethe	6.00	1.00	26.	heal	5.27	1.22	46.	teeth	3.47	1.40
7.	weave	6.00	1.00	27.	e	5.20	0.94	47.	beef	3.40	1.24
8.	g's	5.87	0.99	28.	he	5.20	0.94	48.	seek	3.40	1.45
9.	need	5.87	1.12	29.	fee	5.13	0.83	49.	'neath	3.33	1.29
10.	meal	5.80	1.14	30.	we	5.07	0.88	50.	neat	3.27	1.62
11.	peel	5.80	1.32	31.	eel	5.07	1.39	51.	jeep	3.27	1.90
12.	seethe	5.80	0.68	32.	v	5.00	1.13	52.	leaf	3.20	1.78
13.	heave	5.73	0.70	33.	p	5.00	1.64	53.	deep	3.13	1.12
14.	keel	5.73	1.16	34.	jean	4.93	1.10	54.	reef	3.13	1.50
15.	deed	5.73	1.33	35.	mean	4.93	1.10	55.	leap	2.87	1.19
16.	seed	5.73	1.03	36.	d	4.67	0.98	56.	heap	2.73	0.80
17.	peag	5.60	1.30	37.	veal	4.60	1.63	57.	heath	2.73	1.39
18.	deal	5.53	0.91	38.	reel	4.53	1.24	58.	peat	2.53	1.55
19.	knee	5.53	1.06	39.	keen	4.47	0.91	59.	weep	2.47	1.19
20	league	5.47	0.99	40.	e'en	4.40	0.99	60.	sheaf	2.40	0.99

The rank order of items (R), mean typicality ratings and their associated standard deviations for each word including / i / are shown in table 5. This table shows that the standard deviations of subjects' typicality judgements of instances of / i / have low variability (0.50 < SD < 1.18). This indicates that subjects generated similar responses when rating the typicality of different realisations of / i /. For example, when a particular example of / i / obtained a high typicality rating, most subjects tended to provide high numbers. When an example of / i / obtained a low typicality rating, most subjects generally provided low numbers. Further confirmation of the hypothesis was obtained by calculating the coefficient of variation for every example of / i /. The mean coefficient ofvariation was 26.99%, which is again relatively low and confirms the hypothesis that Spanish learners of English produced similar typicality ratings for different instances of / i /. Figure 2 shows the two words for which the highest ("peat": 61.27%) and the lowest ("seethe": 11.66%) coefficients of variation were obtained.

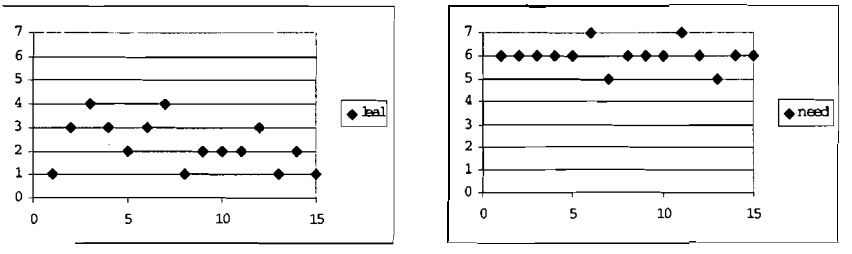

Figure 1: **Highest coefficient of variation ("leal") & lowest coefficient of variation ("need"): English group.**

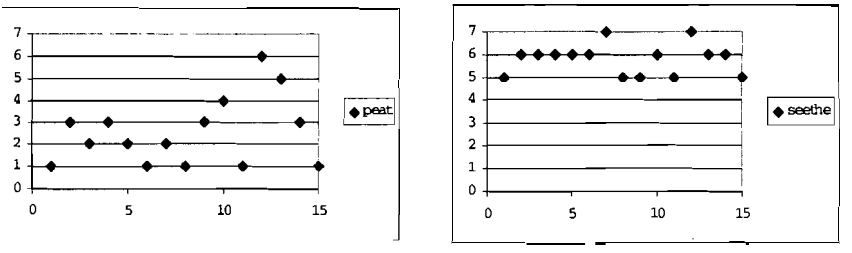

Figure 2: **Highest coefficient of variation ("peat") & lowest coefficient of variation ("seethe"): Spanish group.**

In order to determine the degree of convergence between the Spanish and English speakers' typicality ratings, *t* tests were calculated. For 39 out of the 60 words including / i / (65% of the sample) the typicality ratings generated by both Spanish and English subjects were significantly different ($p < 0.05$). This indicates that, although for a 35 per cent of the sample

both groups produced similar typicality ratings, the two groups followed different pattems of response for most words. This is not surprising as differences in the typicality ratings of members of roughly equivalent common semantic categories by members of different cultural or linguistic communities have been extensively reported. Studies have compared the typicality ratings by British and American subjects (1983), monolingual speakers of English and Spanish (Schwanenflugel & Rey 1986), monolingual speakers of English and French (Segalowitz & Poulin-Dubois 1990), monolingual speakers of English and German (Eckes 1985; Hasselhom 1990), and monolingual speakers of English and Chinese (Lin & Schwanenflugel 1990; Lin et al. 1990). These studies suggest that, although there is a more or less significant convergence in the typicality ratings of English-speaking populations and Spanish-, French-, German-, and Chinese-speaking ones, differences also exist.

Once the typicality of different members of the category / i / has been obtained from both cultural and linguistic groups a logical question to ask is what the source of those typicality ratings might be. Fortunately, the literature on typicality offers no shortcoming of responses. Reports of typicality ratings and effects are frequently accompanied by several possible determinants of typicality. However, although investigators agree about the ubiquity and importance of typicality, they do not concur on its explanation. What determines whether some members are more typical of their category than others is still a matter of debate.

In general we can distinguish two main types of determinants of typicality: materialistic and non-materialistic.

Materialist determinants are those based on either the material structure of the human perceptual apparatus, or the material characteristics of the referents of category members (Geeraerts 1988). There are four main types of materialistic determinants of typicality: similarity, perceptual salience, frequency of instantiation and familiarity with the referents of category members.

Following the work or Rosch and Mervis (1975), there has been widespread acceptance (e.g. Boster 1988; Rosch 1975b, 1978; Rosch et al. 1976; Roth & Mervis 1983) that the typicality of a category member depends on its average similarity to other category members (also called its "family resemblance"). The more similar an exemplar is to other category members (in terms of shared attributes), the more typical it will be of its category. Robin, for example, is very similar to other members of the category birds like canary, sparrow, etc. In contrast, *penguin* is not as similar to other birds as robin. Consequently robin is more typical of bird than *penguin*.[12]

The typicality of members within categories has also been claimed to be the result of the physiological structure of the perceptual apparatus and inherent properties of human perception. For a limited number of (mainly perceptual) categories like colours (e.g. Heider 1971; Rosch 1973a, 1973b, 1975c), geometrical forms (Rosch 1973a, 1973b), or sounds (Nathan 1986), some members of categories seem to be more typical than others because they appear to be perceptually more salient.

Two further materialistic determinants of typicality are frequency of instantiation and familiarity with the members of categories in the real world. Frequency of instantiation refers to how often subjects have experienced a certain kind of entity as a member of a category while familiarity refers to how often subjects have experienced that entity across all contexts. For example, people are generally more familiar with chair than with log, having experienced chair more often across all contexts (i.e. familiarity). However people have probably experienced log more often as an instantiation of *firewood* (i.e. frequency of instantiation). Unfortunately, these two determinants of typicality are very difficult to test. This can best be done in studies with artificially-constructed categories in which subjects' encounter with category members is controlled. In relation to perceived frequency of instantiation such studies have provided mixed evidence. Some work suggests that there is no correlation between typicality ratings and controlled frequency of instantiation (e.g. Rosch et al. 1976) although more recent evidence suggests the opposite (Nosofsky 1988b). Familiarity with the referents ofcategory members has been measured with printed word frequency. Again the evidence is mixed, some studies have found no correlation between printed word frequencies and rated typicality (McCloskey 1980; Mervis et al. 1976). Still, other research has found more positive evidence in at least social categories (e.g. Dahlgren 1985). However, Malt and Smith (1982) claimed that word frequency does not necessarily reflect how common in the environment an object is or has been experienced by subjects. Dahlgren (1985) expressed similar reservations.

Although the four types of factors mentioned account for the typicality of members of some categories satisfactorily, the literature on typicality has evinced materialistic factors are just one set of mechanisms responsible for typicality. Much research suggests that a host of non-materialistic factors related to conceptual knowledge structures account for typicality ratings and effects.

Amongst the many non-materialistic determinants of typicality we can also highlight four: perceived frequency of instantiation of category members, perceived familiarity with category members, perceived frequency of the name of category members and the possession of "ideals" by category members.[13]

Perceived frequency of instantiation refers to the frequency people believe they encounter or have encountered members of a category as members of that particular category. Perceived familiarity can be defined as people's subjective estimate of how often they have experienced an entity across all contexts. Although related to frequency of instantiation and familiarity with the referents of category members, these two variables emphasise people's intuitive knowledge about such factors, which may or may nor correspond with actual facts.

Only a few studies have investigated the relationship between perceived frequency of instantiation and typicality. In general, this variable seems to predict typicality (e.g. Barsalou 1985; Loken & Ward 1990). In relation to perceived familiarity, although some research has found weak evidence for it as a determinant of typicality (e.g. Barsalou 1985; Glass & Meany 1978; Hampton & Gardiner 1983; Loken & Ward 1990), some research has found more positive

evidence suggesting that people may actually know more about (and therefore be more familiar with) typical than atypical members of categories. Some studies have measured familiarity by asking subjects to list the attributes of category labels. For example, people are able to retrieve fewer characteristics of atypical category members than typical ones (Ashcraft 1978; Malt & Smith 1982). In addition, people rate typical category members as more familiar than atypical ones in familiarity rating tasks (Lin & Schwanenflugel 1990; Lin ***et al.*** 1990; McCloskey 1980; Schwanenflugel & Rey 1986).

A third possible determinant of typicality (although seldom investigated) is perceived word frequency. Segalowitz and Poulin-Dubois (1990) stressed the importance of distinguishing between objective measures of word frequency such as written word counts, and more subjective measures such as perceived frequency of name instantiation, which they called "linguistic familiarity" and for which they found evidence as a determinant of typicality.

Finally, another possible non-materialistic determinant of the typicality of a category member in its category is the degree to which it possesses ideal characteristics (called "ideals"). These are attributes that category members should have if they are to best serve a goal associated with their category. For example, the ideal charactenstic in a category like ***foods to eat on a diet*** is "zero calories"; consequently, the fewer calories a category member has, the better it serves the goal associated with its category, namely, lose weight and the more typical it will be considered to be. Some research supports ideals as determinants of typicality (e.g. Barsalou 1981, 1983, 1985; Chaplin ***et al.*** 1988; Read ***et al.*** 1990).

In light of the evidence mentioned so far and resuming the original question of why some members of / i / might be more typical than others, both materialistic and non-materialistic hypotheses can be put forward.

A materialistic explanation might entail that, in judging typicality, subjects concentrate on one or more acoustic characteristics of the speech signal itself. A non-materialistic explanation would require that subjects rate typicality on the basis of some other information not specified by the acoustic signal itself but rather by more general knowledge about the words they hear. Three possible types of such knowledge may be perceived familiarity with the words, perceived frequency of name instantiation, and spelling. The research on perceived familiarity mentioned earlier testifies to its influence on typicality. Subjects might also draw on their knowledge about the category, like, for example, its conventional spelling representations. It might be that those members of / i / spelled with a certain vowel letter or combination of vowel letters would be more typical than others spelled differently.

In order to find out about the origins of typicality ratings for / i /, experiment 3 was carried out.

11.3. Experiment 3

The purpose of this experiment was to determine whether general knowledge about the words

in which / i / is found influences the typicality ratings obtained from the English and Spanish subjects for / i / in experiments 1 and 2. General knowledge was operationalised in two different ways. First, as "familiarity with words" (i.e. reasonable knowledge of or acquaintance with the word) and second, as "perceived frequency of name instantiation in language use" (i.e. how often a word is used in both spoken and written everyday language). Perceived word frequency may be a more sensible measure of familiarity than word frequency, although the latter may also be considered as a measure of cultural importance (Dahlgren 1985). It is hypothesised that, if subjects, as instmcted, actually focus on sounds and not on words as lexical items, perceived familiarity with words and perceived frequency of use will not affect people's typicality ratings.

In addition, some statistical operations were calculated to investigate whether there is a systematic correspondence between typicality ratings and spelling form, typicality and vowel length as determined by the type of coda.

II.3.1. Method

113.l .a. Subjects

The subjects in this experiment were the sarne as those employed in the typicality rating tasks of experiments 1 and 2.

113.1.b. Stimuli

The stimuli for this study were printed words corresponding to the spoken words of experiments 1 and 2. These words were written along the left-hand side of new answer sheets following the order in which they had appeared in the previous experiments. Subjects were only exposed to these written words not to the spoken ones.

II.3.1.c. Procedure

After subjects finished the typicality rating task, they were told they would be doing a new task (the one reported below). The English subjects were tested in the first place. The order in which individuals were tested was exactly the same as that followed in the typicality rating tasks. Subjects were again mn individually. The procedure was very similar to the one used in experiments 1 and 2. It included a pre-test, a test session and a post-test interview.

The experimenter gave each subject eight stapled sheets with instructions (page 1) and answer sheets (pages 2 to 8). The instmction sheet now asked subjects to rate their familiarity with the words printed on the answer sheets (section 1) and the frequency with which they thought the words were used in the language (section 2). As a consequence, there were two types of 7-point scales: one for familiarity with the word and another for perceived word frequency.

Instructions for the English subjects were as follows:

> In this task, what you have to do is to read each of the words written on the answer sheets and rate them according to 1) how familiar you are with the word and 2) how frequently you think the word appears in language (spoken and written). As you have to rate two things (how familiar or acquainted you are with the word and how oílen you think the word is used in the language), you have two sections on the answer sheets and two types of 7-point scales. Here is an example of the scale you are going to use in the sectionfamiliarity with the word.

Unknown	Almost Unknown	Little Known	Relatively Known	Known	Well-known	Extremely Known
1	2	3	4	5	6	7

> As you can see, a 1 means a word that is unknown to you and a 7 means a word which is extremely familiar or known to you. Use other numbers to indicate intermediate decisions.
>
> In the section *frequency* with whichyou believe the word *is* used, you also have a 7-point scale. A 1 means a word you think is practically out of use and a 7 means a word you think is extremely frequent. Please do use other numbers to indicate intermediate decisions. Here is an example of the scale.

Not Used	Seldom Used	Little Used	Occasionally Used	Frequent	Quite Frequent	Extremely Frequent
1	2	3	4	5	6	7

> Notice that the two things you have to rate (how familiar you are with the word and how oílen you think the word is used) may not necessarily be similar: you may be very familiar with the word "ostrich" or "artery" and still think that these words do not appear very oílen in everyday conversations or written texts.
>
> The order in which you are going to read the words is the same as that in which you listened to them in the previous exercise but this time the sounds are not important.

These instructions were adapted for the Spanish subjects (the instructions are also available from the author on request).

II.3.2. Results and Discussion

For the English group, rank order of items (R), mean ratings of perceived familiarity with words (PFW) and their associated standard deviations are shown in table 7. The results for perceived word frequency (PF) are shown in table 8. For the Spanish group, rank order of items (R), mean ratings of perceived familiarity with words and their associated standard deviations are shown in table 9 and the results for perceived word frequency in table 10.

Table 7: **Rank order of items, mean ratings of perceived familiarity with words and their associated standard deviations: English group**

R	Items	PFW	SD	R	Items	PFW	SD	R	Items	PFW	SD
1	eat	7.00	0.00	21.	seed	6.47	1.06	41.	heap	5.87	1.72
2	he	6.93	0.26	22.	weep	6.47	1.06	42.	eel	5.67	1.63
3	teeth	6.87	0.35	23.	jeep	6.47	1.12	43.	weave	5.67	1.68
4	we	6.80	0.56	24.	jean	6.40	0.99	44	heed	5.60	1.45
5	beef	6.80	0.56	25	p	6.40	1.35	45	v's	5.53	1.55
6	deep	6.80	0.56	26	fee	6.33	1.11	46	d's	5.40	1.80
7	feel	6.80	0.56	27	lean	6.33	1.17	47	e's	5.26	1.70
8	meal	6.80	0.56	28	deal	6.27	1.28	48	sheen	5.13	1.88
9	e	6.80	0.77	29	leap	6.27	1.39	49	teethe	5.13	1.99
10	knee	6.73	0.59	30.	peel	6.13	1.30	50.	wean	5.07	1.67
11	mean	6.73	0.80	31	heave	6.13	1.36	51.	heath	5.00	1.77
12	knees	6.67	0.72	32	keen	6.13	1.40	52.	seethe	4.73	1.70
13	leaf	6.60	0.63	33	reef	6.13	1.46	53.	lea	4.67	2.09
14	leave	6.60	0.63	34	seek	6.13	1.46	54.	sheaf	4.67	2.12
15	d	6.60	0.91	35	v	6.07	1.62	55.	keel	4.53	1.72
16	league	6.53	0.83	36	g's	6.00	1.19	56.	'neath	4.13	1.68
17	heal	6.53	0.91	37	deed	6.00	1.30	57.	peat	3.80	2.33
18	weed	6.53	1.30	38	veal	6.00	1.41	58.	e'en	1.93	1.67
19	neat	6.47	0.91	39	beam	5.87	1.12	59.	leal	1.80	1.01
20	need	6.47	0.91	40.	reel	5.87	1.68	60.	peag	1.27	0.59

Table 8: **Rank order of items, mean perceived word-frequency ratings and associated standard deviations: English group**

R	Items	PF	SD	R	Items	PF	SD	R	Items	PF	SD
1	eat	6.87	0.35	21.	league	5.20	1.61	41.	wean	3.80	0.86
2	he	6.87	0.35	22.	weed	5.13	1.24	42.	teethe	3.73	1.39
3	we	6.67	0.61	23.	lean	5.13	1.46	43.	heave	3.60	0.73
4	feel	6.53	0.63	24.	leap	5.07	1.10	44	v's	3.53	1'64
5	meal	6.53	0.63	25	jeep	5.07	1.49	45	reel	3.33	1.29
6	mean	6.33	0.81	26	deal	5.00	1.07	46	weave	3.27	1.33
7	need	6.33	0.90	27	peel	5.00	1.19	47	g's	3.13	1.84
8	beef	6.27	0.59	28	veal	4.73	1.43	48	heed	2.87	0.91
9	leave	6.20	1.08	29	heap	4.47	1.06	49	eel	2.87	0.99
10	knee	6.13	0.91	30.	keen	4.47	1.24	50.	keel	2.87	1.30
11	teeth	6.07	0.80	31	seek	4.33	1.44	51.	sheen	2.80	1.32
12	leaf	5.87	0.91	32	weep	4.33	1.50	52.	peat	2.67	1.04
13	deep	5.73	1.39	33	d	4.33	1.95	53.	seethe	2.67	1.04
14	neat	5.66	0.91	34	deed	4.20	1.42	54.	heath	2.60	0.73
15	knees	5.66	1.30	35	e's	4.13	1.36	55.	lea	2.40	1.24
16	p	5.40	1.45	36	e	4.07	2.21	56.	sheaf	2.27	0.96
17	jean	5.40	1.88	37	reef	4.00	1.07	57.	'neath	2.13	1.64
18	heal	5.27	0.80	38	beam	4.00	1.19	58.	e'en	1.60	1.35
19.	fee	5.27	1.28	39	d's	4.00	1.68	59.	leal	1.33	0.49
20	seed	5.27	1.16	40.	v	3.93	1.62	60.	peag	1.07	0.26

Table 9: **Rank order of items, mean ratings of perceived familiarity with word and their associated standard deviations: Spanish group**

R	Items	PFW	SD	R	Items	PFW	SD	R	Items	PFW	SD
1	he	7.00	0	21	jeep	5.73	1.39	41.	leap	3.13	2.07
2	eat	6.93	0.26	22.	knees	5.73	2.19	42.	veal	3.07	1.90
3	e	6.87	0.35	23.	p	5.67	1.63	43.	reel	2.87	1.88
4	leave	6.87	0.35	24.	seek	5.60	1.12	44.	weed	2.87	2.07
5	need	6.87	0.35	25.	beef	5.60	1.24	45.	heath	2.80	1.82
6	teeth	6.80	0.41	26.	keen	5.47	1.80	46.	eel	2.80	1.97
7	meal	6.73	0.59	27.	g's	5.47	2.13	47.	teethe	2.67	1.91
8	feel	6.60	0.74	28.	neat	4.93	1.94	48.	heave	2.53	1.40
9	we	6.60	0.82	29.	heal	4.80	1.52	49.	sheen	2.40	1.59
10	deep	6.53	0.64	30.	weep	4.73	2.12	50.	heap	2.40	1.92
11	league	6.46	0.74	31	leaf	4.73	2.26	51.	keel	2.27	1.49
12	mean	6.46	1.30	32.	seed	4.27	2.12	52.	'neath	2.00	1.36
13	jean	6.40	0.91	33.	e's	4.13	1.92	53.	heed	2.00	1.51
14	deal	6.33	0.72	34.	reef	4.00	2.17	54.	leal	1.93	1.16
15	d	6.27	1.22	35.	fee	3.53	2.41	55.	seethe	1.80	1.42
16	knee	6.00	1.77	36.	beam	3.40	1.45	56.	wean	1.67	0.81
17	v	5.93	1.83	37.	weave	3.40	1.88	57.	e'en	1.60	1.35
18	peel	5.87	1.06	38.	deed	3.40	2.06	58.	peat	1.60	1.55
19	v's	5.87	1.55	39.	lean	3.26	1.90	59.	peag	1.47	1.30
20	d's	5.80	1.37	40.	lea	3.20	1.97	60.	sheaf	1.40	0.91

A close inspection of standard deviations in the four tables shows that for both perceived familiarity with words and perceived word frequency in both groups, subjects' ratings were very similar. However, this study was essentially aimed at finding out whether both familiarity with the word and perceived word frequency influenced typicality ratings in both groups, Pearson product moment correlations were calculated. These correlations are shown in table 11. These results show that, for the Spanish group, there is no significant correlation between typicality and perceived familiarity with words and between typicality and perceived word frequency ($p > 0.05$). However, there is a significant correlation between typicality and perceived familiarity with word ($p < 0.0003$) and between typicality and perceived word frequency ($p < 0.0060$) in the English group. These results confirm our hypothesis that these non-materialistic factors do not influence typicality ratings by the Spanish group but do not confirm it for the English group.

Given that non-materialistic factors like subjects' perceived familiarity with words and perceived word frequency do not seem to determine typicality in the Spanish group (but they do to some extent in the English group), it might be wondered whether other non-materialistic factors could determine or be strongly related to the typicality of different realisations of / i /. A possible influential non-materialistic factor could be spelling. Spelling is a part of people's knowledge about any sound category and, consequently, it could have an influence over perceived typicality ratings. In fact, this has already been shown to be so. In her study of the category "English / k /". Jaeger (1980) showed that when essentially the same phonetic allophone was considered (i.e. voiceless aspirated stops), those allophones spelled with the letter

"q" were clearly the least typical examples while those spelled with the letters "ch", "k", and "c" were increasingly more typical (in this order). Jaeger claimed that the reason aspirated allophones spelled with "k" and "c" were the most typical ones could be that "k" is the name most often given to the sound, and "c" the letter most often used to spell it.

Table 10: **Rank order of items, mean perceived word-frequency ratings and associated standard deviations: Spanish group**

R	Items	PF	SD	R	Items	PF	SD	R	Items	PF	SD
1	he	7.00	0.00	21	peel	5.20	1.14	41.	lea	3.20	1.37
2	eat	6.93	0.25	22.	jeep	4.73	1.16	42.	heap	3.13	1.36
3	we	6.93	9.25	23.	neat	4.47	1.46	43.	reel	3.13	1.40
4	meal	6.80	0.56	24.	p	4.40	2.06	44.	veal	3.07	1.48
5	leave	6.73	0.59	25.	leaf	4.13	1.72	45.	weed	3.07	1.58
6	need	6.73	0.59	26.	weep	4.00	1.92	46.	v's	3.00	1.59
7	mean	6.67	0.81	27.	e's	3.80	1.14	47.	heed	2.93	1.22
8	feel	6.60	0.73	28.	e	3.80	2.11	48.	leal	2.87	1.40
9	teeth	6.13	1.12	29.	d	3.80	2.14	49.	heath	2.80	1.08
10	deal	6.00	0.84	30.	beam	3.60	1.40	50.	'neath	2.80	1.32
11	deep	5.93	1.03	31	d's	3.60	1.72	51.	keel	2.73	1.16
12	knee	5.80	1.08	32.	fee	3.60	1.80	52.	sheen	2.67	1.04
13	beef	5.73	1.22	33.	leap	3.60	1.63	53.	heave	2.60	0.99
14	jean	5.67	0.81	34.	weave	3.6	1.40	54.	wean	2.53	1.06
15	knees	5.53	1.36	35.	lean	3.53	1.46	55.	seethe	2.53	1.46
16	league	5.33	1.17	36.	seed	3.53	1.46	56.	eel	2.33	1.04
17	peel	5.20	1.14	37.	deed	3.53	1.64	57.	sheaf	2.33	1.04
18	keen	5.00	1.41	38.	g's	3.53	1.84	58.	peag	2.20	1.32
19	seek	4.93	1.70	39.	v	3.47	1.92	59.	peat	2.13	1.36
20	heal	4.80	1.47	40.	teethe	3.33	1.76	60.	e'en	2.07	0.96

Table 11: **Correlations between typicality and familiarity with word, and typicality and perceived word frequency for both groups**

	English group	Spanish group
Typicality and familiarity with words	42	0.17
Typicality and perceived word frequency	0.31	0.11

In order to find out whether spelling may have been influential in the case of / i /, the means of mean typicality ratings in both groups for equally-spelled instances of / i / were calculated. These data are shown in table 12.

Table 12: **means of the mean typicality ratings for equally-spelled members of / i / in both groups**

Spelling forms (vowel letter(s))	English group	Spanish group
< e >	5.41	5.42
< Ø >	5.18	5.48
< ee >	4.76	4.77
< ea >	4.09	4.36

Table 12 suggests that < e > is the most typical spelling form of / i / on the basis that the mean of the mean typicality ratings of those words in which / i / is spelled with < e > is higher than that for other spelling forms. Why should < e > be a very typical spelling?. One possible reason may be that the letter "e" is perhaps the name most often given to the sound. Not surprisingly, Daniel Jones, referring to / i / said that it was "the so-called 'long' sound of the letter e", giving as first examples of the sound the words "tree", "see", "even", "complete", and "immediate", and later stating that / i / was also "the sound of ea, ie, ei, and i in many words" (Jones 1989:65). In addition, < e > has been shown to be the most typical spelling form in children's developing spelling skills. Read (1986) showed that children's most frequent spelling of / i / was simply the letter that it names. In children under age six, 46.5 per cent of the spellings of / i / are e. Children spell words like "feel" as "fel" or "eagle" as "egle" Also, Treiman (1993) found that first-graders used < e > in 62.2 % of all their attempts to spell / i /. The most likely reason, she thought, was their knowledge of letter names. First-graders know that the name of e is / i /. So, in searching for a way to symbolise / i /, children often use e because they associate / i / with e. In both Read and Treiman's studies < ee > and < ea > were much less frequent spelling forms of / i / (4.7% and 6.1% for < ee > and 0.9% and 1.3% for < ea > in Read and Treiman's studies respectively). To sum up, one of the possible factors making a particular phonetic realisation of / i / be typical may be that is spelled with < e >.

However, the results of this study clearly show that perceived familiarity with words, perceived word frequency and spelling are not the only determinants of typicality ratings. The phonetic context of / i / is extremely important. Table 13 and figure 3 show the means of the mean typicality ratings of / i / grouped by type of coda. In the English group, those realisations of / i / followed by nasal stops and lateral consonants are (in this order) clearly the least typical ones Why could this be so?. First, one possible reason why subjects considered that vowels followed by / m / and / n / are less typical could be that those instances of / i / are slightly nasalised. Jones (1989:212) argued that although slight nasalisation of vowels occurs in English when nasal consonants follow, nasalisation is not sufficient to give the vowels the characteristic nasal timbre. However, if the category vowel were investigated, the most typical vowels would probably be [-nasal]. In fact, as is well-known, nasalised vowel phonemes are rare in languages and, when they appear, they are acquired only after oral vowels (Jakobson 1968). Subjects may then consider realisations of / i /, slightly nasalised due to the influence of the following nasal consonant as less typical examples of / i / because, to them, typical vowels should be completely [-nasal]. In fact, previous research has also found a similar effect of nasality on typicality ratings. Davis & Kuhl (1992) obtained average typicality ratings of ten naturally-produced voiceless velar stops followed by / æ /, digitised and edited to include only the initial consonant and the first two pitch periods of the following vowel. These researchers found that examples of / k / followed by a nasalised vowel (as a consequence of the final nasal consonant in the original

production) received lower iypicality ratings than those exarnples in which the vowel was not followed by a nasal consonant.

Second, why might examples of / i / followed by / l /be the least typical exarnples?. One reason could be that the specific allophone of / l / after / i / in the stimuli presented to the subjects, that is, "dark" l, implies a raising of the back of the tongue in the direction of the soft palate and therefore it has a back vowel (or velarised) resonance. In addition, the veralisation of [ɬ] often has the effect of retracting and lowering slightly the articulation of a preceding front vowel so that / i / lacks its characteristic tongue height and tongue advancement values. Also, when / i / is followed by [ɬ], a central glide between the vowel and [ɬ] is often noticeable (Gimson 1978:103). Presumably typical examples of / i / should not have such a glide. This is an aspect that many English subjects intuitively mentioned in the post-test interview after the typicality rating task.

Table 13: **Mean of mean typicality ratings of instances of / i / grouped by type of coda: English and Spanish subjects**

type of coda	English group	Spanish group
voiceless oral stops	5.80	3.02
voiced oral stops	5.40	5.57
voiceless fricatives	4.86	3.60
voiced fricatives	5.19	6.03
nasal stops	3.31	4.40
laterals	3.00	5.32
open syllable	5.38	5.13

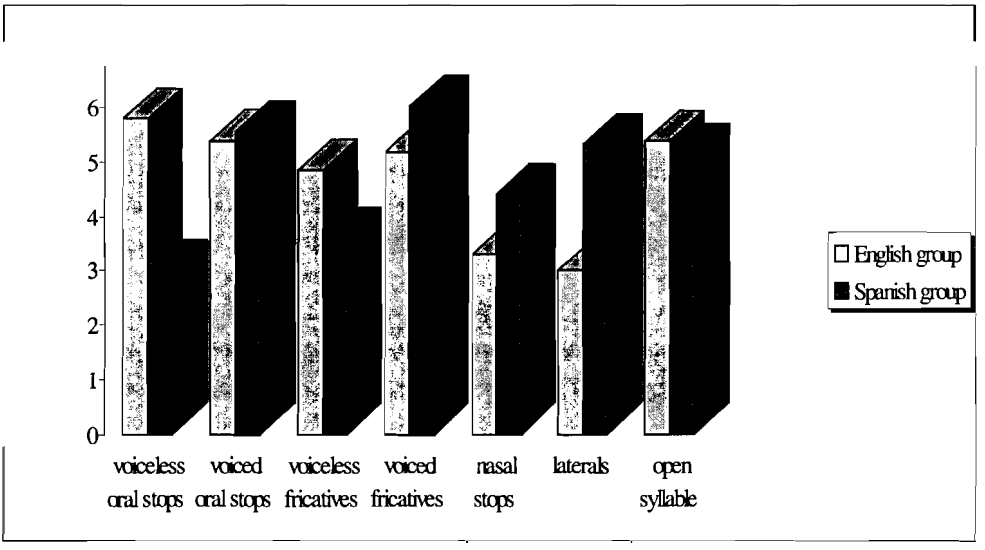

Figure 3: **Means of mean typicality ratings of instances of / i / followed by a particular type of coda in both groups**

The Spanish group seemed to be focusing on a different phonetic property: length. Although phonologically / i / is considered as a long vowel, phonetically it is sornetimes rather short. As is well-known, the reason lies in the effect produced by the coda. Final voiceless (or fortis) obstruents (i.e. stops and fricatives) shorten preceding long vowels and final voiced (or lenis) obstruents lengthen thern. Thus, the length of /·i / in accented syllables decreases depending on the character of the following consonant as table 14 and figure 4 show.

Table 14: **Mean duration of / i / (in msc) from shortest to longest depending on the phonetic character of the coda[14].**

Type of coda	voiceless stop	voiceless fricative	nasal stop	open syllable	voiced stop	voiced fricative
Mean duration	123 msc	130 msc	195 msc	280 msc	285 msc	360 msc
Example	"seat"	"reef"	"seen"	"see"	"lead"	"leave"

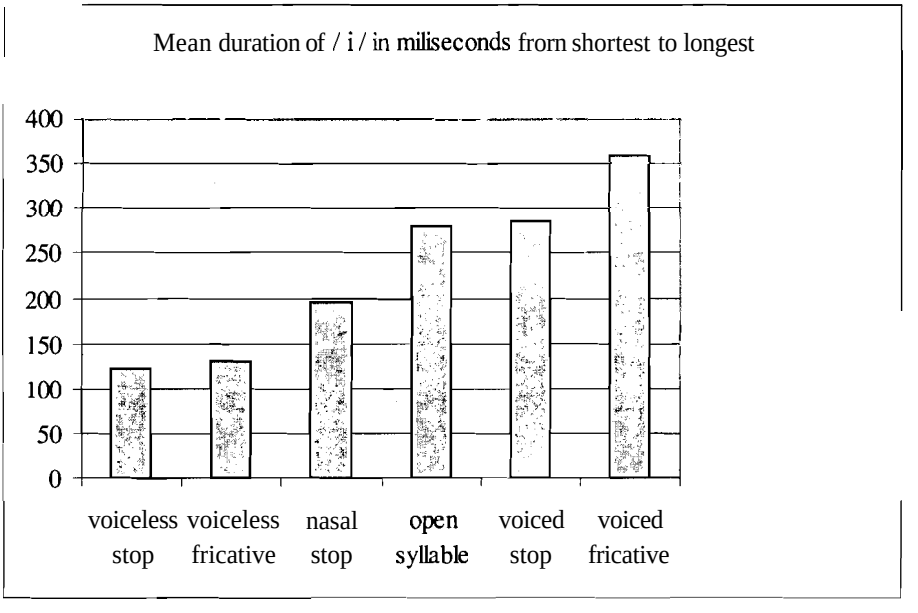

***Figure* 4: Mean duration of / i / (in msc) from shortest to longest depending on the phonetic character of the coda**

A close comparison of the rnean duration of members of / i / as determined by the type of coda and the rnean typicality ratings for members of / i / followed by the same type of coda reveals that typicality ratings increase as vowel length increases. The longer the mean duration of / i /

in a vowel, the more typical the vowel is considered to be and the shorter the mean duration, the less typical. Length seems then to be an important phonetic feature contributing to make members of / i / as more typical members.

It might be wondered why Spanish leamers of English and English native speakers followed different phonetic criteria to rate the typicality of the different realisations of / i /. Apparently, the English group disregarded length as a criterion to decide the typicality of each vowel sound. In fact, the English subjects' vowel-plus-coda group with the highest mean typicality ratings (i.e. / i / followed by voiceless oral stops) is that which has the shortest mean duration of the vowel. The reason why the Spanish group focused on length may have been that the name they learned for the category in an instructional setting was "long *i*". As a consequence, they paid attention, as most of them said in the post-test interview, to how long the vowel was. However, as native speakers of English do not have a conscious knowledge of the / ɪ /-/ i / length contrast (as most of them said in the post-test interview), they focused on other phonetic features like, for instance, nasality. In this respect, an interesting question to investigate in future work could be whether the typicality ratings provided by Spanish leamers of English who have not mastered the category yet are similar to the ones obtained for the English subjects in this study.

All these explanations are consistent with the perceptual salience determination of typicality. Following different criteria, both native speakers of English and leamers of English consider those realisations of / i / that are longer (in the case of the Spanish), or oral and non-diphthongised (in the case of English) as better examples of / i /. However, the criterion the Spanish group followed seems to be a somewhat mixed determinant of typicality (half materialistic and half non-materialistic). Spaniards might be attending to some acoustic characteristic of the speech signal itself but following conceptual knowledge about the category, that is, their knowledge of the phonological name of the sound. In this respect, length might be a kind of "ideal" characteristic that typical members of / i / should have. Knowing that the sound they are judging is often called "long *i*", Spanish learners of English focus on differences in length to judge typicality.

III. GENERAL DISCUSSION

Two main sets of findings can be discussed in relation to the experiments reported above: those related to typicality ratings and those related to determinants of those ratings. In addition, implications of these findings for the development of an interlanguage segmental phonology are discussed.

Experiments 1 and 2 provide further support to the growing evidence that stimuli considered as members of the same phonetic and/or phonological category are far from equivalent but differ in how typical they are rated as members of their category. However, this

study is the first to provide typicality ratings for the same phonological category by two different cultural and linguistic groups: native speakers of English whose / i / category belongs to their mother tongue and Spanish learners of English whose / i / category belongs to their interlanguage phonology and leamed it in an instructional setting. An important finding from this study is that, although typicality ratings are highly robust in both groups, there is only partial convergence in the mean typicality ratings generated for each instance of / i /.

Experiment 3 and the several analyses included therein tried to determine whether the typicality ratings obtained in experiments 1 and 2 could derive from several factors like perceived familiarity with stimuli as real English words, perceived word frequency, the spellings of / i / and phonetic influence of the coda.

In the English group evidence for perceived familiarity with words, perceived word frequency, spelling and influence of the coda as determinants oftypicality was obtained. Spelling and influence of the coda but not familiarity with words and perceived word frequency seemed to determine typicality in the Spanish group. Although both groups seemed to base their typicality ratings partly on the effect produced by the coda on instances of / i /, they paid attention to different types of influence of codas on preceding vowels.

The present findings provide evidence for multiple determinants of typicality for one and the same category at the same time. This is not surprising as experimental research has suggested that different factors rnay determine the typicality of the different members of a category at the same time. Barsalou (1981, 1985) and Barsalou and Sewell (1985) found that similarity, perceived frequency of instantiation and ideals predicted typicality in common semantic categories like bird and perceived frequency of instantiation, ideals (but not similarity)[15] predicted typicality in goal-derived categories. Nosofsky (1988b) found evidence for both similarity and frequency of instantiation of referents of category members in perceptual categories and Loken and Ward (1990) for similarity, ideals and perceived frequency of instantiation in product categories (Loken & Ward 1990).

Furthermore, the fact that different factors determine the typicality of the members of a category in different groups is also not surprising. It has long been shown that the determinants of the typicality of the members of a particular category rnay vary depending on the circumstances in which the category is processed. For example, whereas ideals rnay determine the typicality of category members in one context, similarity rnay determine their typicality in another (Barsalou 1985, 1987). Therefore, instead of a fixed determinant being responsible for a category's typicality ratings on all occasions, different contexts rnay cause different factors to determine typicality for one and the same category. The context-dependent character of the determinants of the typicality of members of a particular category suggests that there rnay be no invariant typicality for a given category. As the determinants of the typicality of category members change, the typicality ratings of those members rnay also change. In fact, the literature on typicality is full of studies showing that the same group of people or different populations

generate different typicality ratings for the same semantic categories depending on a host of factors like the linguistic context in which a category appears (e.g. Roth & Shoben 1983), the points of view people adopt (Barsalou & Sewell 1984), the mood people are in (e.g. Isen *et al.* 1992), the level of abstraction in a taxonomy in which a particular category is processed (e.g. Roth & Mervis 1983), the processing of a category in isolation or in a conceptual combination (e.g. Hampton 1988; Osherson & Smith 1982; Smith & Osherson 1988), or even subjects' age (e.g. Bjorklund *et al.* 1983). Phonetic categories are also sensitive to global context effects (e.g. Diehl & Kluender 1987; Repp & Liberman 1987). The typicality of the members of phonetic categories varies as a function of changes in syllable-intemal rate (e.g. Miller & Volaitis 1989, Miller *et al.* 1997; Volaitis & Miller 1992; Wayland *et al.* 1994; see also Miller 1994), syllable-external rate (e.g. Wayland *et al.* 1994) and changes in any of the multiple acoustic properties specifying any given phonetic segment (e.g. Hodgson 1993; Hodgson & Miller 1996; see also Miller 1994 for a discussion).

An extremely important finding in all these studies is that, although typicality structures change, the typicality ratings subjects produce are also statistically reliable, which indicates that typicality is notan arbitrary phenomenon. It simply means that, when subjects make judgements of typicality, they draw upon many different sources of knowledge, depending on the circumstances (Barsalou 1985, 1987; Segalowitz & Poulin-Dubois 1990). It appears that the determination of typicality is a highly flexible dynamic and context-dependent process. Typicality seems to reflect people's current conceptualisation of a category, and to the extent this conceptualisation changes, typicality will change. It is important to remark that typicality refers to behaviour, not to cognitive or conceptual structure. It refers to how people order the members of a category according to how good or typical of the category they think those members are. In this sense, the typicality of the members of the category *bird* is simply the rank ordering of different types of birds from most to least typical; therefore typicality does not carry any conceptual representational assumptions so it does not provide any specific theory of mental representation (Barsalou 1987).[16]

In relation to the present experiments it can be claimed that to the extent that both groups were basing their typicality ratings on different factors (e.g. knowledge of phonological name of the category in the Spanish group, familiarity with words in the English group, etc.) their typicality ratings differed.

Finally, it is interesting to consider some implications of typicality for the leaming of English phonology by Spanish leamers of English. In this respect, future work will have to determine whether the typicality of members of / i / predicts performance on different experimental tasks and naturally-occurring phenomena in much the same way as typicality predicted performance as reviewed at the beginning of this study. The evidence mentioned above in relation to dichotic competition, selective adaptation, generalisation and category verification in phonetic categories seems to make us hypothesise this will be so.

One of the main groups of variables has to do with category leaming and development

of category structure. Reports with both visual (e.g. Hupp & Mervis 1982; Mervis & Pani 1980) and auditory categories (e.g. Grieser & Kuhl 1983,1989; Kuhl 1991) have shown that categories are leamed easily and faster if initial exposure to the category is through typical category members. For example, in Grieser and Kuhl's (1989) study, infants leamed the categories / e / and / i /. Their generalisation to other members within the same vowel category was tested and it was found that when infants leamed the phonetic categories, if the referent stimulus was a good or typical exemplar of the vowel, infants showed greater generalisation to other members of the category than if a poor vowel exemplar served as the referent stimulus. A very typical vowel assimilated more novel variants of the vowel category than a less typical vowel so generalisation to other members of a vowel category was significantly altered by the typicality of the stimulus on which infants were trained. It remains to be determined whether this ease of leaming also applies to adult Spanish leamers of English. Taking for granted that, as Repp and Liberman (1984) claim, "mastery of a new language does imply the establishment of new phonetic categories", it is likely that if students were to acquire a new category (like / i /), the typicality of the stimuli to which they are first exposed would have a strong influence in shaping the category. Future work will have to determine whether this is so. The selection of the reference keywords first presented to students becomes then a fundamental issue. The hypothesis is that if words containing very typical examples of the category are shown as examples and leaming the category proceeds first with these words (and not with less typical examples), leaming will take place more easily and faster.

NOTES:

1. Rosch's (1975b) study used a 7-point scale with 1 meaning "most typical" and 7 "least typical". Malt and Smith's (1982) and Schwanenflugel and Rey's (1986) studies used a 7-point scale with 7 meaning "most typical" and 1 "least typical". Hampton & Gardiner's (1983) study used a 5-point scale with 1 meaning "most typical" and 5 "least typical".

2. People often create categories not well-established in memory to achieve a novel goal. These categories are not conventional but rather are made upon the fly for some immediate purpose (i.e. a goal). In this case they are called "ad hoc".

3. For other variables determining reaction time in such tasks see Chumbley (1986).

4. Jaeger also studied the categories [+/-anterior], [+/-sonorant] and [+/-voice] (Jaeger 1980; Jaeger & Ohala 1984). The results showed that 1) labials, labiodentals and alveolars were generally equally typical members of the category [+anterior], while palatals, velars, low back vowels and laryngeals were increasingly less typical. In the case of the category [-anterior], the pattern reversed; 2) nasals and liquids were clearly the most typical instances of the category [+voice], while fricatives and glides were the least typical. Voiceless stops and voiceless fricatives were the best instances of the [-voice] category; 3) approximants and nasals were the best exemplars of the category [+sonorant] with voiced fricatives and voiced affricates as the least typical examples. For the [-sonorant] category, voiceless stops were the most typical members. In addition, Nathan's (1989) study of *sonority*, and its opposite, *consonantality*, in the context

of syllable structure, provided further evidence. Nathan suggested, for example, that a vowel is a very typical example of sonorant and consequently of syllable nucleus while a voiceless stop is, for example, a very good example of non-sonorant and consequently of syllable margin.

5. Massaro (1987) distinguishes between two types of processes in phonetic categorization, ***sensory*** and ***decisional.*** Massaro claims that while discrete decision processes cause stimuli to be "partitioned" categorically into either "member" or "not member" of a phonetic category, these processes do not imply that stimuli are perceived categorically. Massaro speaks of "categorical partitioning" to refer to what has generally been called categorical perception. According to Massaro, all sensory processes are continuous, and categorical perception boundary effects arise only because of discrete "decision" processes.

6. The reasons Kuhl (1991) gives are two: / i / is extensively used in the world's languages and it is one of the 3 "point" vowels (the vowels that are at the articulatory and acoustic extremes of the vowel space).

7. We would like to thank Liz Murphy for her co-operation.

8. These include < ae > (e.g. "Caesar"), < ay > (e.g. "quay"), < e > (e.g. "equal"), < ea > (e.g. "beach), < ee > (e.g. "beef"), < ei > (e.g. "ceiling"), < eo > (e.g. "people"), < ey > (e.g. "key"), < i > (e.g. "ski"), < ie > (e.g. "field"), and even < œ > (e.g. "foetus").

9. Homophones differing only in the spelling form of / i / were ruled out to avoid a possible mismatch between lexical items intended by the experimenter and those possibly understood by the subjects. The excluded homophones were "be"-"b", "beach"-"beech", "bean"-"been", "cheap"-"cheep", "feat"-"feet", "leach"/"Leach"-"leech"/"Leech", "leak"-"leek"/"Leek", "leat"-"leet", "meat"-"meet", "peak"-"peek", "peal"-"peel", "read"-"reed", "sea"-"see"-"c", "seam"-"seem", "sea"-"see", "seen"-"scene", "tea"-"tee"-"t", "team"-"teem", "thee"-"the", "weak"-"week", "weal"-"wheel"-"we'll" (and plurals in the case of nouns). Other homophones spelled at least one with < ea >, < ee >, < e > or < o > and the other with some other spelling form were also ruled out. These were "peace"-"piece" and "seas"-"sees"-"seize". The only exceptions were "e's"-"ease", "p"-"pea"-"pee", "heel"-"he'll"-"heal". Subjects were told that, if they heard any pronunciation which could be more than just one word, the one meant was the letter name (this would focus their attention on "p" and "e's") that was if they found a word that could be either a noun or a verb, the one meant was the verb (this would focus their attention on "heal" vs. "heel").

10. For the type of CV, VC, and CVC syllable structures selected in this study, / i / may be preceded by any consonant except for / ŋ / (in fact this applies to any vowel as / ŋ / constitutes as phonological segmental constraint in English word-initially). / i / is preceded to a limited extent by / ʒ / (ex. "gîte"), and / θ / (ex. "theme"). Similarly, word-finally in monosyllables, / i / is followed, to a very limited extent, by / ʃ / (ex. "niche") / ɡ / (ex. "league") and / dʒ / (ex. "liege", "siege"). It is never followed by either / ʒ / or / ŋ /.

11. The margins of syllables (either the head or the coda) whose nucleus is / i / may be occupied by more than just one consonant. Two-consonant clusters, which are very common, include oral stops or fricatives followed by / l / (e.g. "plead", "bleak", "clean" "glean", "flee", "sleep"), / w / (e.g. "queen" "tweed", "sweet") or / r / (e.g. "preach", "breathe", "tree", "dream", "cream", "Greek", "three", "freak", "shriek"). They also include voiceless oral stops preceded by / s / (e.g. "speak", "steel", or "ski") or nasals preceded by / s / (e.g. "sneeze"). Three-consonant clusters include / s / as the first consonant, a voiceless stop as the second, and / r / (e.g. "spree", "streak", "screen"), / l / (e.g. "spleen") or / w / (e.g. "squeak") as the third. Similarly, two-consonant codas are also found preceded by / i /. These include

fricatives followed by stops (e.g. "yeast", "seized"), nasals followed by fricatives (e.g. "nineteenth"), etc. Three-consonant clusters are extremely rare (e.g. "nineteenths".

12. Another way to view an exemplar's similarity is as its similarity to some sort of central information (e.g. average or modal attribute values) abstracted from category members (e.g. McCloskey & Glucksberg 1979; Rips *et al.* 1973; Rosch *et al.* 1976; Smith *et al.* 1974).

13. Other non-materialistic factors discussed in the literature are "social salience" (e.g. Whitfield & Slatter 1979), higher-order knowledge structures called "idealized cognitive models" (Lakoff 1987) or knowledge of feature correlations (e.g. Malt & Smith 1984).

14. The durations are taken from Wiik (1965).

15. It has also been found that different factors may determine typicality in different types of categories. Barsalou (1985) found that similarity did not predict typicality in goal-derived categories but it did in common taxonomic categories. In seems then that no factor accounts for the typicality of all possible categories.

16. However, at the beginning of the research on typicality, typicality ratings were believed to mirror the structure of a category in mental representations (e.g. Rosch 1975b). The names "internal structure" or "graded structure", occasionally applied to typicality, testify to this early but eventually rejected interpretation (e.g. Rosch 1978). At present, typicality ratings are considered as mere constraints on what representations might be, though bearing profound implications for our understanding of categorization and memory. In relation to phonetic categories, some studies have also explicitly addressed representational (e.g. Grieser & Kuhl 1989; Miller 1977; Oden & Massaro 1978; Repp 1977; Samuel 1982). However, the same caution should be taken not to identify typicality judgements with the representation of sounds in long-term memory.

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