Sensitivity to the Morphological Composition of 'Action Nouns': Evidence from a Grammatical Category Identification Task.

M.A. Thesis

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Abstract

Access to morphological structure during lexical processing has been established across a number of languages. However, uncertainty remains about the degree of decomposition in morphologically complex words, and whether different processing strategies may be employed alongside the knowledge of a morphologically rich language. The present study examined the auditory recognition of nouns through a speeded grammatical decision task, manipulating the presence of a verbal derivation and nominalizing suffix form, and the presence of 'action-like' semantics. Participants were native Spanish speakers with differing proficiency in the morphologically rich language, Basque. Comparisons were drawn between word-class identifications of 1) 'Event nouns' - no verbal derivation (i.e., *Avalanche*); 2) 'Nominalizations' – verbal derivation and word-final nominal suffix (i.e., *Argument*); 3) 'Pseudo-suffixes' - word-final 'nominal' form, identical to a nominalizing suffix, but without the corresponding verbal derivation (i.e., *Excursion*) and 4) 'Prototypical nouns' – items with no verbal derivation or word-final nominal suffix (i.e., *Medicine*). The aim was to provide insight into the strength and temporality of constituent activation. Results showed that Nominalizations were the most difficult to classify as a noun, displaying significantly slower response times and higher error rates. No differences were found between Pseudo-Suffixed and Prototypical nouns. The Spanish dominant, highly proficient Basque speakers showed greatest difficulty for decomposable nouns, in comparison to both the Basque dominant and low Basque group and the other conditions, suggesting that language profile can affect lexical processing. These findings support the claim that listeners decompose morphologically complex words, and activate the stem rather than the suffix in derived items.

Introduction

Processing Morphologically Complex Items

In studies of the mental lexicon, there has been great interest in the processing of words with a complex morphological structure (e.g., "*argue + ment*"). A number of theories have been proposed to explain the mental representation of complex words, and can be identified relative to the degree of decomposition assumed during lexical storage and retrieval. These accounts span a continuum between two primary models of morphological processing: the word-whole or 'continuous' approach (Butterworth, 1983) and the decompositional 'parsing' approach (Cutler and Norris, 1988; Taft and Forster, 1975; Marslen-Wilson, Tyler, Waksler and Older, 1994; Pinker and Ullman, 2002).

Processing based on a continuous model suggests that morphologically complex items are not decomposed into their constituent morphemes before retrieval (Butterworth, 1983). The main criticism of this approach, as Wurm (1997) and others have highlighted, is the high degree of redundancy caused by representing all words independently in the lexicon. This is particularly clear in the auditory domain, as a strict left-to-right parsing would require an inefficient separation between 'cover', 'uncover' and 'discover'. However, some believe that the emphasis on storage efficiency is misguided, given the huge storage capacity of the human brain (Sandra, 1994).

Contrastively, more decompositional theories hypothesize a morphemic breakdown of lexical items, using a strategy that does not employ a strict left-to-right or word-whole processing. There are a number of models favouring this approach. For example, the 'affix-stripping model' (Taft, 1981; 1985; Taft and Forster, 1975), predicts that items are segmented into root and affix prior to lexical access, with each element being activated independently. This model is supported by a number of findings, including evidence from event-related potentials (ERP), eye tracking and lexical decision tasks (e.g., Lavric et al., 2007; Fabregas and Marin, 2012; Havas et al., 2012; Andrews, Miller and Rayner, 2004).

In terms of predicting the processing of words composed of a [stem] + [suffix], the affix-stripping model would segment each morpheme, and place focus upon the base stem element. This claim is evidenced by a number of neuro-imaging and electrophysiology studies, drawing comparisons between de-verbal nominalizations (i.e., '*argument'*) and the verb from which they were derived (i.e., '*argue'*). Evidence from functional magnetic resonance imaging (fMRI), for example, found no difference in the regions of activation in the left inferior frontal gyrus (Sharpiro et al, 2001; Oliveri et al., 2004; Tyler et al, 2001; 2004; Siri et al., 2008; see Crepaldi et al., 2011 for a review). Furthermore, ERP studies found similar processing costs for the nominalization and its verb-stem counterpart, indicated through both increased amplitude in the 300 – 450ms time window, and similar topographical distribution (Barber, Kousta, Otten and Vigliocco, 2010). This suggests that the neurological difference between a verb stem and derived noun and minimal, despite the word-class change (Garbin, Collina and Tabossi, 2012), and that the inclusion of a suffix serves only to alter the grammatical word class, with little impact upon processing (Taft, 1985; Beard, 1995).

Within the body of decompositional theories, there have been a number of approaches to constituent identification within complex lexical items. Cutler and Norris (1988) propose segmentation on the basis of sub-lexical syllable stress, and suggest we place emphasis on the most important elements and therefore the elements to be processed first. Findings supporting syllabic stress have also been established with visual presentation of word and pseudo-word priming, suggesting that stress markings are not limited to auditory lexical processing (Arciuli and Cupples, 2006). However, these findings have not been consistently replicated, with evidence to suggest that derivational and inflectional morphology are processed independently in the visual domain, despite neither unit having syllabic stress (Leinonen et al, 2008). Furthermore, evidence from the decomposition of morphological compound items suggest equal activation of constituents in words such as '*milkshake'* and '*postman'*, despite differences in semantic importance (Duñabeitia, Laka, Perea and Carreiras, 2009). The use of

stress as a cue for decomposition is therefore not clear-cut across modalities, although evidence is stronger for auditory processing.

An alternative view draws evidence from cross-modal priming tasks, suggesting the degree of overlap in form and meaning between word-whole unit and semantic stem facilitates decomposition. For example, Marslen-Wilson, Tyler, Waksler and Older (1994) suggest that semantic transparency is required for constituent activation in derivationally suffixed and prefixed words, and that phonological overlap is not sufficient to decompose the stem from its affix. Contrary findings have been established in a similar cross-modal priming task by Kielar and Joanasse (2010), however, finding graded priming effects in relation to either semantic or phonological overlap in isolation. This sensitivity was further evident in exploring the ERP responses to such priming, as they found the degree of form and meaning overlap was the greatest predictor of N400 effect modulation, above the bivariate distinction between derived (e.g., *establish + ment*) and opaque forms (e.g., *apart + ment*). Based on this evidence, it suggests that both form and meaning are important elements in the decomposition of complex units, and further, that these elements may be in direct correlation with the degree of decomposition imposed.

Contrasting to full-decomposition theories, more hybrid approaches such as the dual-mechanism model suggest we employ both word-whole and decompositional strategies depending upon the composition of the lexical item (Clahsen, 1999; Pinker, 1999; Pinker and Ullman, 2002). This model suggests that irregularly inflected and simple words are stored as whole units, and directly retrieved from the lexicon. Regular complex items are instead stored in terms of their morphological constituents, and are consequently processed segmentally through the 'root' and the additional suffix. It is proposed that we do not independently represent complex words with regular inflectional or derivational morphology in our lexicon. Instead, online grammatical rules are employed to process these affixes, reducing the size and frequency of the units required to be stored in aid of efficiency.

The final processing model to be discussed is the parallel dual route model proposed by Baayen and Schreuder (1999). It has a number of similarities to the dual-mechanism model described above as it follows a hybrid approach, but differs in the proposition that all morphemic constituents are represented in our lexicon. The model suggests that we access the segmental representation and the full form in parallel, and store all affixes and base forms in our lexicon. It is based on the assumption that the cognitive costs of storage are less than the cost of rule computation, and so mass storage is a more efficient technique. An item such as '*disappears'* would therefore be stored fully segmentally and word-whole, both as '*dis-appear-s*' and '*disappears'*, despite its regular inflection. The method with which we process an item is based within the summative Base Frequency (stem and affix units) and Surface Frequency Effects (word-whole). This is supported by findings from regular and irregular forms in Dutch, Finnish and English, illustrating that the frequency of all units within a word can affect speed of lexical access, not just the stem or word-whole frequency (Baayen, Dijkstra and Schreuder, 1997). However, a counter explanation is the frequency of the speed in which the rule is applied, rather than the frequency of the units themselves.

Decomposition Across Languages

Evidence supporting the decomposition of morphologically complex items has been established across a number of different languages, including French (Longtin and Meunier, 2005); English (Rastle, Davis, & New, 2004), Italian (Marangolo et al, 2006), Basque (Duñabeitia et al., 2007a; 2007b), Spanish (Havas et al, 2012), Finnish (Lehtonen et al., 2007; Leinonen et al., 2008), German (Janssen, Wiese, and Schlesewsky, 2006), Hebrew (Plaut and Gonnerman, 2000) and Dutch (Lemhöfer et al., 2011).

Importantly this suggests that morphological parsing is a universal processing strategy, and is not specific to a limited set of languages. However, as acknowledged by Hankamer (1989), there is substantially more affixation and composition employed in languages such as Finnish and Basque than in romance languages such as Spanish and Italian. This may suggest that users of

morphologically rich languages may more frequently employ these morphological decomposition mechanisms, due to higher levels of regular inflection. It remains unclear, however, whether this processing strategy would be employed across all of a multilingual individual's languages, or remains specific to the morphologically rich language that requires greater decomposition.

There is a large and varied body of research to support the adoption and combination of linguistic strategies across language processing. An interaction has been established between a bilingual's languages on a number of levels, including phonology, semantics and syntax (see Desmet and Duyck, 2007 for a review), suggesting that these elements share a processing system independent of language. However, as relatively little investigation has been conducted into the morphological processing strategies of bilinguals who are proficient in both a morphologically rich and a morphologically poor language, it is less clear whether a bilingual's languages interact on the morphological level. This presents the opportunity to explore whether the suggested parsing bias for users of morphologically rich languages could remain while processing a comparably morphologically poor language.

Strategies in Grammatical Classification Tasks

One of the most common distinctions made in the world's languages is between the grammatical categories noun and verb (Baker, 2001). There are a number of characteristics that determine this distinction, and we are sensitive to these cues to support effective everyday communication (Pinker, 1984). If asked to make an explicit decision of word-class, a distinction based upon syntax may be the most reliable information source (Folk & Morris, 2003). However, this is not always readily available when presenting a word in isolation, and may leave the individual to rely on the information provided within the word to indicate its grammatical category.

In terms of structural cues for grammatical category classification, in morphologically derived items such as nominalizations, the suffix determines the

resulting word class. It may be expected, therefore, that lexical processing during tasks requiring grammatical classification may place greater focus on morphological units containing these syntactic cues. Arciuli and Monaghan (2009) found that participants identified nouns and verbs slowest when they had 'inconsistent' endings – i.e., statistically infrequent orthographic endings for that word class. For example, in English, the segmental structure of *marble* is more prototypical of a noun than *insect,* and it is claimed that our sensitivity to these word-final probabilistic cues can cause a delay in recognizing these less typical structures. Interestingly, this delay was found both in lexical decision and grammatical decision tasks, has been established in auditory recognition (Farmer, Christiansen and Monaghan, 2006) and across a number of languages, including English, French, Dutch and Japanese (Monaghan, Christiansen and Chater, 2007). This has led to the claim that in making lexical decisions we also simultaneously assess that item for grammatical class (Sereno and Jongman, 1990).

Furthermore, semantic reliance has also been shown to alter depending upon task demands. For example, Kacinik and Chiarello (2002) found differences in noun and verb processing when comparing results from three experiments employing different tasks: grammatical classification, lexical decision and word naming. They found that imageability and word-class typicality were the best predictors of noun/verb latencies for the grammatical decision task, whereas familiarity was more significant for lexical decision and word-naming. This demonstrates that individuals are more sensitive to word-class prototypicality during grammatical decision, and that different lexical processing techniques may be employed depending upon the needs of the task.

These findings suggest that we can identify grammatical categories on the basis of both semantic and structural information, and that we are sensitive to these subtle structural cues without conscious awareness. However, it remains unclear whether we have an equal reliance on each of these cues, and whether this preference can differ depending upon context. For example, in situations where lexical semantics are not typical of word class, do we rely more on structural and syntactic cues during lexical retrieval?

Semantically Atypical Nouns

In defining and classifying nouns with 'incongruent' semantic properties, two categories can be identified, relating to whether the lexemes have been derived from a verbal stem (i.e., deverbal nominalization) or not (i.e., event noun).

What is meant by an 'event' or 'action' noun is particularly important, as the term has been used somewhat inconsistently in the literature. For example, Oliveri et al. (2004) use the term to refer to objects that are used during motor actions (i.e., *axe* and *pencil*); whereas Bel et al (2010) and Resnik (2004; 2009) define 'non-deverbal event nouns' as nouns without a nominalizing suffix but which can also be used in a verb form (i.e., *battle* and *campaign*), as well as objects 'insinuating' movement (i.e., *summit* and *holiday*).

The working definition of 'event nouns' employed in this paper follows from Fabregas and Marin (2012:42). They propose that these items are 'a class of words that are not derived from verbs […] but denote aspectual notions, such as events and states.' – offering examples such as *terremoto* 'earthquake' and *fiesta* 'party'. Crucially, the items defined as event nouns for the present discussion have no relation to verb forms, and were identified on the basis of referring to the event itself, rather than the result of an event.

The second class of nouns with 'action-like' semantics are derived from the nominal suffixation of a verb. In de-verbal nominalizations such as '*entertainment'*, the semantic and syntactic behavior appear to be encoded into separate morphological units: the meaning is maintained in the verbal root (i.e., *entertain*), and the syntactic behavior indicated through the nominalizing suffix (i.e., –*ment*). Consequently, the semantic incongruency is highly transparent, as the semantics of the verbal stem are in disagreement to the syntax of the nominal suffix. This is an interesting composition, as the verb root has a different grammatical class to the word-whole form.

As these atypical nouns share the characteristics of referring to 'actions' rather than 'objects', they may be considered more 'verb-like' than 'noun-like' in a layman's grammatical distinction (Levin, 1999). In terms of the word-class identification discussed above, both can be seen to have incongruent semantics as compared to their syntactic category: for nominalizations, the source of the 'action' meaning is within the verbal stem, at the morphological level. By contrast, in the event nouns, the source of the 'action' semantics is at the word-whole level, as they do not have a related verb stem. The compositionality of these nouns therefore provides the opportunity to explore the significance of decomposition when processing words matched on semantic 'action' but differing in morphological composition.

Aims of the Present Study

There are two questions that the current paper aims to address. The first is whether a different processing strategy is employed depending upon the morphological composition of 'action-like' nouns. We therefore ask whether morphologically complex items composed of [verb stem] + [regular nominal suffix] are processed word-whole, or through primary activation of the first or second element. This is particularly interesting given the disagreement between decomposed and word-whole word class. The second is whether the knowledge of a morphologically rich language may support stronger segmental processing strategies, and if these strategies are employed across both languages of a bilingual.

To investigate these questions, reaction times and error rates in a grammatical category classification task were measured in response to a series of spoken words, including nouns differing in semantic and morphological composition. Primary comparisons were drawn between the two types of 'action' nouns described above: those which could be decomposed into [verb stem] + [nominal suffix] (i.e., *Argu + mento (*Argument)), and those that could not be decomposed (i.e., *Avalancha* (Avalanche)). The source of the action semantics was at the sub-lexical 'stem' level in the nominalizations, and the word-whole level in the event

nouns. The difference between these items is therefore the presence of a verb stem, allowing insight into the sensitivity to this unit within the derived word. Furthermore, as the decomposable nominalization included a suffix cue of its word class, we were able to explore the temporality of constituent activation. Comparisons were additionally drawn between nominalizations and nouns with a similar surface structure, containing a 'pseudo' derived suffix and a false stem, [false stem] + [nominal suffix] (i.e., *Excursión* (Excursion)). This was to determine whether there is sensitivity to the word-final morphological unit, and furthermore whether the item is decomposed despite the absence of a free base morpheme. Finally, prototypical nouns with 'object-like' semantics and no potential for decomposition were included (i.e., *Medicina* (Medicine)). This allowed for a baseline comparison to non-decomposable words with more typical nominal semantics.

Results on this task were compared among three groups of Spanish native bilinguals, differing in Basque proficiency. The groups included Basque dominant with a high level of Spanish (Group B), Spanish dominant with a high level of Basque (Group S), and Spanish dominant with low knowledge of Basque (Group L). Previous studies (Hankamer, 1989; Frauenfelder and Schreuder, 1992) have suggested that knowledge of a morphologically rich language such as Basque may cause a parsing bias during native lexical processing, and the formation of stronger morphological representations. However, less investigation has been conducted into the consequences this may have on a bilingual's second language. If decomposition is a general language processing strategy, the degree of Basque proficiency may be expected to affect the processing of decompositional words independent of the language being tested. Alternatively, if an increased reliance on decompositional processing is only employed when processing the morphologically rich language, there is no difference to be expected between the three groups. The present study therefore explores the processing of morphologically complex words in the romance language Spanish, in the light of differing Basque proficiency.

Methods

Participants

Seventy-five right-handed participants with normal hearing took part in this study for €6. Participants were either students of, or employed by, the University of the Basque Country and were recruited through an online participant database with self-selection. All participants provided written informed consent, and the study was approved by the Basque Centre on Cognition, Brain and Language Ethical Committee.

Three participant profiles were specified during the recruitment process. This was based on individuals' first language and self-rated Basque and Spanish proficiency. Twenty-five participants were included in each language profile group; dominant Basque (Group B) (mean age = 24.46, *SD* = 5.07, 18 female, 7 male), dominant Spanish (Group S) (mean age = 22.42, *SD* = 3.74, 13 female, 12 male) and low Basque (Group L) (mean age = 23.5, *SD* = 4.68, 18 female, 7 male). Participants in Groups B and S were Spanish-Basque bilinguals, with a self-rating of proficiency between 8-10 in both languages, on a 10-point scale. The difference between these groups was therefore which language they considered to be dominant. The low Basque group were Spanish dominant bilinguals, and provided a self-rating of Basque between 0-3. They considered English to be their second language, and did not identify Basque as their L3.

In addition to self-rating scores, participants' language proficiency was assessed through the Basque English Spanish Test (BEST) and interviews before the recruitment process. Group average scores are displayed in Table 1. The possible scores in the BEST range from 0 – 77, and are based on a picture naming task across the three languages. Interview scores range between 0 and 5, and are based on the responses provided to a series of 5 conversational questions.

Group	BEST Spanish	Interview Spanish	BEST Basque	Interview Basque	BEST English	Interview English
B	75.98	4.98	74.53	4.98	54.90	3.58
S	76.48	5.00	62.06	4.23	44.84	3.00
L	76.67	4.85	13.52	3.59	48.56	3.15
M=	76.38	4.94	50.04	4.26	49.43	3.24

Table 1. Average scores for BEST and interview scores for each group, mean average across all groups.

Stimuli

A total of 39 critical items were selected from the Spanish Es-Pal database (Duchon et al., 2013) to form the three subsets of nouns. Critical stimulus items are presented in Table 2. These consisted of: 13 'event-nouns', selected on the basis of an event/action semantic representation, but absent of verbal derivation; 13 de-verbal nominalizations, selected on the basis of having a clear verbal derivation and nominalizing suffix. And finally, 13 'pseudo-suffixes' were selected on the basis of a word-final 'nominal' form, identical to a nominalizing suffix, but without the corresponding verbal derivation.

Event Noun		Nominalization		Pseudo-suffix	
Campaña	Campaign	Argumento	Argument	Adicción	Addiction
Accidente	Accident	Duración	Duration	Comunión	Communion
Huelga	Strike	Creencia	Belief	Excursión	Excursion
Tormenta	Storm	Ganancia	Gain	Vocación	God call
Terremoto	Earthquake	Herencia	Heritage	Desventura	Misfortune
Trayecto	Journey	Matanza	Slaughter	Ruptura	Rupture
Huracán	Hurricane	Donación	Donation	Lección	Lesson
Cirugía	Surgery	Fijación	Fixation	Audición	Audition
Travesía	Crossing	Curación	Healing	Falacia	Fallacy
Avalancha	Avalanche	Mudanza	Move	Noción	Notion
Ciclón	Cyclone	Crianza	Breeding	Vigencia	Validity
Cataclismo	Cataclysm	Alzamiento	Lift	Coalición	Coalition
Escaramuza	Skirmish	Abdicación	Abdication	Sección	Section

Table 2. Critical Spanish items and English translations.

The presence or absence of verbal derivation respectively was judged by ten native Spanish speakers. They assessed each item in isolation, through an online form. For each word they were asked to indicate whether it had a verbal counterpart, by

either selecting 'yes' or 'no'. If the answer was 'yes', they were then asked to suggest which verb was associated. Only items reaching 90% native-speaker agreement were included. Any items not meeting this threshold were discarded, and new items were selected and judged until 90% agreement was obtained.

Filler items consisted of 26 'prototypical' nouns, 52 infinitive verbs and 52 inflected verbs. Sets of stimulus were created by matching for phoneme number (PN), log frequency (log.), log frequency of the base 'stem' (base log.) and phonological uniqueness points (UP) to the nominalizations. A total of 13 sets were created using this structure. Each set included one nominalization (i.e., **Argumento**, *PN* = 9, *log.* = 1.67, *base log.* = 4.49*, UP* = 10), one event noun (i.e., **Accidente**, *PN* = 9, *log*. = 1.69, *UP* = 10), one pseudo-suffix (i.e., **Coalición,** *PN* = 9, *log.* = 1.62, *UP = 10)* and two prototypical nouns (i.e., **Organismo**, *PN* = 9, *log.* = 1.68, *UP = 10;* **Facultad**, *PN* = 9, *log.* = 1.69, *UP = 10).* Eight verbs were also included in each stimulus set. This included 4 inflected verbs matched on base-stem length and log frequency to the nominalization (i.e., **Cifrabais,** *PN* = 9, *base log.* = 4.12, *UP = 10*), and 4 infinitive verbs matched for word-whole length and log frequency (i.e., **Continuar,** *PN* = 9, *log.* = 1.7, *UP = 10*). The verbal inflection in Spanish was a conjugation indicating either person or tense agreement.

Average frequency, length and uniqueness points across all items are presented in Table 3. Length and UP are measured in phoneme number. UP was measured as the position of the first phoneme in the word where it becomes unique from all other words in the lexicon. PN was measured as the number of other words that could be formed by changing one phoneme. Imageability and phonological neighbourhood density are also reported, as they have been identified as important factors in predicting RT's in nouns (Kacinik and Chiarello, 2002).

Condition	Log Freq.		Length		UP		Imageability		PN	
	M=	*SD=*	*M=*	*SD=*	*M=*	*SD=*	*M=*	*SD=*	*M=*	*SD=*
Event Noun	1.08	0.5	7.92	1.32	8.77	1	5.19	0.74	3.31	2.98
Nominalization	1.07	0.37	8.00	1.08	9.08	1.04	3.71	0.92	1.62	1.33
(Base)	*3.62*	*0.49*					*4.20*	*1.16*	*14.77*	*7.12*
Pseudo-suffix	1.04	0.42	7.69	1.18	8.92	1.04	3.71	1.43	2.23	2.17
Prototypical	1.06	0.39	8.08	1.08	9.08	1.04	5.27	0.77	3.81	2.47
Verb Filler										
Inflected	1.04	0.52	7.83	1.04	9.02	1.03			5.14	3.20
(Base)	*3.67*	*0.49*					*4.64*	*1.03*	*16.91*	*10.49*
Infinitive	1.06	0.47	7.85	1.46	8.77	1.36	4.28	0.89	6.15	3.35

Table 3. Means and standard deviations across conditions and filler items. UP = Uniqueness point, PN = Phonological neighborhood density. Imageability is placed on a 1 – 7 scale, *M = 4.47*.

All stimuli were recorded by a female native speaker of Spanish in a sound-treated room. Each item was read in isolation with sentence-internal intonation. Amplitude intensity was computationally equalized to 70 dB using Praat (Boersma and Weenik, 2001) for all items.

Three presentation lists were composed, combining the 65 nouns and 104 verbs. The order of the total 169 items was pseudo-randomised in each list, and all three lists presented a critical item after the same number of fillers (i.e., in the 11th, 15th, 17th, 20th position, etc.). Critical items did not appear until the 11th word to allow participants to become familiar with the task.

Procedure

Before the task began, noun and verb definitions and examples were provided to ensure that all participants had a full understanding of the task. A noun was defined as 'a word for a person, a place, a thing or an idea. It can be modified with adjectives, and specified with "a" or "the"'; examples were highlighted in the sentence 'El **perro** mordió al **gato** blanco el **domingo'**, *The Black **dog** bit the white **cat** on **Sunday***. A verb was defined as 'a word for an action or event. It refers to what is 'happening' in a given situation.': 'Ella **corrió** y **saltó** por la calle' *She **ran** and **jumped** down the street.*

The word ‘Verbo’ was always presented on the left, and ‘Sustantivo’ on the right side of the screen. Participants were asked to indicate whether they perceived a verb or noun by pressing the respective left or right key on a response board using their index fingers. They were also instructed to respond as quickly and as accurately as possible. Seven hundred and fifty milliseconds after the response was made, the next item was presented regardless of accuracy on the previous trial. No feedback was provided.

All participants listened to all three lists at a comfortable volume, which was the same across all subjects. A short break was provided between each list. Presentation was counter-balanced in a Latin-square design, so that each list was presented equally as the first, second and third pass.

Results

Table 4 displays the mean reaction times and percentages of errors across all experimental conditions and filler verb items. Trials which fell 2.5 standard deviations from the mean, by-subject and by-item, were removed from the analysis. This eliminated 3.29% of the individual responses. No participants or items were eliminated from the final analyses.

Condition	Correct RT	% Errors
Event Noun *e.g., Avalancha*	1054	2.5
Nominalization *e.g., Fijación*	1133	11.4
Pseudo-suffix *e.g., Excurs**ión***	1118	5.6
Prototypical Noun *e.g., Medicina*	1107	4.7
Inflected Verb *e.g., Besaréis*	1107	2.1
Infinitive Verb *e.g., Cumplir*	1162	7.5

Table 4. Mean reaction time and percentage of errors across all conditions.

The two primary questions of this study were whether 'action nouns' are treated differently depending upon morphological composition, and whether language profile may influence the processing of decomposable items. To address these questions, both reaction times and error rates were analysed across all conditions and groups. Analyses were conducted using both a repeated measures 4 x 3 x 3 (F_1 F_2) ANOVA, and a linear mixed model with restricted maximum likelihood estimation (REML) fit. Both included Condition (Event x Nominalization x Pseudo-suffix x Prototypical), Group (B x S x L) and Pass (1^{st} x 2^{nd} x 3^{rd}) in the analysis. A combination of ANOVA and mixed-model statistical approaches were selected due their prevalence in the current literature (Baayen, Davidson and Bates, 2008).

Reaction Times

Mean results of response times and error rates across all conditions and groups are displayed in Figure 1.

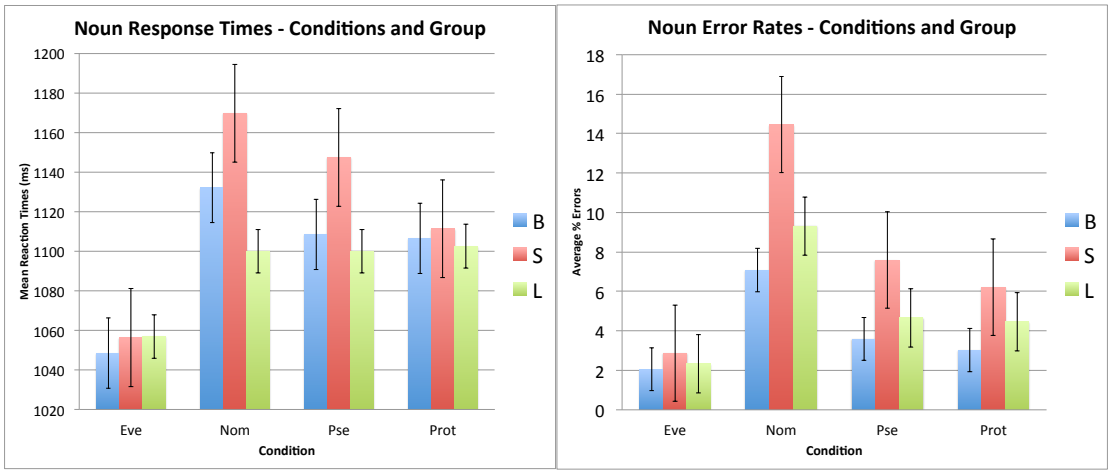

Fig. 1. Mean reaction times across conditions. Legend: B = Basque dominant; S= Spanish dominant; L = Low Basque; Eve = event noun; Nom = nominalization; Pse = pseudo-suffixed noun; Prot = prototypical noun.

The ANOVA analysis revealed significant main effects of Condition, by-subject (F_1 (3, 223) = 31.41, $p < 0.001$) but not by-item (F_2 (3, 61) = 1.73, $p = 0.17$). The effect of Condition indicates that a difference in word 'type' can predict differences in processing behavior, as reflected in the visual depiction of response times above. Furthermore, a main effect of Group was found to be highly significant by-item (F_2 (2, 122) = 11.54, $p < 0.001$), but was not significant by-subject (F_1, (2, 72) = 0.3, $p = 0.74$). The by-item effect suggests that language profile may also be a significant predictor of lexical processing. There was no significant main effect of Pass, (F_1 (2, 144) = 0.51, $p = 0.74$, F_2 (1, 61) = 0.95, $p = 0.33$), suggesting that lexical processing did not change when items were heard for a second or third time.

Interestingly, for the questions stated above, a significant interaction was observed between Group and Condition by-item (F_2 (6, 122) = 2.77, $p = 0.015$) and approaching significance by-subject (F_1 (6, 216) = 1.81, $p = 0.097$). Furthermore, a three way interaction was also observed among Group, Condition and Pass (F_1 (12, 432) = 3.45, $p = 0.003$, F_2 (12, 244) = 2.59, $p = 0.022$). This therefore suggests that there is a relationship between word type, language profile and the number of times the item has been heard.

The analyses conducted with the linear mixed model yielded conclusions that were generally consistent with those from the F_1 ANOVA. The main effect of Condition approached significance (F (3, 223) = 1.78, p = 0.16), the main effect of Group was not significant (F (2, 223) = 0.49, p = 0.41), and no main effect of Pass was observed (F (1, 223) = 0.9, p = 0.57). Group and Condition again displayed a significant interaction (F (6, 223) = 3.45, p = 0.004), as did the three way interaction of Group x Condition x Pass (F (6, 223) = 2.85, p = 0.008).

Error Rates

Participants' accuracy across conditions was analysed with a similar repeated measures 4 x 3 x 3 (F_1 F_2) ANOVA. In line with the reaction time data, a significant main effect of Condition was found (F_1, (3, 219) = 25.79, p < 0.001, F_2, (3, 61) = 6.18, p < 0.001). There was also a significant main effect of Group (F_1, (2, 73) = 3.17, p = 0.048, F_2, (2, 122) = 31.31, p < 0.001). An interaction of Group x Condition was also found by-item (F_2, (6, 122) = 3.59, p = 0.003), but not by-subject (F_1, (6, 219) = 1.56, p = 0.16). The three way interaction between Group x Condition x Pass was not observed for the error rate data (F_1 (12, 432) = 0.45, p = 0.85, F_2 (12, 244) = 0.49, p = 0.81). This suggests that the greatest predictors of accuracy in word-class identification are the type of word being presented, and the language profile of the listener.

Noun Composition

In order to assess whether decomposable nouns were processed differently from items which could not be decomposed, paired t-tests were conducted using the Bonferroni pairwise correction. Event Nouns (SD = 160.86) were significantly faster than all other conditions: Prototypical Nouns (SD = 162.51) (t(72) = 1.79, p < 0.001), Pseudo-Suffixes (SD = 195.7) *(t(*72) = 2.41, p < 0.001) and Nominalizations (SD = 202.58) (t(72) = 2.8, p < 0.001). The comparisons between other conditions did not reach significance (p's > 0.05).

Pairwise comparisons were also conducted on the error rate data, yielding similar results to the response time analysis. Event Nouns were identified significantly more accurately than all other noun types: Prototypical Nouns ($t(72)$, $p = 0.024$), Pseudo-Suffixes ($t(72)$, $p = 0.005$) and Nominalizations ($t(72)$, $p < 0.001$). Furthermore, Nominalizations were analysed significantly less accurately than Prototypical Nouns ($t(72)$, $p < 0.001$) and Pseudo-Suffixes ($t(72)$, $p < 0.001$). No difference was found between Pseudo-Suffixes and Prototypical Nouns ($t(72)$, $p > 0.05$).

Taken together, these results suggest that decomposable 'action-words' are significantly more difficult to identify than those which are non-decomposable. Furthermore, as there was no difference between Pseudo-suffix items and Prototypical nouns in either reaction times or accuracy (p's > 0.05), it suggests that the presence of a morphological ending which uniquely corresponds to a noun cannot predict ease of word-class identification.

Linguistic Profile

To assess the significance of language profile on lexical processing, the group reaction times and error rates were analyzed. Pairwise comparisons with Bonferroni pairwise correction revealed that the Spanish dominant group were significantly slower than both the Basque dominant ($t(72)$, $p < 0.001$) and low Basque group ($t(72)$, $p < 0.001$). There was no significant difference between the Basque dominant and low Basque groups ($t(72)$, $p > 0.05$). Accuracy for the three groups patterned in accordance to reaction times, and revealed that the Spanish dominant group (Group S) made significantly more errors than both the Basque dominant group ($t(72)$, $p < 0.001$) and low Basque group ($t(72)$, $p < 0.001$). Again, no differences were found between the Basque dominant and low Basque group ($t(72)$, $p = 0.32$).

In order to investigate the interaction of Group x Condition, an analysis of the fixed effects of the factors within the linear 3 x 4 x 4 model was conducted. The Spanish dominant group were significantly slower than the other two groups in

identifying Nominalizations ($t(72) = -3.23$, $p < 0.001$), and Pseudo-suffixes ($t(72)$, = 2.5, $p = 0.007$) but not Prototypical nouns ($t(72) = 0.069$, $p = 0.47$), or Event nouns ($t(72) = -0.69$ $p = 0.24$). There was no significant difference between the Basque dominant and low Basque groups in any condition. Accuracy was again consistent with the response time analysis for this comparison, and a similar mixed-effect model was conducted on the error rate data. The Spanish dominant group made significantly more errors in Nominalizations ($t(72) = 3.08$, $p < 0.001$), and Pseudo-suffixes ($t(72) = 2.21$, $p = 0.015$) than Prototypical Nouns ($t(72) =$ 1.71, $p = 0.045$) in comparison to the other two groups.

As described in the main ANOVA results, there was a significant Group x Condition x Pass interaction. The fixed effects revealed that nominalizations were the only item to significantly differ across Passes, visualized in Figure 2.

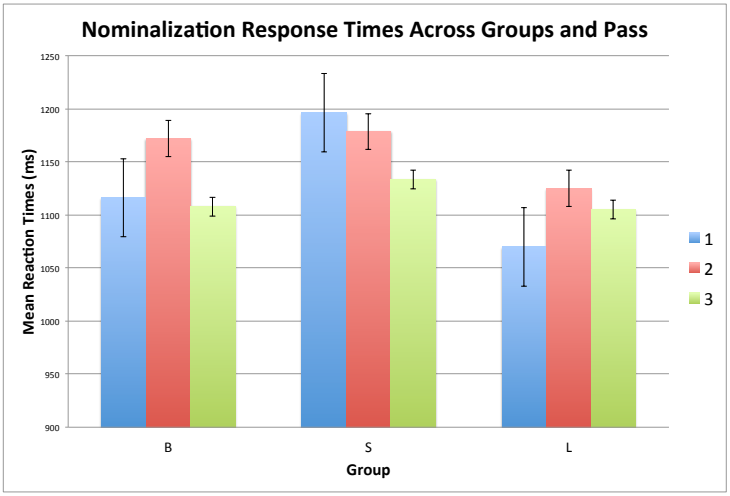

Fig. 2. Mean response time across nominalization items, for each of the three groups. Legend: B = Basque dominant; S = Spanish dominant; L = Low Basque; 1 = Pass 1, 2 = Pass 2, 3 = Pass 3.

The Nominalizations were slower in the 2nd Pass, but this did not reach significance in comparison to either Pass 1 ($t(72) = -1.17$, $p = 0.12$), or Pass 3 ($t(72) = -1.25$, $p = 0.015$). The other conditions did not significantly differ across Passes (p's > 0.05). Pursuing group reaction times within the Nominalization condition revealed that the Spanish dominant group's responses (Groups S) patterned differently to the other two groups, showing significantly slower identification in Pass 1 than both other groups: Basque dominant ($t(72)$, $p = 0.044$ and low Basque ($t(72)$, $p < 0.001$). There was no difference between the Basque

dominant and low Basque group in their responses within Pass 1 ($t(72)$, $p = 0.46$). This therefore suggests that the interaction was mainly driven by the differences in the Nominalization condition across Passes, and slow responses in Pass 1 for the Spanish dominant group.

In summary of the group findings, the results suggest that linguistic profile is a significant factor in lexical processing. The Spanish dominant group (Group S) appeared to display the greatest difficulty in classification, and these differences were clearest in items with the potential for decomposition, shown in the classification of Nominalizations and Pseudo-suffix items. These results are in line with the prediction that the main differences in groups would be displayed in items with the potential for decomposition.

Verb Analysis

Finally, an ANOVA was conducted on the reaction time and errors for the verb items. This was to determine whether the compositionality of verbs was a significant predictor of speed and accuracy of verb decision, and whether this patterned in accordance with the noun results (see Figure 3 below).

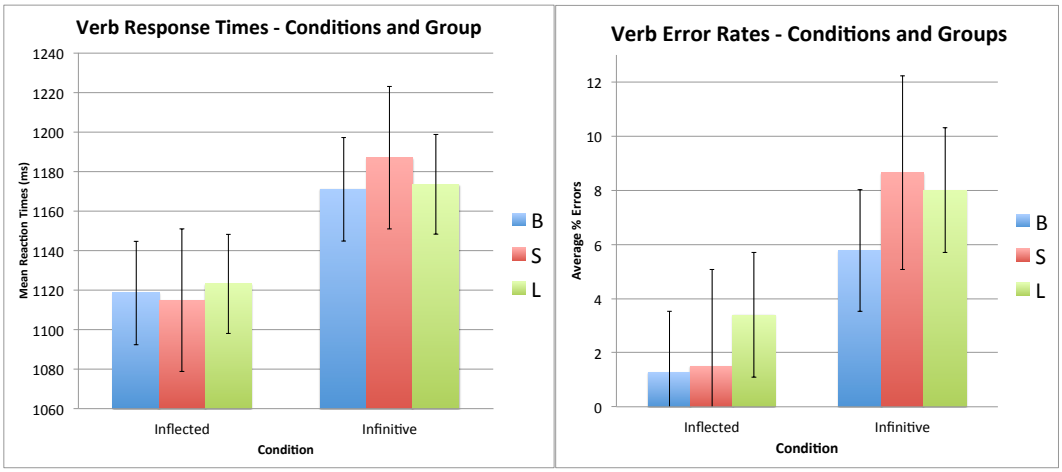

Fig. 3. Mean response time and percentage of errors across verb conditions, for each of the three groups. Legend: B = Basque dominant; S= Spanish dominant; L = Low Basque; Inflected = inflected verb; Infinitive; infinitive verb.

An analysis of reaction times and accuracy was conducted using a 2 x 3 x 3 (F_1 F_2) ANOVA. This included Condition (Inflected x Infinitive), Group (B x S x L) and Pass

(1^{st} x 2^{nd} x 3^{rd}). For reaction times, the analysis only displayed a main effect of Condition (F_1 (1, 146) = 51.336, p < 0.001, F_2 (2, 101) = 5.79, p = 0.004), which was also apparent for the accuracy data (F_1 (1, 146) = 106.89, p < 0.001, F_2 (2, 101) = 4.84, p = 0.0098). In terms of error rate, there was also a significant interaction of Condition x Group by-item, (F_2 (4, 202) = 4.85, p < 0.001), and approaching significance by-subject (F_1 (4, 146) = 2.08, p = 0.087). This interaction was explored further with pairwise comparisons using Bonferroni p-value adjustment method. The Spanish dominant group made significantly more errors than the Basque dominant group (t(72) p < 0.001), and there was no significant difference between the low Basque group and either the Basque dominant (t(72), p = 0.061) or Spanish dominant group (t(72), p = 0.47).

Both the response time and accuracy data therefore suggest that participants found it easier to identify inflected verbs than infinitive forms. Similar to the analysis of the nouns, these differences appear to be modulated by the specific language profile of the participant, as well as the composition of the word.

General Discussion

The current study aimed to address the question of whether items with an 'action-like' meaning are processed differently depending upon their composition. The primary comparison of interest was between verb/noun classifications of 'Event nouns', which cannot be decomposed (*i.e., Avalancha* (Avalanche)), 'Nominalizations' which can be decomposed into a verb stem and nominal suffix (*i.e., Argumento* (Argument)), and 'Pseudo-Suffixed' nouns containing a nominal suffix but no corresponding verb stem (*i.e., Excursión* (Excursion)). This allowed insight into the significance of 'action' meaning at the word-whole vs. morphological level, and the use of a nominal suffix as an indicator of word-class.

The secondary aim was to determine whether differing levels of proficiency in Basque, a language employing a high degree of morphological composition, may affect lexical processing. Responses to the grammatical decision task suggest that both nominal compositionality and linguistic profile evoke differences in processing strategies. The discussion that follows presents possible interpretations of these findings, in turn.

Significance of 'Action' Semantics in Grammatical Decision

One of the most striking findings was the speed with which event nouns were identified in comparison to prototypical nouns. Participants were better at classifying non-decomposable nouns with an 'action-like' meaning than a typical 'object-like' meaning, suggesting that this semantic incongruency does not determine speed of word-class identification.

One possible explanation for this finding comes from previous studies investigating semantic influences on lexical processing. Wurm et al. (2007) explored the significance of 'usefulness' and 'danger' as dimensions predicting speed of auditory perception, and found that responses to 'low useful' concepts (e.g. *card*) were faster when coupled with 'high danger' (e.g. *crime*). Interestingly,

many of the event nouns included in the current investigation were also included as stimuli in Wurm et al.'s study, and were rated highly on the 'danger' dimension.

Their results support the observed speed of event noun identification in comparison to prototypical nouns, in that semantically 'dangerous' concepts (e.g., *hurricane*) were responded to faster than non-dangerous concepts, (e.g., *telescope*), despite being matched on other lexical features such as frequency, uniqueness point, concreteness and family size. When looking closer at the within-condition responses in the current investigation, the data correspond to that of Wurm and his colleagues, whereby items connoting high danger (e.g., *Tormenta* (Storm), *Huelga* (Strike) and *Huracan* (Hurricane)) were responded to, on average, 200ms faster than items without this level of danger (e.g., *Travesia* (Crossing), *Campaña* (Campaign) and *Escaramuza* (Skirmish))[1]. These findings therefore support the interpretation that we access 'high danger' concepts faster, in both tasks requiring semantic and syntactic identification. In light of our research question, this suggests that a noun with non-prototypical 'action-like' meaning does not necessarily cause difficulty in word-class identification.

Decomposing the Stem of Morphologically Complex Items

Considering both response times and accuracy as indicators of classification 'difficulty', morphological composition in itself did not predict ease of identification. For the noun items, participants appeared to have the greatest difficulty classifying decomposable nominalizations. Contrastively, inflected verbs were identified more easily than infinitive verb forms.

The comparison between verbs and nominalizations is particularly interesting, as both items are composed of [verb stem] + [suffix]. The only morphological difference resides in the presence of a verb inflection or derivational suffix respectively. Importantly however, although the grammatical category of the stem

[1] 'Danger' ratings were beyond the aims of this investigation, and future study should include semantic ratings on this dimension to allow for a more objective evaluation.

is the same in both items, its correspondence to the word-class of the full form, and therefore the required 'correct' response in the task, is different.

Previous studies have suggested we activate the stem during processing of morphologically complex forms, including derived and inflected words such as the nouns and verbs of the present discussion. In masked priming studies, for example, significant stem-priming of semantically transparent prime-target pairs (*driver – drive*) has been established in both the visual domain (Rastle et al., 2000; Rastle et al., 2004; Lavric et al., 2007; Silva and Clahsen, 2008) and auditory domain (Marslen-Wilson et al., 1994; Kieler and Joanasse, 2010). This suggests that we are sensitive to the morphological structure of complex items, and that the observed priming effect is due to the activation of the corresponding stem during lexical retrieval.

These findings are consistent with the present results. The increased difficulty displayed for nominalizations may be explained through the activation of the stem, which has a different word-class to the word-whole lexeme. This means that participants are required to inhibit their response to the 'verb' morphological unit, and employ additional processing in order to repair and avoid the original 'wrong' decision. Furthermore, as the inflected verbs were identified faster than the infinitive verbs, this adds additional support to the explanation of stem activation. These items differed in the frequency of the base unit, which was matched to the base of the nominalizations in the inflectives, and the word-whole frequency in the infinitives. The faster responses to the inflected verbs can be explained in terms of the Base Frequency Effect (Baayen, Dijkstra and Schreuder, 1997), suggesting access to the 'correct' response was faster in the inflective over the infinitive verbs due to the stem having higher frequency than the word-whole unit.

This account of stem activation in derived words is often framed in terms of dual-mechanism theory (e.g. Pinker and Ullman, 2002). Such models propose the regular use of two processing methods, depending upon compositional regularity. According to this view, morphologically complex words formed though irregular

inflections are stored as full forms in our memory. The item is therefore recognized using direct lexical retrieval rather than segmentation of constituents. Regular forms, however, are processed through morphologically structured representations. This means that derivations are retrieved segmentally; first processing the stem of the item and later applying an online grammatical rule to process the derivational form. As the segmental route requires the storage of smaller units and in a reduced quantity, this is proposed to be the more efficient method of storage and retrieval; supported by faster response times in processing decomposable than non-decomposable items (Clahsen and Neubauer, 2010).

Given that the nominalizations are regularly derived items, applying this model to the current findings would support decomposition of [verb stem] + [regular nominal suffix], and indeed, primary processing of the verbal unit. As this activation would cause an 'incorrect' classification early-on in word processing, more time would be necessary in order to repair and inhibit the original decision. Furthermore, in processing the regularly inflected verbs, this theory suggests that classification would be faster for inflected rather than infinitive forms, as participants are able to decipher the 'correct' classification through the initial segment.

If it is the case that decomposition is a lexical processing strategy which takes an increased length of time, we would similarly expect the inflected verbs to be processed more slowly than the infinitive verbs. However, as discussed, our results do not follow this prediction. This therefore suggests that it is not the process of decomposition per se that is causing a greater time-cost in lexical processing. Instead, it appears that extracting a stem, incongruent to the final decision to be made, is causing problems in classification.

Figure 4 below presents a model of lexical processing during a grammatical category identification task. It details that the first step is to determine whether a word is decomposable or not. If the item is not decomposable, we have no choice but to process the word-whole unit, which is the more time-consuming option. A decomposable lexeme next requires a check for regularity of composition. If the

inflection or derivation is irregular, we process the word similarly to non-decomposable items, and follow the word-whole route. If, however, the item is regularly decomposable, we identify the 'main' unit, as signaled through morphological representations and syllabic-stress, and extract this unit for further inspection. Through activation of the stem, we also access its word-class. If this word-class is in agreement to the word-whole unit we can then process the stem, which is quicker due to its higher frequency in the lexicon and reduced length. However, if the stem is of a different word class to the word-whole unit, an alternative method is required to avoid making the wrong classification. As the derived suffix does not hold a representation in the lexicon, it does not allow access to semantic or syntactic information. We are therefore forced to backtrack and process in a word-whole manner.

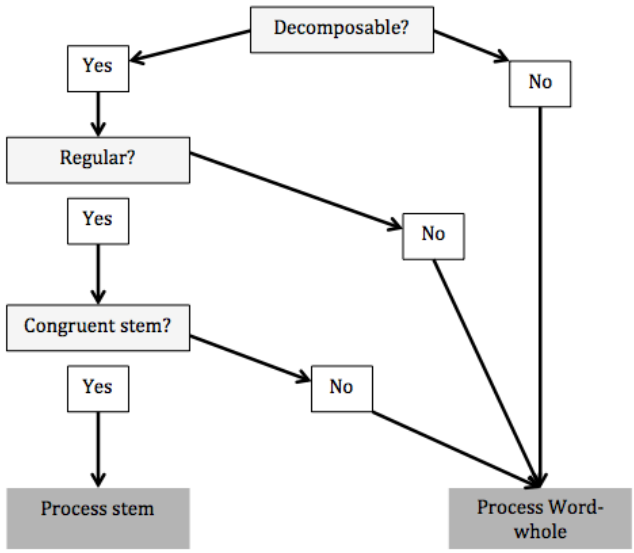

Fig. 4. Model of processing during grammatical decision task.

This model can be applied to explain the results in the present study. Within the verb condition, where the stem and word-whole grammatical decision was in agreement, we see quicker responses for the more decomposable items. This suggests that participants were able to identify the regular inflection, and process the verb stem directly in order to make their decision, thus taking less time. For the nominal items, the two non-decomposable items with 'normal' semantics (Prototypical nouns and Pseudo-Suffixes) did not differ in either accuracy or

response time, suggesting that a similar word-whole processing technique was employed. Additionally, the event nouns without the 'dangerous' semantic quality were processed in a similar manner to the prototypical nouns, suggesting that this again followed the word-whole approach. Finally, the decomposable nominalizations would require more time than the non-decomposable nouns, as the incongruency between stem and word-whole required additional time in order to repair the initial decision and process word-whole rather than segmentally.

Although the results for both the decomposable nouns and verbs appear to be quite consistent with the dual-mechanism interpretation, this is not the only theory to be proposed regarding the processing of morphologically derived words. Single-mechanism and connectionist models instead claim that all word forms are stored and processed word-whole, with inflectional and derivative structure playing no direct role in processing. These theories explain evidence from priming studies such as those discussed above in terms of overlapping activation in form and meaning between prime and target. For example, the facilitating effect of morphological family size in inflected and derived words (Bertram et al., 2000) is explained in terms of the semantic frequency (see Wurm, Ernestus, Schreuder, and Baayen, 2006) in compound and derived words (work – worker – workbook), rather than constituent activation process.

Perhaps the difficulty observed for the nominalizations could be interpreted from the single-mechanism model as activating a series of verb cohorts rather than the single verb from which is was derived. This would mean that the semantic representation supported by its phonological neighbors is again incongruent with the target word-class being identified. However, as the single-mechanism does not recognize the difference between simple and complex forms, it is not clear how the theory would explain the significant difference displayed between inflected and infinitive verb forms in the current findings. This is particularly evident, given that the phonological neighborhood of the inflected verbs (M= 5.14, SD= 3.2) was less dense than the slower identified infinitive verbs (M= 6.15, SD= 3.35), thus in contradiction to family size predictions.

Sensitivity to Word-Final Grammatical Cue

In addition to the question of stem activation, this study also investigated whether the syntactic information coded in the word-final suffix may aid grammatical decision. It appeared that this was not the case, as participants were no different in identifying nouns with and without this lexical cue, despite it uniquely corresponding to the noun word-class.

This finding is in disagreement with previous studies exploring probabilistic cues in lexical and grammatical decision. Arciuli and Monaghan (2008) reported a significant sensitivity to word-final lexical structure, finding that participants were faster to respond to items with a form more closely corresponding to its word-class. They interpret the faster responses to *marble* than *insect,* for example, as being due the former having an orthographic structure that more frequently occurs in nouns.

The lack of facilitation shown for Pseudo-Suffixes in the current study is interesting, given that derivative suffixes have a more prevalent orthographic structure than probabilistic cues. However, other studies exploring the processing of suffixes have found results in accordance to the present discussion. In a previous study exploring the processing of suffixed pseudo-words in a visual lexical decision task, Lehtonen et al. (2007) found no differences between inflected and non-inflected words with a false stem, but a significant difference in relation to those with a real stem. Similar results were also found in a cross-modal priming study of regular derivations, displaying priming effects for items with an interpretable stem + suffix combinations (e.g., '*rapid + ifier'*) (Meunier and Longtin, 2007). This suggests that a recognizable base form is necessary in order to initiate decomposition, and that there is a reduced sensitivity to the word-final unit in the absence of a decomposable stem.

A possible explanation of this lack of suffix facilitation is again based within assumptions of the dual-mechanism model. The theory suggests that we process a regularly inflected item by decomposing its morphological units; placing focus upon the 'stem' of the item, and later drawing upon regular grammatical rules in order to process the suffix. The pseudo-suffix items therefore present an interesting composition, as although they cannot be decomposed into [verb] + [nominal suffix], their surface structure would indicate that this is a possibility. This account therefore offers two related interpretations. If we process a complex item based upon the form of the suffix, then we would attempt to process the item segmentally, only to realize this is not an option. This would mean we are forced to process the word in a non-decomposable manner, similar to the Prototypical Nouns. Secondly, as the dual-mechanism model suggests that regular inflections are not stored in the lexicon, these suffix elements cannot be actively retrieved unless they occur alongside a decomposable stem. Our lack of sensitivity to this unit, in contrast to more subtle probabilistic differences contained within the word-whole representation, may therefore be explained in terms of the relative absence of derivative suffix representation.

Finally, it is interesting to note that Nominalizations were more difficult to identify than the Pseudo-Suffix items. This is an important observation in light of the single-mechanism theory of processing, as it is based on the assumption that we are sensitive to the 'surface' structure of the items rather than the compositional units. This model would therefore predict that Pseudo-Suffixes and Nominalizations would be processed the same way, given that the only difference is at the sub-lexical level. Our results therefore suggest access to the morphological structure distinguishing these items, and more specifically, sensitivity to the verb stem not present in the Pseudo-Suffix items.

Effect of Language Profile on Decomposition

The second major purpose of the current study was to explore whether differences in known languages may affect lexical decomposition. In particular, to explore whether the knowledge of a 'morphologically rich' language such as

Basque may affect morphological representation, and therefore lexical retrieval. The main finding relative to linguistic profile was that the Spanish dominant group (Group S) had more difficulty than the Basque dominant (Group B) and low Basque group (Group L). Critically, these differences were modulated by the composition of the word being identified, with the Spanish dominant group having particular difficulty with Nominalization and Pseudo-Suffixed items.

In terms of linguistic profile, groups S and L differed only in terms of their knowledge of Basque. Our initial research question was whether the knowledge of Basque could increase the amount of decomposition employed, due to Basque being a morphologically rich language. In comparing these two groups, performance differed specifically for the Nominalization and Pseudo-suffix items. This is interesting given that these are the only items to include a derivative suffix.

In Basque, the majority of morphological information is located in word-final position. Similarly, within the dual-mechanism model, the cue to whether an item requires morphological parsing or word-whole processing depends upon the regularity of the suffix, also in word-final position. The level of decomposition employed can therefore be seen to directly relate to the recognition of this 'regularity'. Given that the decompositional route posits increased sensitivity to the 'stem' of derived items, as discussed above, the more an individual employs decomposition, the more sensitive to this root an individual will be. The suggested explanation for the increased difficulty for Spanish dominant participants with high Basque proficiency (Group S), is their greater sensitivity to, and employment of, morphological representation. Specifically, for Nominalizations, processing the stem may cause greater sensitivity to its word-class incongruency with the word-whole unit. For Pseudo-Suffix items, attempting to decompose on the basis of a 'regular suffix' would require a later repair to follow the word-whole route, explaining the increased response time. Contrastively, as the low Basque group would not place as much emphasis on the word-final suffixes, their reduced reliance on decompositional processing would produce similar results across both decomposable and non-decomposable nouns, as observed in the present findings.

Although this interpretation can account for differences in Basque knowledge, it does not explain the differences between Basque dominant (Group B) and Spanish dominant groups (Groups S and L). Instead, I turn to previous studies exploring L1 and L2 processing of derived and inflected items. In a masked-priming study conducted by Silva and Clahsen (2008), native English speakers showed priming for both inflected and derived word forms, but an L2 group displayed reduced priming for derived words and no priming for inflected words. This suggests there is a greater sensitivity to the stem of morphologically complex words in L1, but that inflected word forms are stored as unanalyzed wholes in L2.

Although the language groups recruited in the present study are very early L2 learners, this proposal is consistent with the findings of the current investigation. The Spanish dominant group (Group S) had difficulty with derived nominal items, while the Basque dominant group (Group B) did not display this increased difficulty. These findings may therefore be interpreted as the Spanish dominant group showing an increased sensitivity to the stem in the derived and inflected items, due to a stronger morphological representation of these in the L1 lexicon. This is in comparison to the more 'word-whole' storage in the Basque dominant group, who were processing Spanish as an L2. Furthermore, as these nominalizations are being presented in a list of verbs, the increased difficulty may be additionally emphasized through a word-class priming effect, again in agreement with previous findings that we are more sensitive to stem-priming in our L1.

It is therefore suggested that there are two elements involved in the group differences in lexical processing. First, knowledge of a morphologically rich language may establish stronger morphological representations in the lexicon, and support a processing strategy more reliant upon decompositional parsing. Second, constituent activation is more prevalent in L1 processing, and L2 language users are more likely to employ word-whole processing techniques during lexical retrieval.

Summary

The results presented allow for insight into whether nouns with 'action-like' meaning are processed differently depending on their morphological structure, and whether this difference varies across different language profiles. Our main findings suggest that a decomposable word like '*Explosion'* is processed differently compared to a non-decomposable word such as '*Avalanche'*, and that this is due to activation of the stem within the morphologically complex item. Additionally, it appears there is no sensitivity to the derivative suffix unit, even in a task requiring the extraction of syntactic information, as a pseudo-derivative such as '*Excursion'* yielded the same results as a prototypical noun such as '*Medicine'*. The use of decomposition also appeared to differ in relation to the level of Basque proficiency, suggesting that proficiency in a morphologically rich language may affect processing mechanisms, independent of the specific language in use.

References

Andrews, S., Miller, B., & Rayner, K. (2004). Eye movements and morphological segmentation of compound words: There is a mouse in mousetrap. *European Journal of Cognitive Psychology,* **16**, 285-311.

Arciuli, J., & Cupples, L. (2006). The processing of lexical stress during visual word recognition: Typicality effects and orthographic correlates. *Quarterly Journal of Experimental Psychology*, **59**, 920–948.

Arciuli, J., & Monaghan, P. (2009). Probabilistic cues to grammatical category in English orthography and their influence during reading. *Scientific Studies of Reading*, **13**, 73–93.

Baker, M. (2001). *The atoms of language: The mind's hidden rules of grammar*. New York: Basic Books.

Barber, H. A., Kousta, S. T., Otten, L. J., & Vigliocco, G. (2010). Event-related potentials to event-related words: Grammatical class and semantic attributes in the representation of knowledge. *Brain research*, **1332**, 65-74.

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of memory and language*, ***59***(4), 390-412.

Baayen, H., & Schreuder, R. (1999). War and peace: Morphemes and full forms in a noninteractive activation parallel dual-route model. *Brain and Language*, **68**(1), 27-32.

Baayen, R. H., Dijkstra, T., & Schreuder, R. (1997). Singulars and plurals in Dutch: Evidence for a parallel dual-route model. *Journal of Memory and Language*, **37**(1), 94-117.

Beard, R. (1995). *Lexeme–morpheme base morphology*. Albany, NY: SUNY Press.

Bel, N., Coll, M. & Resnik, G. (2010). Automatic Detection of Non-deverbal Event Nouns for Quick Lexicon Production. Proceedings of the 23rd International Conference on Computational Linguistics (Coling 2010), pages 46 – 52. Beijing, August 2010.

Bertram, R., Baayen, R. H., & Schreuder, R. (2000). Effects of family size for complex words. *Journal of Memory and Language,* **42**(3), 390-405.

Bisetto, A. & Melloni, C. (2005). Result nominals: A lexical–semantic investigation. Poster presented at «5th Mediterrean Morphology Meeting (MMM5)», Frejus, September 21–24.

Boersma, P. & Weenik, D. (2001). Praat. Available on the www at http://www.praat.org.

Borer, H. (1999). The form, the forming and the formation of nominals. Paper presented at the 2nd Mediterranean Morphology Meeting, September 1999.

Butterworth, B. (1983). "Lexical representation." In: Butterworth, B. (Ed.), *Language Production*, vol. 2. Academic Press, London, pp. 257–294.

Clahsen, H., & Neubauer, K. (2010). Morphology, frequency, and the processing of derived words in native and non-native speakers. *Lingua*, **120**(11), 2627-2637.

Clahsen, H., Felser, C., Neubauer, K., Sato, M., & Silva, R. (2010). Morphological structure in native and nonnative language processing. *Language Learning,* **60**(1), 21-43.

Clahsen, H. (1999). Lexical entries and rules of language: A multidisciplinary study of German inflection. *Behavioral and brain sciences*, **22**(6), 991-1013.

Crepaldi, D., Berlingeri, M., Paulesu, E., & Luzzatti, C. (2011). A place for nouns and a place for verbs? A critical review of neurocognitive data on grammatical class effects. Brain and Language, **116**, 33–49.

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

Desmet, T. & Duyck, W. (2007). Bilingual Language Processing. *Language and Linguistics Compass* **1**, 168 – 194.

Duchon, A., Perea, M., Sebastián-Gallés, N., Martí, A., & Carreiras, M. (2013). EsPal: One-stop shopping for Spanish word properties. *Behavior Research Methods,* 1-13.

Duñabeitia,J.A.,Perea,M., & Carreiras,M. (2007a). Do transposed letter similarity effects occur at a morpheme level? Evidence for morpho-orthographic decomposition. *Cognition* **105**, 691–703.

Duñabeitia, J. A., Perea, M. & Carreiras, M. (2007b). The role of the frequency of constituents in compound words: Evidence from Basque and Spanish. *Psychonomic Bulletin and Review* **14**, 1171 - 1176.

Duñabeitia, J.A., Laka, I., Perea, M. & Carreiras, M. (2009). Is Milkman a superhero like Batman? Constituent morphological priming in compound words. *European Journal of Cognitive Psychology* **21**, 615 – 640.

Hankamer, J. (1989). "Morphological Parsing and the Lexicon." In *Lexical Representation and Process*, William Marslen-Wilson, ed., 392–408. Cambridge, MA: MIT Press.

Havas, V., Rodriguez-Fornells, A. & Clahsen, H. (2012). Brain Potentials for Derivational Morphology: An ERP Study of Deadjectival Nominalizations in Spanish. *Brain and Language* **120**, 332-344.

Fabregas, A. & Marin, R. (2012). The role of Aktionsart in deverbal nouns: State nominalizations across language. *Journal of Linguistics* **48**, 35 – 70.

Farmer, T. A., Christiansen, M. H., & Monaghan, P. (2006). Phonological typicality influences lexical processing. *Proceedings of the National Academy of Sciences*, **103**, 12203–12208.

Folk, J. & Morris, R. (2003). Effects of syntactic category assignment on lexical ambiguity resolution in reading: An eye movement analysis. Memory and *Cognition*, **31**(1).

Frauenfelder, U. H., & Schreuder, R. 1992. "Constraining psycholinguistic models of morphological processing and representation: The role of productivity." In G. E. Booij & J. van Marle (Eds.), *Yearbook of morphology 1991*. Dordrecht: Kluwer.

Garbin, G., Collina, S., & Tabossi, P. (2012). Argument Structure and Morphological Factors in Noun and Verb Processing: An fMRI Study. PLOS ONE, 7(9), e45091.

Janssen, U., Wiese, R., & Schlesewsky, M. (2006). Electrophysiological responses to violations of morphosyntactic and prosodic features in derived German nouns. *Journal of Neurolinguistics*, **19**, 466–482.

Kacinik, N., & Chiarello, C. (2002). Predicting noun and verb latencies: Influential variables and task effects. In *Proceedings of the 24th Cognitive Science Society Conference (pp. 524-529).* Mahwah, NJ: Lawrence Erlbaum.

Kielar, A. & Joanisse, M. F. (2010). The role of semantic and phonological factors in word recognition: An ERP cross-modal priming study of derivational morphology. *Neuropsychologia* **49,** 161 – 177.

Lavric, A., Clapp, A., & Rastle, K. (2007). ERP Evidence of Morphological Analysis from Orthography: A Masked Priming Study. *Journal of Cognitive Neuroscience* **19**, 866–877.

Lehtonen, M., Cunillera, T., Rodríguez-Fornells, A., Hultén, A., Tuomainen, J., & Laine, M. (2007). Recognition of morphologically complex words in Finnish: Evidence from event-related potentials. *Brain research*, **1148**, 123-137.

Leinonen, A., Brattico, P. Miika Järvenpääc, & Christina M. Krausea. (2008). Event-related potential (ERP) responses to violations of inflectional and derivational rules of Finnish. *Brain Research* **1218**, 181 – 193.

Lemhöfer, K., Koester, D., & Schreuder, R. (2011). When bicycle pump is harder to read than bicycle bell: effects of parsing cues in first and second language compound reading. *Psychonomic bulletin & review*, **18**(2), 364-370.

Levin, B. 1999. "Objecthood: An event structure perspective". In *CLS 35, volume 1: The Main Session*.

Longtin, C.-M., & Meunier, F. (2005). Morphological decomposition in early visual word processing. *Journal of Memory and Language*, **53**, 26–41.

Marangolo, P., Pira, F., Galati, G. & Burani, C. (2006). Functional Anatomy of Derivational Morphology. *Cortex* **42,** 1093 – 1106.

Marslen-Wilson, W., Tyler, L. K., Waksler, R., & Older, L. (1994). Morphology and meaning in the English mental lexicon. Psychological *Review*, **101**, 3–33.

Meunier, F. & Longtin, C.M. (2007). Morphological decomposition and semantic integration in word processing. *Journal of Memory and Language* **56**, 457 – 471.

Monaghan, P., Christiansen, M., & Chater, N. (2007). The phonological-distributional coherence hypothesis: Cross-linguistic evidence in language acquisition. *Cognitive Psychology,* **55**, 259–305.

Oliveri, M., Finocchiaro, C., Shapiro, K., Gangitano, M., Caramazza, A., & Pascual-Leone, A. (2004). All talk and no action: a transcranial magnetic stimulation study of motor cortex activation during action word production. *Journal of Cognitive Neuroscience*, **16**(3), 374-381.

Perea, M., & Carreiras, M. (2006). Do transposed-letter effects occur across lexeme boundaries*? Psychonomic Bulletin & Review*, **13**, 418-422.

Pinker, S. & Ullman, M. T. (2002). The past and future of the past tense*. Trends in Cognitive Sciences*, **6**, 456– 463.

Pinker, S. (1984). *Language learnability and language development.* Cambridge: Harvard University Press.

Pinker, S. (1999). *Words and rules*. New York, NY: Basic Books.

Plaut, D. C., & Gonnerman, L. M. (2000). Are non-semantic morphological effects incompatible with a distributed connectionist approach to lexical processing? *Language & Cognitive Processes* **15**, 445-485.

Rastle, K., Davis, M. H., Marslen-Wilson, W. D., & Tyler, L. K. (2000). Morphological and semantic effects in visual word recognition: A time-course study. *Language and Cognitive Processes*, **15**, 507–537.

Rastle, K., Davis, M. H., & New, B. (2004). The broth in my brother's brothel: morpho-orthographic segmentation in visual word recognition. Psychonomic *Bulletin and Review*, **11**, 1090–1098.

Resnik, G. (2004). Los nombres eventivos no deverbales en español . Proyecto de Tesis. Institut Universitari de Lingü.stica Aplicada, Universitat Pompeu Fabra.

Resnik, G. (2009) "La determinación de la eventividad nominal en español". En G. Ciapuscio (ed.) De la palabra al texto: estudios lingüisticos del español . Buenos Aires: Eudeba.

Sandra, D. (1994). The morphology of the mental lexicon: Internal word structure viewed from a psycholinguistic perspective. *Language and cognitive processes*, **9**(3), 227-269.

Sereno, J. A., & Jongman, A. (1990). Phonological and form class relations in the lexicon. *Journal of Psycholinguistic Research, **19***, 387-404.

Shapiro, K., Pascual-Leone, A., Mottaghy, F.M., Gangitano, M., & Caramazza, A. (2001).Grammatical distinction in the left frontal cortex. Journal of Cognitive *Neuroscience*, **13**, 713-720.

Silva, R., & Clahsen, H. (2008). Morphologically complex words in L1 and L2 processing: Evidence from masked priming experiments in English. *Bilingualism Language and Cognition*, **11**(2), 245.

Siri, S., Tettamanti, M., Cappa, S.F., Della Rosa, P., Saccuman, C., Scifo, P., & Vigliocco, G. (2008). The neural substrate of naming events: Effects of processing demands but not grammatical class. *Cerebral Cortex,* **18**, 171-177.

Taft, M. (1981). Prefix stripping revisited*. Journal of Verbal Learning and Verbal Behavior,* **20**(3), 289-297.

Taft, M. (1985). "The decoding of words in lexical access: A review of the morphographic approach." In D. Besner, T. G. Waller, & G. E. MacKinnon (Eds*.), Reading research: Advances in theory and practice,* Volume 5. New York: Academic Press.

Taft, M., & Forster, K. I. (1975). Lexical storage and retrieval of prefixed words. Journal of verbal learning and verbal behavior, **14**(6), 638-647.

Tyler, L.K., Bright, P., Fletcher, P., & Stamatakis, E.A. (2004). Neural processing of nouns and verbs: the role of inflectional morphology. *Neuropsychologia*, **42**, 512-523.

Tyler, L.K., Russell, R., Fadili, J., & Moss, H.E. (2001). The neural representation of nouns and verbs: PET studies. *Brain*, **124**, 1619-1634.

Wurm, L. H., Whitman, R. D., Seaman, S. R., Hill, L., & Ulstad, H. M. (2007). Semantic processing in auditory lexical decision: Ear-of-presentation and sex differences. *Cognition and emotion*, **21**(7), 1470-1495.

Wurm, L. H., Ernestus, M. T., Schreuder, R., & Baayen, R. H. (2006). Dynamics of the auditory comprehension of prefixed words: Cohort entropies and conditional root uniqueness points. *The Mental Lexicon*, **1**(1), 125-146.

Wurm, L. H. (1997). Auditory Processing of Prefixed English Words Is Both Continuous and Decompositional. *Journal of Memory and Language* **37**, 438 – 461.

Appendix 1: Noun Items

Nominalization	English Translation	Log. Freq.	Base Freq.
Argumento	argument	1.67	4.49
Duración	duration	1.62	4.11
Creencia	belief	1.34	4.10
Ganancia	gain	1.22	3.94
Herencia	heritage	1.36	3.85
Matanza	slaughter	1.22	3.80
Donación	donation	0.98	3.69
Fijación	fixation	0.99	3.45
Curación	healing	0.94	3.43
Mudanza	move	0.77	3.26
Crianza	breeding	0.72	3.13
Alzamiento	lift	0.67	3.10
Abdicación	abdication	0.43	2.75

Pseudo-suffix	English Translation	Log. Freq.	Base Freq.
Adicción	Addiction	0.78	4.49
Comunión	Communion	0.90	4.11
Excursión	Excursion	0.63	4.10
Vocación	God call	1.21	3.94
Desventura	Misfortune	0.47	3.85
Ruptura	Rupture	1.30	3.80
Lección	Lesson	1.23	3.69
Audición	Audition	0.69	3.45
Falacia	Fallacy	0.55	3.43
Noción	Notion	1.22	3.26
Vigencia	Validity	1.06	3.13
Coalición	Coalition	1.62	3.10
Sección	Section	1.83	2.75

Event Noun	English Translation	Log. Freq.
Campaña	Campaign	2.02
Accidente	Accident	1.69
Huelga	Strike	1.52
Tormenta	Storm	1.32
Terremoto	Earthquake	1.19
Trayecto	Journey	1.18
Huracán	Hurricane	1.17
Cirugía	Surgery	1.01
Travesía	Crossing	0.91
Avalancha	Avalanche	0.71
Ciclón	Cyclone	0.53
Cataclismo	Cataclysm	0.39
Escaramuza	Skirmish	0.35

Prototypical Noun	English Translation	Log. Freq.
Organismo	Organism	1.68
Facultad	Faculty	1.69
Salario	Salary	1.28
Catálogo	Catalogue	1.21
Infierno	Hell	1.37
Clínica	Clinic	1.25
Alcaldía	Major's Office	1.04
Estatura	Height	1.00
Diagrama	Diagram	0.89
Afrenta	Insult	0.70
Ensueño	Dream	0.76
Locomotora	Locomotive	0.61
Pasatiempo	Hobbie	0.45
Comisaria	Presinct	1.63
Medicina	Medicine	1.67
Experto	Expert	1.23
Dictador	Dictator	1.24
Mediodía	Noon	1.29
Pantano	Swamp	1.13
Goleador	Scorer	1.02
Elefante	Elephant	0.91
Desayuno	Breakfast	0.90
Corbata	Tie	0.79
Mancebo	Assistant	0.72
Caricatura	Caricuture	0.65
Portezuela	Door	0.40

Appendix 2: Verb Items

Decomposable. Verb	ENG.	Base Freq.	Decomp. Verb	ENG.	Base Freq.
acud[irían	to come	4.43	Cesa[remos	to stop	4.10
roga[bais	to pray	4.09	Medi[rías	to measure	4.23
reg[iría	to govern	3.99	Ama[bais	to love	4.43
suma[rías	to add	4.19	Obra[steis	to do	3.75
así[amos	to grasp	3.80	Fia[rían	be reliable	4.03
besa[réis	to kiss	3.82	Guia[bais	to lead	3.75
borra[rían	to delete	3.70	Bati[rías	to sweep	3.74
chupa[steis	to suck	3.42	Odia[rías	to hate	3.70
nada[réis	to swim	3.60	Roza[bais	to touch	3.54
mece[rías	to rock	3.13	Urdi[rían	to weave	2.87
liga[bais	to bind	3.16	Tose[réis	to cough	2.93
reñi[ríamos	to scold	3.09	Serra[ríamos	to saw	3.04
incuba[rían	to incubate	2.75	Delira[rían	talk nonsense	2.71
Llena[rías	to fill	4.17	Dura[rían	to last	4.23

Viaja[ban	to travel	4.47	Agita[mos	to shake	3.74
Situa[rían	to put	4.41	Juzga[rías	to judge	4.33
Temí[amos	to fear	4.37	Calla[rían	to shut up	3.87
Acentua[ron	to emphasise	3.51	Reanuda[mos	to resume	3.82
Rei[rán	to laugh	4.34	Hiri[eron	to hurt	3.83
Osa[rías	to venture	3.34	Rae[ríais	scrape off	3.14
Ole[rían	to smell	3.57	Ara[rías	to plow	3.66
Jura[ste	to swear to	3.72	Honra[ste	to honor	3.50
Loa[rías	to praise	2.99	Hui[rías	to run away	4.33
Apea[bais	to take down	3.04	Rugi[réis	to roar	3.13
Cifra[bais	to code	3.12	Aloja[rías	to host	3.47
Asa[réis	to roast	3.12	Pia[rías	to chatter	2.90

Infinitive Verb	**Eng.**	**Freq.**	**Infinitive Verb**	**Eng.**	**Freq.**
aparecen	appear	1.70	mejorar	improve	1.92
continuar	continue	1.71	reconocer	recognise	1.70
dirige	lead	1.55	merece	deserve	1.49
construyó	construct	1.37	preocupa	worry	1.37
advierte	warn	1.21	mantenía	maintain	1.21
sostener	support	1.18	imaginar	imagine	1.23
cortar	cut	1.18	refiero	refer	1.22
acabaron	end	0.98	recupero	recouperate	1.02
difundir	broadcast	0.94	expulsar	eject	0.85
convivir	coexist	0.68	presumir	show off	0.62
aludir	mention	0.49	jugarán	play	0.51
amontonaba	pile up	0.35	recomponer	repair	0.39
desactivar	deactivate	0.40	subestimar	underestimate	0.38
cumplir	carry out	1.86	esperar	wait	1.84
establece	establish	1.74	responder	respond	1.68
llevaron	wear	1.48	sucedió	happen	1.53
discutir	discuss	1.28	subrayar	emphasise	1.30
componen	compose	1.22	competir	compete	1.22
mostraba	show	1.19	distingue	distinguish	1.15
llamaban	call	1.17	suponen	suppose	1.15
conlleva	carry	1.01	valorar	appreciate	1.05
lanzando	throw	0.90	proponía	propose	0.93
derrotaron	defeat	0.66	pretendemos	pretend	0.74
flotar	float	0.45	portar	wear	0.48
compaginar	combine	0.31	sobreviene	happen	0.33
replantear	think over	0.32	tratándo	treat	0.32