Connecting lexica in bilingual cross-script morphological processing

Madeleine Voga, Anna Anastassiadis-Symeonidis

Connecting lexica in bilingual cross-script morphological processing: base and series effects in language co-activation

Madeleine Voga

Université Paul-Valéry Montpellier III et CLLE UMR 5263, CNRS & Université Toulouse Jean-Jaurès
madeleine.voga@univ-montp3.fr

Anna Anastassiadis-Symeonidis

Université Aristote de Thessalonique
ansym@lit.auth.gr

Abstract

The study aims to specify the role of morphological information in the architecture and organisation of the bilingual lexicon by clarifying the respective roles of complex words' base and suffix. The experiment which involved advanced Greek-French bilinguals, used a masked priming cross-script protocol, where all primes were in Greek (L1) and all targets in French (L2). Three categories of suffixed words were tested, using the suffixes *-ιστής* /istís/ '-ist' and *-isme*: the first two categories were cognates, among which one was of complex but non-constructed words, i.e. whose base does not correspond to a lexical entry for the Greek speaker, e.g. *ρεαλιστής* /realistís/ 'realist' (Corbin, 1987, pp. 457-459), and the third category were non-cognates. The pattern of results demonstrates the strength of connections within the word family, even when the suffix is applied on an inexistent base. The data suggest the existence of an integrated lexicon, in which words from the two languages are interconnected, including through connections exclusively at the level of the suffix. In terms of language co-activation, the lexicon is shown to be much more sensitive to the 'larger chain of morphological relations' (Mulder, Dijkstra, Schreuder & Baayen, 2014), than to sub-lexical information during processing complex words.

Keywords: cognates, masked priming, Greek-French bilinguals, suffixed words, word family, morphological family.

Résumé

Cette étude se donne comme objectif de spécifier le rôle de l'information morphologique dans l'architecture et l'organisation du lexique bilingue, en précisant les rôles respectifs de la base et du suffixe des mots complexes. L'étude, menée auprès de bilingues d'un niveau de compétence avancé, utilise un protocole d'amorçage masqué inter-langues, où toutes les amorces sont en grec (L1) et les cibles en français (L2). Trois catégories de mots suffixés ont été testées, avec les suffixes *-ιστής* /istís/ '-iste' et *-isme* : deux catégories de cognats, dont une avec des mots complexes non-construits, i.e. dont la base ne correspond à aucune entrée lexicale, e.g. *ρεαλιστής* /realistís/ 'réaliste' (Corbin, 1987, pp. 457-459), et une de non-cognats. Le pattern de résultats démontre la force des liens à l'intérieur

de la famille de mots, y compris lorsque les suffixes s'appliquent à des bases non existantes. Ces données corroborent une vue intégrée du lexique bilingue, dans lequel les mots des deux langues sont interconnectés, y compris par des connections uniquement au niveau du suffixe. En termes de co-activation de langues, nos données démontrent que le traitement bilingue est nettement plus sensible à la « chaine étendue des relations morphologiques » (Mulder, Dijkstra, Schreuder & Baayen, 2014) qu'à l'information sous-lexicale lors du traitement des mots complexes.

Mots-clefs : cognats, amorçage masqué, bilingues grec-français, suffixe, famille de mots, famille morphologique.

1. Introduction

Among the vast variety of studies on bilingualism published in the last 25 years, many use cognate materials. Cognates, in their *conventional* psycholinguistic definition, are translation equivalents sharing significant formal overlap, for instance, *hotel* or *sport* in English, French and Dutch (e.g. Dijkstra, Grainger & Van Heuven, 1999), or *gat – gato* 'cat' in Catalan-Spanish (Costa, Caramazza & Sebastien-Gales, 2000). The fact that a cognate word presented as a prime in a masked priming protocol, e.g. *palace* in English, will facilitate the recognition of its translation in the other language (*palacio* in Spanish), is one of the best-studied and robust bilingual effects. In many studies, very often published by the proponents of Kroll & Stewart's (1994) Revised Hierarchical model (for a critical review, Kroll, Van Hell, Tokowicz & Green, 2010), the definition of the cognate relation is more flexible than in lexical access studies and pairs of words such as *height – hoogte* are found to induce cognate effects of large amplitude, comparable to those sharing maximal formal overlap (e.g. *sport – sport*). For this kind of cognate, de Groot & Nas (1991), under masked conditions, obtain robust facilitation effects with Dutch-English bilinguals (exp. 2: 58ms from L1 to L2 and 39ms from L2 to L1; see also Dufour & Kroll, 1995; Van Hell & de Groot, 1998, for similar effects). Data coming from production protocols, mainly naming, more likely to tap into top-down processes, corroborate the fact that the semantic component is crucial in the various manifestations of the cognate effect (Kroll & de Groot, 1997), irrespectively of formal differences. As far as lexical access protocols are concerned, cognate facilitation is found not only when the words are written in the same alphabet, but also when they are cross-script, e.g. *κέντρο* /kéntro/ – *centre* in Greek-French (Voga & Grainger, 2007; Gollan, Forster & Frost, 1997, Hebrew-English). This suggests that the processes underlying the identification of cognates are not only formal in nature, but also semantic.

Usually, the cognates tested in cross-language psycholinguistic experiments have a base and, depending on the purpose of the experiment, an affix. Our goal in this paper was to go further into the study of the factors of formal and semantic nature that constitute the base of morphological relations present in constructed words. For this purpose, we took advantage of a special category of Greek-French (i.e. cross-script) suffixed cognates, which is formed with a stem that does not exist in Greek

(the L1 of our subjects). We consider these words e.g. *ρεαλιστής* /realistis/ 'realist', where the segment *ρεαλ-* /real-/ does not correspond to an existing base in Greek (for details, see section 1.3) as non-constructed, following the seminal work by Corbin (1987, pp. 457-459). The stimuli were tested in a masked priming protocol combined with a lexical decision task (see section 2.1). The translation and morphological facilitation induced by the presentation of the '0-base' suffixed cognate prime is compared to that of a non-cognate sharing the same series (*-ιστής* /istís/ '-ist' for the prime; *-isme* for the target) but formed with an existing, non-overlapping base. The last category of stimuli is composed of suffixed cognates, once again from the same derivational family (*-ικός* /ikós/ '-ic', and *-isme*) and represents the upper baseline, i.e. the experimental condition that should induce the greater facilitatory priming effect (for details and examples, see section 2.1.2). In our experiment, the morphological relation between primes and targets, both belonging to the same derivational family, is kept constant, in such a way that the differences in the amplitude of translation and morphological priming effects reflect the way in which the three categories of materials are processed. The main goal of our study is to shed light on the representation of words which are both complex *and* non-constructed (Corbin, 1987), and determine the way in which they are processed. Will 0-base words induce facilitation in the translation and morphological conditions? If this is the case, will this facilitation be comparable to that of 'classic' constructed cognates from the same derivational family? Or would it be closer to that of non-cognates? With respect to the architecture and organisation of the bilingual lexicon, our study seeks to explore a particular kind of mapping between L1 and L2 (i.e. 0-base words), in order to draw conclusions on the role of the suffix during processing of complex words. Corbin considers the suffix to be the 'dynamic' element of the constructed word, especially in a case such as the one tested here, where the base of the complex word does not correspond to a lexical entry. In processing terms, this will allow us to define the relative weight of the 'base' and 'series' factors in bilingual morphological processing.

1.1. Testing various types of cognates with masked priming

As mentioned above, results from cross-script studies reinforce a looser conception of cognateness, given that under these conditions and in the visual modality (masked priming), visual overlap is discarded because of the difference between the two alphabets. Although cross-script cognate priming is not automatic, as shown by lack of facilitation found in the Arabic-French study by Bowers, Mimouni & Arguin (2003), in most of the experimental situations tested, cross-script cognate effects are observed. In Gollan et al. (1997) for example, with the masked priming technique and a 50ms SOA[1], Hebrew-English bilinguals exhibit a 53ms effect for cognates in exp. 1 (and a 36ms effect for non-

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[1] Stimulus Onset Asynchrony

cognates[2]), with pairs of words such as *television-televizya*[3]. This cognate effect, independent of visual overlap, is found for other pairs of languages, sharing more or less dissimilar writing systems, e.g. Chinese-English (e.g. Jiang, 1999; Jiang & Forster, 2001), or alphabets, e.g. Greek-French (e.g. Voga & Grainger, 2007). In this study, the cognate effect induced by the L1 Greek prime *κύκλος* /kíklos/ 'cycle' on the L2 French target *cycle* 'cycle', under conditions very similar to those of Gollan et al. (1997), induces a 36ms facilitation (Exp. 1)[4]. It is noteworthy that this robust cross-script cognate effect is found relative to a phonological control baseline, and not an unrelated one, as in most of the published studies.

The fact that the cognate effect implies a formal and a semantic component has led several studies to focus on morphological effects (e.g. Kirsner, Lalor & Hird, 1993; Sánchez-Casas & García-Albea, 2005). In Table 1, we present a summary of results with Greek-French bilinguals and stimuli overlapping in various ways. In these studies, various kinds of words are tested, both constructed and non-constructed[5], as well as various mappings between the L1 and the L2 word. It is useful to note that the extensive borrowing in both directions (French to Greek and Greek to French), not only in terms of lexical units but also suffixes (e.g. *-erie*/*-ερí*, Anastassiadis-Symeonidis, 1994) and syntactical structures (e.g. *loi-cadre* – *νόμος-πλαίσιο* 'framework law') provides us with a great variety of possible materials.

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[2] This is an important finding, given that in many of the previously published studies non-cognates either induce no effect (e.g. Sanchez-Casas, Davis & Garcia-Albea, 1992), either induce effects of smaller amplitude (De Groot & Nas, 1991). More recent studies with Greek-French materials report non-cognate priming effects, with several types of participants and materials: for low-proficiency bilinguals and morphologically simple words (e.g. Dimitropoulou, Duñabeitia & Carreiras, 2011, e.g. *υγεία*–SALUD), for intermediate proficiency participants and simple words (Voga & Grainger, 2007; e.g. *λάθος* /làthos/ – *erreur* 'error'), as well as for high proficiency bilinguals and constructed words (Voga, 2017, see Table 1 for details). Non-cognate effects spring from shared semantic representations, given that they share no orthographic or phonological overlap.

[3] Presented in Hebrew characters in the Gollan et al. study (1997).

[4] Cross-script situations (Hebrew-English, Arabic-French, Greek-French) are not all equivalent. They differ not only with respect to orthographic overlap, but also historically: words such as *κέντρο*/kéntro/'center' and *centre* in Greek-French bear a diachronic relationship, leading to a rich morphological family in the 'other' language, here, French.

[5] Greek words, i.e. verbs, nouns and adjectives always have an inflectional suffix, but words without inflectional suffixes can be found among the Greek-French cognates, especially among loanwords that have not been adapted, e.g. *κουπ* /koup/ – *coupe* 'style, line'.

Type of relation between L1 and L2	Stimuli sample for primes (in Greek) and targets[6] (in French)	Cross-language priming effect
a) Identical form and identical meaning Targets: Morph. simple words (V&G[7], 2007; V, 2014)	T: *ταξί* /taksí/ taxi' M: *ταξιτζής* /taksitzís/ 'taxi-driver'	T: 60ms M: 55ms
b1) Same base – Similar form and identical meaning Targets: Morph. simple cognates (V, 2014; V&Gi, forthcoming.)	T: *ιδέα* /iδέa/ *idée* 'idea' M: *ιδεατό* /iδέató/ 'ideal'	T: 56ms M: 50ms
b2) Cognates with limited form overlap, phonological controls (V&G, 2007)	T : *χημεία* /ximía/ *chimie* 'chemistry'	T: 46ms
c1) Only meaning – morph. simple words, phonological controls (V&G, 2007, exp. 2 & 3)	T: *λάθος* /láθos/ *erreur* 'error' T: *οθόνη* /oθóni/ *écran* 'screen'	T: 27-36ms
c2) Complex suffixed words, non-cognates (V, 2017)	*λογιστής* /loγistís/ *comptable* 'accountant'	T: 41ms
d) Only meaning – constructed words: Prefixed non-cognates with base non-word (V, 2017)	T: *αποκλειστικός* /apoklistikós/ *exclusif* 'exclusive' M: *αποκλειστικότητα* /apoklistikótita/ 'exclusivity'	T: 29ms M: 34ms
e) Prefixed cognates (V, 2015, 2017)	T: *κατακλυσμός* /kataklismós/ *cataclysme* 'cataclysm' M: *κατακλυσμιαίος* /kataklismiéos/ *cataclysmique*	T: 57ms M: 50ms

Table 1. Summary of cross-language priming effects[8] with the cross-script masked priming protocol (L1: Greek, L2: French): Type of relation, stimuli sample for the translation (T) and the morphological condition (M) and masked priming effects (T and M[9]).

It is noteworthy to mention at this point that the term *bilingual*, in the present study as well as in all the experiments presented in Table 1, refers to:

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[6] Targets in italics.

[7] The authors corresponding to the letters of each reference are the following: V&Gi: Voga & Giraudo; V&G: Voga & Grainger; V: Voga.

[8] For simplicity reasons, Table 1 summarises experimental results from the L1 to L2 priming direction. The opposite priming direction (L2 to L1), gave mixed results (cf. priming asymmetries, e.g. Chen, Zhou, Gao & Dunlap, 2014; Duyck & Warlop, 2009) and is not considered in this table. In many Greek-French bilingual studies however, significant priming effects occur in the opposite direction, L2 to L1 occur (e.g. Voga & Giraudo, forthcoming; Voga, 2014), which is probably related to the presence of the orthographic cue.

[9] The 'masked priming effect' is the difference in milliseconds (ms), between the response time (RT) to the unrelated condition (or other control, e.g. phonological) and to the translation (T) or the morphological (M) condition. Positive effects mean facilitation.

individuals who acquired L2 in late childhood or early adulthood in a context where L1 was already clearly established, and for the most part, after any biologically sensitive or critical period in development had occurred. One difference between adult and child bilinguals is that for adults most new L2 words correspond to concepts that have already been acquired. (Kroll & Stewart, 1994, p. 151)

The term *bilingual effect* refers to a cross-language effect, i.e. the facilitation (or inhibition) that the prime-word, for instance κατακλυσμιαίος /kataklismiaíos/ 'cataclysmic' in Greek (Table 1, e), induces on the recognition of the target *cataclysme* 'cataclysm' in French. The effects presented in Table 1 are all positive and reflect facilitation in processing.

We are not able to discuss the above results in enough detail here, nevertheless, some remarks seem essential:

1) Priming effects under cross-script conditions are not restricted to words of identical (phonological) form. They occur under conditions in which no formal overlap (orthographic or phonological) is present (c1; d, both non-cognates), under conditions of limited formal overlap (i.e. phonological, mainly b2) and finally, they remain robust and highly significant when estimated relative to phonological controls (b2; c1). The masked priming technique is admittedly quite sensitive to orthographic processes, since it was initially developed to study form factors in lexical access (for a review, see Forster, Mohan & Hector, 2003). Despite the fact that this technique is sensitive to perceptual similarity between primes and targets, the results we can obtain with the appropriate materials and experimental design are nonetheless much more than formal effects and tap into central processes, involving the semantic and conceptual levels of processing. In other words, and to put it in the terms of the RHM (Kroll & Stewart, 1994; Kroll et al., 2010), we can consider that when a prime word facilitates the recognition of the target word in the other language, this facilitation is based, at least partly, on the semantic representation shared by the prime and the target.

2) Priming effects (under cross-script conditions) are not restricted to morphologically simple words, since they occur for prefixed words (see e), suffixed words (see c2), or words with both a prefix and a suffix (see d). More importantly, morphologically complex (prefixed) words which are non-cognates manage to induce morphological priming despite the absence of any formal similarity (see d), yet in the presence of a common morphological structure. This observation leads to the hypothesis that morphological structure along with common meaning, without any formal overlap, can facilitate the contact between the L1 and the L2 representation and induce effects comparable to cognate effects.

3) Morphological conditions, where an L1 morphologically complex prime facilitates the recognition of the L2 target (simple, as in (a) and (b), prefixed, as in (d) and (e), or suffixed, as in c2), induce priming effects that are not substantially different from the translation effect[10]. The two effects, the

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[10] In most of the studies reported in Table 1, the morphological priming conditions do not statistically differ from the translation priming conditions, which also argues in favour of a morphological-type organisation of the bilingual lexicon.

morphological and the translation one, occur at the same time, i.e. they are concomitant, not only when the morphological prime and the target share a common base, as in most of the experiments summarised in Table 1, but also when the base of the complex prime word presents no formal similarity with the target (except the common morphological structure, as in d).

These facts lead us to the hypothesis that the connection between the two lexica of the bilingual could be of morphological nature and invite us to explore the multiplicity of morphological mappings between the two languages of the bilingual. Such an hypothesis would be more compatible with an integrated lexicon, in which both languages are represented. In the next section we will examine the independent versus integrated lexica issue, which is related to a structural component, i.e. to the organisation of the two languages, as well as the various interactions between them (functional component).

1.2. The organisation of the bilingual lexicon: separate lexica versus integrated lexicon.

As far as access to the bilingual lexicon is concerned, it has been acknowledged since the 90s (e.g. Altenberg & Cairns, 1984) that it is non-selective, a position that has been corroborated by evidence of numerous cognate and non-cognate effects (e.g. same-script, Van Hell & Dijkstra, 2002; cross-script, Gollan et al., 1997; Voga & Grainger, 2007). However, the structural aspect, related to the organisation of the two languages in the bilingual lexicon remains an issue. The issue of empirically distinguishing between parallel non-selective access with separate lexica versus parallel access with an integrated, unified lexicon, is a very difficult one (e.g. Brysbaert & Duyck, 2010). We can only have indirect evidence coming from various kinds of interaction between the two languages. For much of the 'word recognition' research, this issue has been addressed through the study of interferences between word-forms of the two languages: for instance, Van Heuven, Dijkstra & Grainger (1998) show that the number of L1 (Dutch) orthographic neighbours influences processing when identifying L2 (English) words. Such a result contradicts the predictions of models assuming selective access and/or independent lexica (Van Heuven et al., 1998, p. 473). In the interactive activation framework (McClelland & Rumelhart, 1981), very often used to account for word recognition effects, the integrated lexicon hypothesis postulates the existence of inhibitory connections between words from different languages. The separate lexica hypothesis, on the other hand, limits inhibitory connectivity to within languages, which is why the authors interpret their data as evidence for integrated lexica.

Some more recent studies refer to language co-activation, (e.g. Van Hell & Tanner, 2012; see also Van Hell & Dijkstra, 2002), which reflects the fact that both languages of the bilingual are simultaneously activated. The various demonstrations of cross-language interaction establish that the interaction is not restricted to languages that are historically related but can be seen in bilinguals for whom the two languages come from different systems (e.g. Hoshino & Kroll, 2008, Japanese-English). The resulting cross-language activation and competition can be seen in brain activity in fMRI studies of

proficient bilinguals (e.g. Van Heuven, Schriefers, Dijkstra & Hagoort, 2008). These interactions have been studied in speech production protocols (e.g. through the picture–word interference paradigm) aiming to establish whether lexical competition only occurs within languages (language-specific se-lection) or also across languages (language non-specific selection, e.g. Kroll, Bobb & Wodniecka, 2006; Finkbeiner, Almeida, Janssen & Caramazza, 2006). As far as Greek is concerned, Hatzidaki, Branigan & Pickering (2011), through a sentence completion protocol, examined whether Greek–Eng-lish (and English–Greek) highly proficient fluent bilinguals activate only the source language or if they also activate the other language. The results demonstrated that the grammar systems of both languages were activated during both one-language and two-language production.

In lexical processing (bottom-up protocols), several studies have established that the non-target language, whether it is the dominant or the weaker one (Van Hell & Dijkstra, 2002), is activated in parallel, which gives another experimental proof for the fact that the multilinguals' processing system is profoundly nonselective with respect to language. Another line of research relative to lexical co-activation, refers to orthographic, low-level factors such as the effect of the orthographic cue in bilin-gual processing (e.g. Casaponsa & Duñabeitia, 2016). While the role of the orthographic cue, shown in several sets of data and especially in cross-script bilingual protocols (Gollan et al., 1997; Voga & Grainger, 2007) is admittedly crucial, we must underline that the study of sub-lexical bottom-up pro-cesses fails to address the role of central factors (semantics, morphology) in the bilingual mental lex-icon. Therefore studying sub-lexical processes is not very informative for the organisational principles of the lexicon/lexica being studied here (see Baayen, 2014; Voga & Giraudo, 2017, for the distinction between lexical and perceptual information in lexical access protocols).

1.3.   Multiplicity of morphological mappings *across* languages

If we go back to the hypothesis we seek to explore here, i.e. that the connection within the bilingual lexicon is of morphological nature, it must be acknowledged that this hypothesis is not a new one. The first researchers to have expressed this idea are Bybee (1985, 1988), on more theoretical grounds, and Kirsner (1986) based on experimental work. Bybee describes the monolingual lexicon as a series of 'lexical clusters' formed by a base-word and its derivations, an organisation transcending languages. In Bybee's Network model (1985, 1995) as well as in other accounts (e.g. Booij, 2010), morphology organises the lexicon according to two main dimensions: i) morphological families, i.e. words con-nected by virtue of a shared root, e.g. *kind/kindness/kindly/unkind/kind-hearted*, etc., and ii) morpho-logical series, i.e. words sharing the same affix, e.g. *kindness/happiness* etc. This organisation is relevant not only for the monolingual but also for the bilingual lexicon and has been experimentally validated through various kinds of bilingual protocols (e.g. long-term priming, Kirsner et al., 1993; masked priming, Sánchez-Casas & García-Albea, 2005). It is quite an attractive account, nevertheless it loses some of its appeal when it has to face some data, mainly evidence for non-cognate priming,

e.g. between *υγεία* /igía/ – SALUD 'health' (Dimitropoulou, Duñabeitia & Carreiras, 2011, with low proficiency bilinguals) or *λάθος* /làthos/ – *erreur* 'error' (Voga & Grainger, 2007, for other examples see Table 1). The 'traditional' position on this issue, at least from a lexical access point of view, is that non-cognates cannot belong to the same lexical paradigm, and hence should not produce priming effects[11]. However, before concluding on this issue, i.e. to what extent the connection between the two lexica is of morphological nature, it is of great importance to test several kinds of L1-L2 mappings between meaning and form. What Table 1 clearly demonstrates, is that there are several ways in which morphological connections come into play in the bilingual lexicon. Despite this 'multiplicity of mappings', the study of the various ways morphological information is triggered in bilingual settings does not seem to have especially inspired psycholinguists[12], except for the study of some variables, such as the Morphological Family Size[13] (e.g. Mulder, Dijkstra, Schreuder & Baayen, 2014; Mulder, Dijkstra & Baayen, 2015), or within the "automatic morphological decomposition" account of morphology (e.g. Duñabeitia, Dimitropoulou, Morris & Diependaele, 2013; see Rastle, Davis & New, 2004, for the monolingual account). As we have argued in previous works (Voga, Anastassiadis-Symeonidis & Giraudo, 2014; Voga & Giraudo, 2017), we consider that this somewhat anglo-centric view on morphological effects, very often oriented towards the question of the controversy between "morphological decomposition" (segmentation) mechanisms versus "lexical listing", is insufficient to unravel the organizational principles of the bilingual lexicon in generally, and the multiplicity of morphological mappings *through* languages in particular.

As stated in the introduction, our goal is to explore the strength and the nature of the connections within the word family in the bilingual lexicon by testing a particular kind of mapping between L1 and L2 words. For this purpose, we took advantage of a special category of Greek-French complex cognates, which we called '0-base cognates'. What is particular about them is that, linguistically speaking, they have an intermediate status between the constructed and the non-constructed word (Corbin, 1987, pp. 457-459: "ils ne sont les produits d'aucune Règle de Construction de Mot"[14]). Let us consider the French loan word *ρεαλιστής* /realistís/ 'realist', perfectly integrated in the Greek lexicon (Anastassiadis-Symeonidis, 1994), but whose "base" does not mean anything in Greek; although it has a small morphological family, mainly restricted to *ρεαλισμός* /realismós/ 'realism' and the adjective *ρεαλιστικός* /realistikós/ 'realistic', its "base", i.e. *ρεαλ-* /real-/ does not mean anything, and cannot be

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[11] In our view, there are several degrees under the term *cognates* as well as for the term *non-cognates*. In the literature, the term *translation equivalents* usually designates words that have no form relation (orthographic and/or phonological), such as those tested in the "non-cognate Greek-base" stimuli of our experiment (see Table 2). The term *non-cognate*, used in some studies (e.g. Dimitropoulou et al., 2011), seemed more clear-cut to us in order to mark the opposition between the two categories of stimuli (cognates vs non-cognates).

[12] With the exception of some studies, e.g. Sanchez-Casas & Garcia-Albea (2005). See also the studies reported in Table 1.

[13] Our purpose here is not to underestimate the influence of the Morphological Family Size, which has been found to play a role in processing Greek-French cognates (Voga & Giraudo, forthcoming), but to stress the lack of bilingual studies focusing on different kinds of morphological information.

[14] 'They are not the products of any Word Formation Rule.'

considered as a non-autonomous base, e.g. *lud(e)* (Corbin, 1987, p. 466), it thus forms a *seemingly* constructed word for the speaker. Words of this type (e.g. *ακτιβιστής* /activistís/ 'activist', *πλουραλιστής* /pluralistís/ 'pluralist') are considered as complex but non-constructed words such as *royaume* 'kingdom', *carpette* 'rug' in French (Corbin, 1987, pp. 456, 458). These complex non-constructed words are words whose internal structure and meaning are only partially superposable (Corbin, 1987, p. 459), because the constituents of their internal structure do not all belong to the list of lexical entries. Their regularities fall under the RSIs (Règles de Structure Interne 'Internal Structure Rules'). Consider for instance the word *carpette* 'rug' (Corbin, 1987, pp. 456-457), a complex non-constructed word and a complex lexical entry. This word has an internal structure that can be represented in the following way: [*carp(ette)*af]$_N$, i.e. *carp* does not belong to a grammatical category and for this reason it is not a lexical entry. Following Corbin (1987, p. 457), the RSIs apply to complex lexical entries, i.e. on lexical entries endowed with internal structure, of which at least one of the constituents is not a lexical entry itself.

Importantly, these words have a Greek equivalent, which, when it exists, has a much lower frequency in the language, e.g. 82.700 occurrences/million in Google for *ρεαλιστής* 'realist' versus 15.400 occ./million for *πραγματιστής* /pragmatistís/ 'pragmatist'. From a processing point of view, the speaker can easily recognise *-ιστής* /-istís/ '-ist' as an affix, but he cannot recognise the base and attribute a grammatical category to such a form, since *ρεαλ-* /real-/ is not a lexical entry. These words constitute Greek words (from a use and a lexicographic point of view), and they form lexical entries listed in the mental lexicon (Corbin, 1987, p. 456). Nevertheless, they could have a representation of an intermediate type, somewhere in-between the constructed and the non-constructed word.

These '0-base complex words' differ however from bound-stem words, since bound-stems, e.g. *vir-* in *viral* 'viral' activate the base-lexeme (Giraudo & Voga, 2016) whereas in the case of 0-base words there is nothing to be activated. As mentioned above, these items have a small morphological family which is quite homogeneous, since, for the materials considered here, the only existing morphological relatives were the noun (*-ισμός* /-ismós/ '-ism') and the adjective (*-ικός*, /-ikós/ '-ic'). This characteristic gives us the opportunity to test the extent of the 'series' factor, i.e. to determine the influence of the derivational/word family, given that, in the case of these 0-base words, it is possible that the connection between the L1 and the L2 is based on the association between *-iste* and *-isme*, i.e. the association between related suffix units, e.g. '-ist' and '-ism' (cf. Giraudo & Voga, 2013, on prefix units in L1 processing).

Although there is substantial evidence on series effects in *monolingual* processing (e.g. Giraudo & Grainger, 2003; Giraudo & Dal Maso, 2016a), the number of studies is very limited when it comes to bilingual processing, especially cross-script. Our study was designed to address the issue of series effects in two situations: with cognate words, sharing the same (phonological but not visual) form in the two languages (e.g. morphological prime: *ρεαλισμός* /realismós/ 'realism' for the target *réaliste*

'realist') and with non-cognate words, i.e. the Greek translation equivalent with L1 base (e.g. translation prime πραγματιστής /pragmatistís/ 'pragmatist' for the same target *réaliste* 'realist').

2. The study

2.1. Method

2.1.1. Participants

One group of subjects participated in the two experiments presented below. The group was formed by 29 undergraduate and post-graduate students from the Paul-Valéry Montpellier III University, 20 female and 9 male, aged 19 to 32 years, who reported normal or corrected-to-normal vision. Six participants were not students at the time of the experiment but had studied in France (Paul-Valéry University) for at least two years. They had (almost) all been exposed quite early to French as an L2 (mean age for age of onset: 12 years, range 4 to 24), and they had been living in France for at least six months, at the time of the experiment (from 6 months to 6 years, mean: 23 months). They were all Greek native speakers, who went to school in Greece. Conforming to how French is taught in Greece, they started quite early to attend classes in small private schools called *frontistiria*, usually starting with one or two hours per week. The aim is after 5-8 years of study, to pass a FLE (Français langue étrangère 'French as a foreign language') exam, in order to have a certificate proving the relevant level in French (at least B2, or C1, C2), meaning that they have all received formal education in French.

2.1.2. Stimuli and design

The three categories of materials, 81 words and 81 pseudowords were tested in a masked priming experiment using the lexical decision task. The priming direction was the L1 to L2, i.e. all the primes were in Greek (L1) and all the targets in French (L2). The three categories of materials, two categories of cognates and one of non-cognates, were the following:

1) 27 pairs of '0-base' cognates, that were complex non-constructed words such as ρεαλιστής /realistis/ 'realist', all formed with the suffix -ιστής /istís/ '-ist'. The visual overlap of this type of cognate is much reduced given the alphabetic difference between the Greek and the Latin alphabet, but the two cognates overlap in phonological form and mean exactly the same thing in Greek and in French. Given the presence of the 'orthographic cue', i.e. the alphabetic difference between the two languages, we can make the assumption that the processing system will be directly oriented towards the appropriate lexicon, which will induce priming effects (e.g. Gollan et al., 1997; Voga & Grainger, 2007; Voga, 2015). However, we should underline that given that the '0-base' does not correspond to a lexical entry, the priming effect cannot come from the base. The priming effect for this category should thus be of lesser amplitude compared to the 'classic' cognate translation effect in cross-script conditions (see Table 1, b).

2) 27 pairs of morphologically complex non-cognate words, with the same suffix (as in 1 above), in which the L1 word had a Greek base and its L2 translation had an L2 base, for instance for the L1 prime *λαϊκιστής* /laikistis/ 'populist', the L2 target was *populiste* 'populist'. These complex words share no formal overlap between the L1 and the L2, but they have a common meaning plus the common suffix. Note however that the Greek base of the L1 prime, e.g. *λαϊκ-* /laïk/ in *λαϊκιστής* /laikistis/ 'populist' often[15] corresponds to a rich morphological family, which means that the L1 Greek prime could exert inhibition on the identification of the L2 target.

3) 27 pairs of morphologically complex Greek-French cognates. These cognates all come from Greek, they all have the *-ique* '-ic' suffix (*-ικός* for the L1 prime, see Table 2). They have a (Greek) base at the center of their morphological family, e.g. *μαγικός* /magikós/ 'magical'. This family ("Morphological Family Size", De Jong, Schreuder & Baayen, 2000) was kept as small as possible, in order to enable comparisons between the stimuli used here (at least those of 'cognates 0-base' and 'cognates Greek-base'). This type of cognate has been shown to induce robust identity and morphological effects, around 50ms for the translation effect (see Table 1, b). Among the three categories tested here, it is the one for which maximum facilitation is predicted ('upper baseline').

Materials for all three categories were balanced for frequency as much as possible, given that the 0-base words have a frequency that is lower compared to the cognates of Greek base. This was not the case of non-cognates, which were quite infrequent too.

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[15] For this category, we chose words that have this kind of 'doublet', which is common for words of this type found in the *Reverse Modern Greek Dictionary* (Anastassiadis-Symeonidis, 2002-2008).

		Primes			
		Translation	Phon. overlap	Morphological	Unrelated
Cognates '0-base'	*pluraliste* 10.3 lett. 1.81 occ./m.	πλουραλιστής /pluralistís/ 'pluralist'	95%	πλουραλισμός /pluralismós/ (75%)	ξεχείλισμα 'overflowing'
Non-cognates Greek-base	*individualiste* 10.22 lett. 2.06 occ./m.	ατομικιστής /atomikistís/ 'atomist'	–	ατομικισμός /atomikismós/ (–)	αστεροσκοπείο 'observatory'
Cognates Greek-base	*monarchique* 10.4 lett. 4.5 occ./m.	μοναρχικός /monarhikós/ 'monarchist'	85%	μοναρχισμός /monarhismós/ (55%)	αφαίρεση 'substraction'

Table 2. Stimuli sample (number of letters and lexical frequency) and phonological overlap for the nine experimental conditions (3 priming conditions: translation, morphological, unrelated x three types of target).

Each target could be preceded by one of the three following types of prime, which constitute the three priming conditions:

– The prime was the translation of the cognate in the other language, e.g. for the prime *πλουραλιστής* /pluralistís/ 'pluralist' in Greek (L1), the target was *pluraliste* in French (L2). Primes were always presented in nominative singular for Greek and in singular for French for nouns.

– The prime had a morphological relation to the target, e.g. for the same target *pluraliste* 'pluralist') the prime was *πλουραλισμός* /pluralismós/ 'pluralism'.

– The unrelated prime, on the basis of which the results were estimated. This prime is a word from the other language without any grapho-phonological or etymological relation to the target.

The 81 pseudowords were created in such a way that they respected the phonotactic constraints of each language (French and Greek) and were preceded by pseudo-primes mimicking those of real words. The materials (words and pseudowords) were distributed in three experimental lists, each one including 9 words and 9 pseudowords in each priming condition, according to a Latin square design, so that every target appeared only once and was preceded only by one prime for a given subject (either the translation prime, the morphological prime or the unrelated one), but appeared in the three conditions (i.e. preceded by the three types of prime) across subjects. 54 filler items were included in the experiment.

2.1.3. Procedure and apparatus

The experiment was conducted on a PC computer using the DMDX software (Forster & Forster, 2003). Each trial consisted of three visual events. The first was a forward mask consisting of a row of 14 hash

marks that appeared for 500ms. The mask was immediately followed by the prime. The prime was in turn immediately followed by the target word which remained on the screen until the participant responded. The intertrial interval was 500ms. The prime duration used in this experiment was 50ms. All stimuli appeared in the middle of the screen presented in lowercase characters in order to preserve stress markers over the appropriate vowels. In order to avoid visual overlap (despite the different alphabet between primes and targets), the size of the font was manipulated (Times New Roman 16 point for targets and Arial 12 point for primes; for a similar presentation see Frost, Forster & Deutsch, 1997). Participants were seated 50 cm from the computer screen. They were requested to make lexical decisions on the targets as quickly and as accurately as possible, by pressing the appropriate button of the keyboard (right shift for YES and left for NO). After 20 practice trials, participants received the 216 experimental trials in one block. As far as the participants are concerned, who are not aware of the existence of the Greek prime, the task is strictly monolingual (all the targets are in French), given the very short SOA (50ms prime duration), i.e. below the conscious perception threshold.

2.2. Results

2.2.1. Reaction Times Analysis.

Correct response times (henceforth RTs) were averaged across participants after excluding outliers (RTs > 1700ms, less than 3% of the data). The results are presented in Table 3. Three items were excluded from analysis (*altermondialiste, nihiliste, passéiste*) because of high error rates (more than 20%). An ANOVA (Analysis Of Variance) was performed on the remaining data with prime type (translation, morphological, unrelated) and stimulus category as within-participants factors.

There was a significant main effect of prime type [$F1(2, 56) = 4.96$, $p < .05$], as well as of type of target [$F1(2, 56) = 56.22$, $p < .0001$]. The interaction between the two main factors showed a trend towards significance [$F1(4, 112) = 2.22$].

Planned pairwise comparisons were performed in order to examine translation and morphological priming relative to the unrelated prime condition for the three types of stimuli. These showed a significant effect of translation priming only for the third category of stimuli, i.e. the Greek-base cognates (e.g. μοναρχικός /monarhikós/ 'monarchic' – *monarchique*), [$F1(1, 28) = 10.58$, $p < .001$]. This category also induced robust morphological priming [$F1(1, 28) = 4.29$, $p < .05$], that does not significantly differ from the translation effect [$F1 < 1$]. The two remaining categories, the 0-base cognates as well as the non-cognates did not yield significant facilitation for the translation conditions [both $Fs < 1$], but the 0-base cognates managed to induce significant morphological effect [$F1(1, 28) = 6.35$, $p < .05$]. The translation and the morphological conditions did not statistically differ between them, neither for the 0-base cognates, nor for the non-cognates (both $Fs < 1$).

Words	Primes (in L1)							
Targets (in L2)	Translation (T)		Morph. (M)		Unrel. (U)		Net prim. effect	
	RT	Err. (%)	RT	Err. (%)	RT	Err. (%)	U – T	U – M
Cognates '0-base' *pluraliste*	1007	1.41	942	1.02	1027	1.15	20	85*
Non-Cognates *individualiste*	1072	3.88	1015	3.61	1020	5.27	-52	5
Greek-base Cognates *monarchique*	883	0.61	917	0.86	966	1.11	83*	49*

Table 3. Reaction times (in milliseconds) and percentages of errors for the lexical decisions to the three types of targets in the three priming conditions (translation, morphological and unrelated). Net priming effects are given relative to the unrelated condition and statistically significant priming effects (translation and morphological) are marked with an asterisk.

2.2.2. Errors analysis

An ANOVA was performed on the errors with the same factors as for the RTs analysis, i.e. prime type and stimulus category. The main effect of prime type was not significant [$F1(2, 56) = 1.3$], neither was the interaction between the two main factors [$F1(4, 112) = 1.16$], but the effect of stimulus category was significant [$F1(2, 56) = 25.99$, $p < .001$]. The planned pairwise comparisons showed that non-cognates induced more errors than cognates [$F1(1, 28) = 30.96$, $p < .001$] and 0-base cognates [$F1(1, 28) = 28.5$, $p < .001$]. For the non-cognate stimulus category, the number of errors did not differ following the prime condition (translation, morphological or unrelated), since all three differences are non-significant (translation versus unrelated, $F1(1, 28) = 1.64$; translation versus morphological $F < 1$; morphological versus unrelated, $F1(1, 28) = 3.56$). For all the differences between priming conditions for 0-base and Greek-base cognates, all $Fs < 1$.

2.3. Discussion

Exploring the role of the different kinds of information during processing is crucial for understanding the bilingual lexicon, since this can help us determine the nature of the connection between the two lexica or between the words of the common lexico-semantic architecture that forms the bilingual lexicon (e.g. Brysbaert & Duyck, 2010; Voga, 2017; Voga, Gardani & Giraudo, forthcoming). The comparison between the three categories of stimuli used here (Table 2) allows us to evaluate the participation of each component: 0-base cognates have no lexical entry, but they have identical (-ιστής /-istís/ '-ist' and *-iste* for translation conditions) or related suffixes (-ισμός /ismós/ '-ism' and *-isme* for morphological conditions). Non-cognates have non-overlapping base but they still share related suffixes (like '0-base cognates'). Finally, Greek-base cognates overlap in form (base + suffix in the translation conditions, base + related suffix in the morphological conditions). This last category was

the one we used as the 'upper' baseline ('full priming'), given that it admittedly induces effects of large amplitude, which is exactly what we observe here, despite the fact that our Greek-base cognates were less frequent (and with more letters) than in previous studies (e.g. *puerta – puertas*; *porta – puertas* in Sanchez-Casas & Garcia-Albea, 2005; *viewer – view* in Diependaele, Duñabeitia, Morris & Keuleers, 2011).

What is of more interest for our study is the unusual, compared to the cognate materials usually tested, pattern for '0-base cognates': these materials have overlapping form in the two languages, they should thus induce some priming by virtue of their perceptual similarity, in the way cognates do in a multitude of studies (e.g. Costa et al., 2000; Gollan et al., 1997; Sánchez-Casas & García-Albea, 2005; Voga & Grainger, 2007). Our 0-base cognates do not behave as cognates: they induce no translation effect, but a robust morphological effect (85ms). The only plausible reason we can see for the absence of translation effect is the fact that the L1 prime and the L2 target do not share any lexical entry, the representation of which could be shared at the form and at the lexical level (in a model such as the BIA, Dijkstra & Van Heuven, 2002), or at the lexical and the conceptual level (in a model such as the RHM, Kroll et al., 2010). This result confirms our hypothesis (Corbin, 1987, p. 456) that word-segments such as *πλουραλ-* /plural/ do not constitute lexical entries and as such fail to induce translation priming from one language to the other.

That being said, the robust morphological priming (85ms) found for 0-base cognates must come from some shared feature between the two units (the prime *πλουραλιστής* /pluralistís/ and the target *pluralisme*). This shared feature obviously arises from the internal structure of primes and targets, which is easily recognisable to the speaker, in other words by the presence of related suffixes in L1 (*-ιστής* '-ist') as in L2 (*-isme* '-ism'). In the general discussion, we present the implications of the above findings for the architecture and the organisation of the bilingual lexicon.

Finally, the absence of non-cognate effect in our study is not surprising. As mentioned in the introduction, in same-script studies, non-cognate effects are not the norm (e.g. Sanchez-Casas et al., 1992). Greek-French non-cognates on the other hand have been found to induce facilitation in most protocols, at least for relatively frequent words with less than ten letters (Dimitropoulou et al., 2011; Voga & Grainger, 2007). Non-cognate priming is considered to be enhanced by the presence of the orthographic cue, which orients the processing system towards the appropriate lexicon. This does not seem to be the case for the constructed and less frequent non-cognates tested here. Furthermore, these non-cognates induced significantly more errors than the two other (cognate) categories. The RT analysis did not yield any significant effect for non-cognates. However, the -52ms arithmetical difference between the translation and the unrelated condition, combined with the highly significant main effect of stimulus type in the RT analysis as well as the higher error rates might suggest inhibition exerted from the representation of the L1 prime, e.g. *λαϊκιστής* /laikistis/ 'populist' on the L2 target, e.g., *populiste* 'populist'.

3. General discussion

One of the first conclusions of the present work is that morphological cross-language priming is not restricted to morphologically complex words with a base and an affix (i.e. our Greek-base cognate words, e.g. *μοναρχισμός* /monarhismós/ 'monarchism' – *monarchique*), but occurs for complex non-constructed words (i.e. 0-base words). The fact that the cognate words (primes and targets) used here were quite long (mean: 10.35 letters for primes) and of relatively low frequency (1.8 occ/m. for 0-base words), did not prevent the occurrence of positive translation and/or morphological priming effects.

The 0-base words present a particular kind of mapping between the L1 and the L2, they are *seemingly constructed* but they cannot activate any lexical entry. The absence of translation priming for these words, despite the maximal phonological overlap between prime and target (e.g. *ρεαλιστής* /realistís/ 'realist' – *réaliste*), corroborates their intermediate status. They are complex non-constructed words whose internal structure and meaning are only partially superposable (Corbin, 1987, p. 459), and their '0-base' does not constitute a lexical entry (Corbin, 1987, pp. 456, 458), exactly as in *carpette* 'rug' (fr.)[16]. Consequently, no translation priming effect occurs, however, the absence of a lexical entry does not prevent robust morphological priming (85ms) from occurring, which demonstrates the strength of the connection between *-ιστής* /-istís/ '-ist' and *-isme*. The amplitude of the morphological priming is found to be greater for 0-base words than for Greek-base cognates (e.g. *μοναρχισμός* /monarhismós/ 'monarchism' – *monarchique,* 49ms). This result suggests that the connection within the word family is active in the very early stages of language processing (50ms SOA), and even when the base of the prime activates no lexical entry, i.e. under circumstances where there is no word-representation to be contacted.

The connection which triggers the morphological priming effect can only be, in the case of 0-base words, the connection within the word family, i.e. between *-ιστής* /-istís/ '-ist' and *-isme*. This connection should be distinguished from those within the derivational family, which includes the derivations (prefixation and suffixation) of a base word, and which, in our experiment, corresponds to Greek-base cognates.

Word family should also be distinguished from the "morphological family". If we consider the morphological family in the definition tested in a variety of psycholinguistic experiments, i.e. the Morphological Family Size (MFS, De Jong et al., 2000; for bilingual processing: Mulder et al., 2014), the morphological family is less inclusive than the word family, since the MFS includes words with

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[16] It is easy to remark that words such as *carpette* 'rug' are quite close to pseudo-derived units such as *baguette* 'baguette bread' (pseudo-derived of *bague* 'ring'), that gives rise to significant morphological-like effects, reported in several masked priming studies as evidence in favour of the "automatic morphological decomposition" account of morphology. It should be noted however that while *bague* (pseudo-theme of the pseudo-derived *baguette*) is a very frequent word, *carp-*, *ρεάλ-* /real/ or *πλουράλ-* /plural/ do not constitute lexical entries (for a discussion on this point, see Voga & Giraudo, 2017; Giraudo & Voga, 2016).

the same base, i.e. derivatives, without excluding compounds ('a morphological family member is a complex word in which a given simplex word appears as a constituent', De Jong et al. 2000, p. 330).

The word family is more inclusive in the sense that it includes words with the same or related suffix, even in cases where there is no base, as the priming effect for 0-base words demonstrates. Word family is the widest type of morphological organisation and includes the morphological and the derivational family. A word-pair such as *μαρξιστής* /marxistís/ 'marxist' and *marxism* belongs both to the same word family and the same morphological and derivational family, while a word-pair such as *ρεαλιστής* /realistís/ 'realist' and *réalisme* does not form a derivational family, or a morphological one.

One of the most interesting implications of the above findings is that the connections within the word family manage to *transcend* languages (Bybee, 1985); Words that are not present in the visual input (here, the prime, e.g. *ρεαλισμός* /realismós/ 'realism', in Greek), but are morphologically related to the target word in the input (*réaliste*) are co-activated in the mental lexicon *across* languages and without sharing any common base. Morphological information related to the word family influences the very early stages of processing, such as those we observed here with the masked priming technique and the 50ms SOA. This early influence reflects the strength of the connection within the word family, which is reinforced through use, via the co-occurrence of *-ist* and *-isme* (e.g. Bybee, 1985, 1988, 2007). Such an interpretation validates the integrated lexica hypothesis (Brysbaert & Duyck, 2010; Schoonbaert, Duyck, Brysbaert & Hartsuiker, 2009). If L1 and L2 words did not belong to a common architecture, we would not observe any co-activation in the morphological conditions, especially for 0-base words. This suggests that word families manage to organise the languages of the bilingual *cross-linguistically.*

This morphological co-activation *via* word-families would be quite difficult to integrate in a sub-lexical account of language co-activation, based on some kind of decompositional mechanism (for the monolingual account: Rastle et al., 2004; for application in bilingual processing, Casaponsa & Duñabeitia, 2016). Our results suggest that the language processing system is not sensitive to the sub-lexical information provided by the common 0-base, e.g. *plural-* or *real-*, despite the fact that these segments correspond to an existing base in the L2. Sub-lexical information does not suffice to induce translation effects under the cross-script conditions of our experiment which obviously prevented an overreliance on low-level orthographic processes, as can be the case in masked priming protocols[17]. From this point of view, the assertion that "language co-activation in bilinguals is highly modulated by sub-lexical processing and […] orthographic regularities of the two languages of a bilingual are a determining factor in lexical access" (Casaponsa & Duñabeitia, 2016, p. 589) is not supported by our data.

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[17] For a discussion on what we called "morphological-like effects" interpreted in morphological terms in masked priming protocols, see Voga & Giraudo (2017).

To summarise, word families provide a fundamental principle of organisation and structure in the bilingual mental lexicon. Within this architecture, the word family creates mappings that circumvent not only the language (L1 or L2), but also the 'base' corresponding to a lexical entry. From this point of view, Corbin's (1987) assumption that it is the suffix that is the principal element in a suffixed word, which is why she refers to suffixation in terms of "application" (le suffixe *s'applique* à une base 'The suffix applies to a base'), is confirmed by our data. To the extent to which it is the suffix that selects the semantic properties of the base, the role of the base seems to be secondary, at least for the kind of stimuli tested here.

Of course, the word family tested in our '0-base' condition is based on salient suffixes, and it has been shown that perceptual and conceptual salience of the affix influences processing and acquisition of morphologically complex words, both for monolingual (Giraudo & Dal Maso, 2016a, 2016b, for suffixes) as well as second language processing (Voga, Nikolaou & Anastassiadis-Symeonidis, 2018). The above data underline the role of experience in the formation of linguistic categories and representations, which has been theorised in what have come to be called usage-based models (Bybee, 1985, 2007) and probabilistic models (Bod, Hay & Jannedy, 2003). In this type of system, often referred to as an emergent system, "a small number of mechanisms operate in real time and with repetition lead to the emergence of what appears to be an organised structure, such as a sand dune" (Bybee, 2007, p. 8). The emergent nature of the bilingual lexicon, modelled through connectionist models, allows us to explain how item-specific knowledge interacts with and gives rise to more general knowledge (Bybee & McClelland, 2005).

Such an interpretation is also compatible with recent statistical accounts based on 'informativity', i.e. the influence that different unit boundary types have on text compressibility (Geertzen, Blevins & Milin, 2016). According to this account, word boundaries are the most informative boundary type, and the demarcation of words provides the most informative description of the regular patterns in a language.

A last hint in favour of the integrated lexica view comes from our results for non-cognates, which do not exhibit the same pattern as in previous studies with Greek-French materials (e.g. Voga & Grainger, 2007; Dimitropoulou et al., 2011; Voga, 2017). This difference is probably due to the low frequency status of the stimuli used here, combined with the fact that the target of the recognition is a 0-base word (e.g. *individualiste* for the prime ατομικιστής /atomikistís/ 'individualist'). The hint of inhibition found for non-cognates could be related to the competition the L1 primes exert on recognition of L2 targets. Although the Greek equivalent of 'realist' (i.e. πραγματιστής /pragmatistís/) has much fewer occurrences than ρεαλιστής /realistís/, it activates the numerous members of its morphological family (e.g. πράγμα /prágma/ 'thing', πραγματικός /pragmatikós/ 'real', πραγματικότητα /pragmatikótita/ 'reality', πραγματοποιώ /pragmatopoió/ 'realise', etc.). This difference in Morphological Family Size (MFS, e.g. De Jong et al., 2000; Mulder et al., 2014) creates inhibition on the recognition of the L2 target *réaliste* 'realist'. The MFS (Morphological Family Size) factor was not

specifically controlled in our experiment, it is however evident that all the L1 bases present in the non-cognates tested here (such as *πραγματ-* /pragmat/ in *πραγματιστής* /pragmatistís/) can activate much more relatives than the 0-base *ρεάλ-* /real/ of *réaliste.* This could be the reason why the non-cognate materials tested here not only fail to induce any translation or morphological priming on the recognition of the L2 target, but also seem much more difficult to process comparatively to the non-cognate materials tested in previous studies. We cannot safely conclude on this point on the basis of the present results, however, if such an inhibition was found to be statistically reliable, it would constitute evidence supporting the sensitivity of the bilingual to cross-language competition and parallel access to a common store for the two languages.

As a final observation, we wish to highlight that the kind of "atypical" mapping between meaning and form, such as the one tested here (0-base words), has been somehow neglected, despite the breadth of psycholinguistic literature studying various relationships between words and their effects on morphological processing (for a review, Voga & Giraudo, 2017). One of the aims of our study was to contribute to filling this gap. The present data support an augmented role for morphological factors, not only in terms of co-occurrences between meaning and form, but also in terms of "the larger chain of morphological relations" (Mulder et al., 2014), insofar as morphology refers not only to what exists inside the word (e.g. bases, suffixes, etc.), but also to a multitude of relationships between words, which may not be "morphological" in the strict sense. This is fully compatible with the idea, mainly based on production and neuro-psychological data (Schwartz & Kroll, 2006; Van Heuven et al., 2008), that cross-language interactions reflect the open architecture of the language system rather than a strategically imposed process that brings the other language into play.

4. References

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