Research Article

Is Syntax Separate or Shared Between Languages?

Cross-Linguistic Syntactic Priming in Spanish-English Bilinguals

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ABSTRACT—*Much research in bilingualism has addressed the question of the extent to which lexical information is shared between languages. The present study investigated whether syntactic information is shared by testing if syntactic priming occurs between languages. Spanish-English bilingual participants described cards to each other in a dialogue game. We found that a participant who had just heard a sentence in Spanish tended to use the same type of sentence when describing the next card in English. In particular, English passives were considerably more common following a Spanish passive than otherwise. We use the results to extend current models of the representation of grammatical information to bilinguals.*

Although a very high proportion of the world's population speaks two (or more) languages, the psychological study of language has concentrated largely on monolingualism. A fundamental psycholinguistic question that is relevant only to bilingualism is the extent to which the two languages are integrated. Put simply, do bilinguals have separate stores for the two languages, or do they have a single store for at least some aspects of language? Most research into this question has considered the representations of words or concepts (e.g., Kroll & Stewart, 1994; McElree, Jia, & Litvak, 2000), and there has been little consideration of whether other aspects of language are shared or separate. Hence, in this study, we asked how bilinguals represent syntax. Do they have two entirely separate syntactic stores, one for each language (the *separate-syntax account*), or is at least some syntactic information shared between the languages (the *shared-syntax account*)?

Different languages have different grammars, of course, but linguistic theories assume that grammars do not vary randomly (e.g., Chomsky, 1981). For any two languages, some constructions will be different, but others will be the same. For example, English and Spanish can express similar things using either an active construction (e.g., *The taxi chases the truck*, *El taxi persigue el camión*) or a passive construction (e.g., *The truck is being chased by the taxi*, *El camión es perseguido por el taxi*), and the form of the sentences is largely similar in the two languages. Thus, English and Spanish may well share at least some syntactic information. This information could be encoded in traditional syntactic rules (i.e., active and passive rules) or in the syntactic component of lexical entries (in linguistic theories in which the combinatorial properties of words are largely or entirely represented in the lexicon; Chomsky, 1995; Pollard & Sag, 1994).

According to the separate-syntax account, Spanish-English bilinguals represent English and Spanish active constructions, and English and Spanish passive constructions, separately, even though this means that some information is represented twice. One possible motivation for having separate representations is that actives and passives (for instance), though they appear superficially similar in different languages, are actually separate constructions (and indeed, the Spanish active places a preposition, *a*, before an animate direct object, but the English active does not). Additionally, having language-specific stores might lead to efficient processing if bilinguals most commonly employ one language at a time (e.g., they have a conversation in either Spanish or English). By having separate representations for syntax, the bilingual can focus entirely on the relevant language and thereby reduce the number of constructions taken into consideration.

According to the shared-syntax account, rules that are the same in the two languages are represented once. This approach has the advantage of reducing redundancy. Even if there are some grammatical differences between the languages (such as the presence or absence of a preposition), the bilingual could represent the shared aspects of the construction once, and store additional language-specific information as necessary. Additionally, sharing syntax might be efficient for bilinguals who code-switch between languages during a conversation, so that they do not need to change which store of information they access midstream.

The fairly extensive work on the bilingual lexicon suggests that at least some information is shared between languages. Most notably, accessing a word in one language leads to the activation of related words in the other language, both in comprehension (Spivey & Marian,

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1999; Van Heuven, Dijkstra, & Grainger, 1998) and in production (Colomé, 2001; Costa, Miozzo, & Caramazza, 1999).

However, most theories of sentence production assume some formal separation between selection of lexical and syntactic information in the process known as grammatical encoding, when the syntactic structure of the utterance is constructed (Bock & Levelt, 1994; Garrett, 1980; Vigliocco & Hartsuiker, 2002). Essentially, people perform two parallel processes of accessing relevant words (strictly, the lemmas associated with those words; Levelt, 1989) and constructing a grammatical frame on the basis of syntactic information that is associated with the words. The grammatical frame contains empty "slots," and the words are used as "fillers" for those slots. Assuming such a separation between frame construction and lexical access, a (largely) shared lexicon is consistent with both the shared- and the separate-syntax accounts. Hence, one cannot discriminate the shared- and separate-syntax accounts on the basis of either a priori arguments or results of studies of the bilingual lexicon. A direct experimental investigation of bilingual syntax is needed.

SYNTACTIC PRIMING IN BILINGUALS

We tested the shared-syntax account using the phenomenon of *syntactic priming*, whereby the effect of processing a particular grammatical form affects subsequent processing of grammatical form. In most demonstrations of syntactic priming, a speaker who uses a particular grammatical form displays a tendency to repeat that form. Thus, Bock (1986) had people alternate between repeating sentences and describing pictures. If they had just repeated an active sentence, they tended to describe the picture using an active sentence, but if they had just repeated a passive sentence, they tended to describe the picture using a passive sentence. Similar effects have been found in Dutch (Hartsuiker & Kolk, 1998a), in written sentence completion (Pickering & Branigan, 1998), in spoken sentence completion (Branigan, Pickering, Stewart, & McLean, 2000), in sentence recall (Potter & Lombardi, 1998), and for many different types of sentences (Ferreira, 2003; Hartsuiker, Kolk, & Huiskamp, 1999; Hartsuiker & Westenberg, 2000). Priming occurs in aphasics (Hartsuiker & Kolk, 1998b), facilitates the learning of syntactic structure by young children (Brooks & Tomasello, 1999), and affects response time (Corley & Scheepers, 2002; Smith & Wheeldon, 2001). Alternative accounts in terms of lexical, semantic, or prosodic repetition do not appear able to explain the data (Bock, 1989; Bock & Loebell, 1990).

The shared-syntax account predicts cross-linguistic syntactic priming, but the separate-syntax account does not. In a recent study, Loebell and Bock (2003) provided some evidence for syntactic priming between German and English in a picture-description task. They found priming between alternative forms of English datives (e.g., *The girl bought the blind woman a newspaper* vs. *The girl bought a newspaper for the blind woman*) and their German equivalents, but not between English actives and passives and their German equivalents.

In dialogue, interlocutors align at many levels of linguistic representation (Pickering & Garrod, in press), including the lexical and the semantic levels (Brennan & Clark, 1996; Garrod & Anderson, 1987), so it might be predicted that syntactic priming occurs between interlocutors. In a test of this prediction, Branigan, Pickering, and Cleland (2000) had a naive participant and a confederate alternate in describing cards to each other and finding the appropriate card in an array. The naive participant tended to repeat the syntactic form used by the confederate.

In our experiment, two bilingual interlocutors described cards to each other using Branigan, Pickering, and Cleland's (2000) method, but with the twist that the confederate spoke Spanish and the naive participant spoke English. Both confederate and naive participants were native Spanish speakers with moderate or high proficiency in English. Prime sentences were Spanish active and passive transitive sentences, as well as intransitive sentences (active sentences without direct objects) and active sentences in which the object came before the verb and the subject after the verb (a form not found in English). Target pictures were designed to be equally well described by active and passive sentences in English. Assuming that English and Spanish actives, and English and Spanish passives, have sufficiently similar representations, the shared-syntax account predicted cross-linguistic syntactic priming. In contrast, the separate-syntax account predicted no effect of the syntactic form of the prime on the target response.

METHOD

Participants

Twenty-four native speakers of Spanish (15 females) were paid to be naive participants. All spoke English as a second language. They were all resident in Edinburgh and had lived in the United Kingdom for 22 months on average (range: 2 months–7 years). Fifteen participants reported using English at home more often than Spanish. Average age was 28 (range: 19–38). The experiment also employed a female confederate.

Materials

There were two sets of 128 cards, each depicting an action. One set, the *naive participant's description set*, contained 32 experimental cards. These cards showed an entity performing an action (the agent) and another entity undergoing an action (the patient). Experimental cards all showed inanimate agents. Patients were animate in 16 cards, and inanimate in the other 16. Agents were always depicted on the right side of the card. Location and animacy of agents and patients affect the baseline number of actives and passives (Bock, 1986; Hartsuiker & Kolk, 1998a). We opted for the present combinations of animacy and location so as to increase the likelihood of obtaining a reasonable number of passive responses. A verb was printed at the bottom of each card, and participants were instructed to use that verb in their response. There were also 96 filler cards, depicting actions best described with sentence structures other than our target structures. The second set of cards, the *naive participant's selection set*, contained 128 filler cards. These cards were used for the naive participant's cover task of checking whether they corresponded to the confederate's descriptions.

A master list of 128 items was designated the *confederate's description set*. Ninety-six items were filler sentences, and 32 items were sets of prime sentences (8 sentences per set; each set represented each experimental condition twice). From the master list, we derived eight counterbalanced lists by selecting a single prime sentence from each set. Across the eight lists, each prime sentence occurred just once. The eight lists all had the same pseudorandom order, which was constrained so that each prime sentence was preceded by 3 filler sentences. The sentences in the confederate's description sets were

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paired with the pictures in the naive participant's description set, so that each prime sentence (spoken by the confederate) would be followed immediately by a target picture (described by the naive participant). Within each list, 8 prime sentences occurred in each of the four conditions: active, passive, intransitive, and OVS (sentence with the word order object-verb-subject). Examples of these sentences are as follows:[1]

1. El taxi persigue el camión (active)
   "The taxi chases the truck"
2. El camión es perseguido por el taxi (passive)
   "The truck is chased by the taxi"
3. El taxi acelera (intransitive)
   "The taxi accelerates"
4. El camión lo persigue un taxi (OVS)
   "The truck[chasee] it chases a taxi[chaser]"

In addition, sentences were selected such that within each condition, half of the prime sentences had an agent and patient (if applicable) of the same animacy as the corresponding target picture, and half had an agent and patient with the opposite animacy. The nouns and verbs in prime and target were never translation equivalents and were never related in meaning or form.

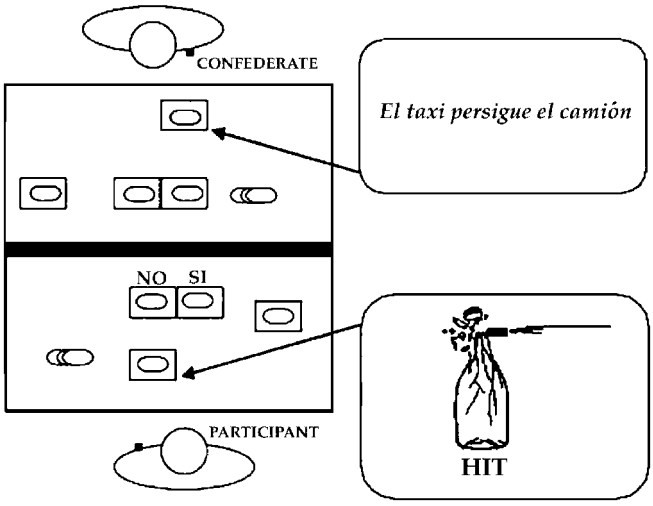

Fig. 1. Experimental setup. On the desk in front of each participant were a box with description cards, a pile of used description cards (the oval object on the left), a box with selection cards (on the right side of the desk), and ''Si'' and ''No'' boxes in which the selection cards were placed according to their match with the other person's last sentence. Each of the confederate's description cards showed a sentence, but each of the naive participant's description cards showed a picture (in this case, of a bullet hitting a bottle).

Procedure

The experiment took place in a quiet room containing two desks separated by a screen. The confederate pretended to be another naive participant, and both participants were informed that the experiment was an investigation of communication in bilinguals. The naive participant's desk contained his or her description set and selection set, plus two response boxes, labeled "Si" ("yes") and "No," respectively. The confederate's desk was similar, but her description set contained cards on which sentences were printed (see Fig. 1). Sessions lasted approximately 40 min.

The naive participant described pictures to the confederate, and the confederate pretended to describe pictures to the naive participant, but in fact read aloud scripted sentences. The confederate spoke Spanish, and the naive participant spoke English. After either participant finished speaking, the other took the topmost card from his or her selection box and determined whether it matched the description just heard or not. The card was placed in the "Si" or "No" box accordingly. The correct response for naive participants was "Si" for 50% of all the items, but "No" for all the experimental items. Before the experimental session, the participants produced three picture descriptions each in a brief practice session. The entire session was recorded on digital audio tape, using high-quality clip-on microphones. The naive participant's descriptions on experimental trials were orthographically transcribed.

Scoring

The descriptions were scored as "active," "passive," or "other." To qualify as an active, the utterance had to contain a subject noun phrase containing the referent designated as agent, a verb, and an object noun phrase containing the referent designated as patient. An utterance was scored as a passive if it contained a subject noun phrase containing the designated patient, a form of *to be*, a participle, and a *by*-phrase containing the designated agent. A further requirement for the score of either passive or active was that the alternative form was possible for that particular sentence. Ungrammatical sentences, except those with slight morphosyntactic deviations (e.g., failures in subject-verb agreement), were scored as "other," as were sentences with passive morphology but without the *by*-phrase or with any preposition other than *by* (e.g., *the ship is being hit*). Code switches were also scored as "other," unless they were restricted to a single noun.

[1]A list of experimental materials is available at the following Internet address: http://allserv.rug.ac.be/~rhartsui/materials.html.

RESULTS

There were 768 descriptions. Items that yielded "other" descriptions on 50% of the trials or more were discarded (6 of the 32 items). The main results reported here are based on the remaining 26 items, which yielded 624 descriptions: 282 active (45%), 221 passive (35%), and 121 "other" (19%). The most frequent type of "other" description had passive word order and morphology, but no *by*-phrase. This kind of construction occurred 77 times (12% of descriptions). "Other" descriptions occurred roughly equally often in the four conditions (active: 18%; passive: 21%; intransitive: 20%; OVS: 19%).

All analyses were conducted with the proportion of passives out of active and passive descriptions as the dependent variable (see Table 1). We subjected the proportions per participant and per item to repeated measures analyses of variance (F_1 and F_2, respectively) with prime as a four-level within-participants and within-items factor. These analyses yielded a significant main effect of prime, $F_1(3, 69) = 5.20$, $p < .01$, and $F_2(3, 75) = 3.64$, $p < .02$. Simple contrasts, comparing each condition with the intransitive condition, indicated that there were significantly more passives in the passive condition than the intransitive condition, $F_1(1, 23) = 9.94$, $p < .01$, and $F_2(1, 25)$

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TABLE 1

Proportion of Passives (out of Actives and Passives) and Standard Deviations (Based on Data per Participant) for Each Prime Condition

Condition	Proportion	Standard deviation
Active	.37	.30
Passive	.56	.35
Intransitive	.39	.34
OVS	.46	.35

Note. OVS = sentence with object-verb-subject word order.

= 6.61, $p < .02$, but that the active and OVS conditions did not differ from the intransitive condition, $F_1 < 1$ and $F_2 < 1$ for the active condition and $F_1(1, 23) = 3.27$, $p = .08$, and $F_2(1, 25) = 1.94$, $p = .18$, for the OVS condition.

We also performed simple contrasts comparing the active condition with each of the other three conditions. These showed that there were significantly more passives in the passive condition than in the active condition, $F_1(1, 23) = 10.57$, $p < .01$, and $F_2(1, 25) = 11.18$, $p < .01$, but that the difference between the active and OVS conditions was not significant, $F_1(1, 23) = 2.42$, $p = .13$, and $F_2(1, 25) = 1.75$, $p = .20$.

An additional analysis included all 32 items, but replaced missing cells and cells based on only a single observation with the grand mean (.45). One cell was replaced in the by-participants analysis, and 12 cells (9.4%) were replaced in the by-items analysis. There were no items for which all cells were replaced. This analysis did not change the pattern of results: The proportion of passives was .39 in the active condition, .56 in the passive condition, .41 in the intransitive condition, and .48 in the OVS condition. There was a significant main effect of prime, $F_1(3, 69) = 4.67$, $p < .01$, and $F_2(3, 93) = 4.03$, $p < .02$. The passive condition differed significantly from the intransitive condition, $F_1(1, 23) = 6.99$, $p < .02$, and $F_2(1, 31) = 6.69$, $p = .02$, but the active and OVS conditions did not, $F_1 < 1$ and $F_2 < 1$ for the active condition and $F_1(1, 23) = 3.70$, $p = .067$, and $F_2(1, 31) = 1.29$, $p = .27$, for the OVS condition. Finally, comparisons with the active condition showed that only the passive condition differed significantly from the active condition: $F_1(1, 23) = 9.60$, $p < .01$, and $F_2(1, 31) = 15.51$, $p < .001$, for the passive condition; $F_1(1, 23) = 3.12$, $p = .091$, and $F_2(1, 31) = 1.97$, $p = .17$, for the OVS condition. Thus, all these statistical tests yielded the same pattern as the main analysis.

DISCUSSION

This experiment showed cross-linguistic syntactic priming in dialogue. Specifically, Spanish-English bilinguals tended to produce English passive sentences more often following a Spanish passive sentence than following a Spanish intransitive or active sentence. Our results therefore demonstrate cross-linguistic syntactic priming between production and comprehension in the context of interactive language use, using two languages that are only moderately related.

One obvious issue raised by our results concerns the symmetry of priming. Priming in this study appeared to be asymmetric, with only the passive diverging from the intransitive. In contrast, some studies have demonstrated symmetric priming (Bock, 1986; Bock & Griffin, 2000; Pickering, Branigan, & McLean, 2002). However, the clearest symmetric effects (both forms differing from the baseline) have emerged in studies of dative verbs (e.g., *gave the book to the man* vs. *gave the man the book*). In such cases, both forms are clearly different from an intransitive. In contrast, an intransitive actually has active morphology (it is in the active voice), so it is possible that it serves as a prime of actives (vs. passives), in a manner consistent with our results.

The main implication of these results is that sentence form is shared between English and Spanish in the group of bilinguals we tested: moderately to highly proficient Spanish-English bilinguals living in a culture in which the second language is dominant. Thus, at least for these speakers, the advantage of parsimoniously storing a syntactic rule only once outweighs the disadvantage of having to consider alternatives in another language.

Our results contrast with those of Loebell and Bock (2003), in that they found no priming between English and German passives (in either direction). They did not find priming of actives versus passives within German either, so it is possible that some aspect of their experimental design or the German language prevented priming with passives. However, a more interesting explanation for the difference between these two studies is that Spanish and English passives have the same word order, with the participle preceding the *by*-phrase, whereas in German, the participle follows the *by*-phrase. Hence, it might be that the syntax of a particular construction is shared between languages only if it is formed in the same way in both languages. In fact, previous work indicates that word order is a very important factor in syntactic priming: Word order itself can be primed (Hartsuiker et al., 1999; Hartsuiker & Westenberg, 2000), and constructions that differ only in word order need not prime each other (Pickering et al., 2002).

It is straightforward to interpret these results in terms of current theories of language production. Such theories assume that the construction of the sentence frame is lexically driven, so that syntactic information associated with lexical representations guides the construction of the frame (see Vigliocco & Hartsuiker, 2002). Pickering and Branigan (1998) suggested that combinatorial information such as the types of arguments a verb takes are represented at the *lemma stratum*, which is a level of lexical representation that encodes syntactic information (Levelt, Roelofs, & Meyer, 1999). In Pickering and Branigan's model, lemma nodes are linked to *combinatorial nodes* (encoding combinatorial information), as well as other nodes (e.g., category nodes that specify grammatical category). For example, the verb *chase* can be used as part of an active or a passive utterance, and would therefore be associated with two nodes, one selected when an active is used, the other when a passive is used. Simplifying grossly, we call these the active and passive combinatorial nodes. When *chase* and the passive node are selected, the speaker produces a passive sentence containing the verb *chase*. Pickering and Branigan argued that combinatorial nodes are shared between lemmas, so that all verbs that can be used in the passive, for instance, are linked to the same passive node.

This proposal can be extended to bilingual lexical-syntactic representations, so that lemmas for English and Spanish verbs are connected to the same category node and to the same combinatorial nodes. Words are also tagged for their language (Spanish or English), by being linked to a "Spanish" or "English" language node (Dijkstra & Van Heuven, 2002; Van Heuven et al., 1998). Activation of the lemma plus one of the combinatorial nodes leads to the activation of the grammatical structure, unspecified for language. The language of

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the utterance is dependent on the choice of lexical items that are inserted into this structure. Such an integrated view of the bilingual lexicon is sketched in Figure 2, which shows the verbs *to hit* and *to chase*, and their Spanish translation equivalents *golpear* and *perseguir*, all connected to the same combinatorial nodes ("Active" and "Passive") (as well as to the same categorical node "Verb"). In this view, *hit* and *golpear* both link to one semantic node, whereas *chase* and *perseguir* both link to another semantic node (Kroll & Stewart, 1994; Van Hell & De Groot, 1998). This representation of the lemma stratum is neutral between production and comprehension (Branigan, Pickering, & Cleland, 2000; Levelt et al., 1999).

This account provides a straightforward way of explaining the close integration of languages that can occur during bilingual conversation. In code switching (e.g., Heredia & Altarriba, 2001; Macnamara, Krauthammer, & Bolgar, 1968), a word or phrase in one language is used instead of a word or phrase in another language, in a manner that is normally highly fluent. For example, one of our naive participants produced the sentence "A coin is being attracted by an *imán*" ("magnet"), which starts in English but ends in Spanish. In our account, both word meaning and word syntax are points of contact between languages. Thus, if a bilingual speaking English activates the English verb lemma *hit* via the conceptual node "HIT (X, Y)," the Spanish verb lemma *golpear* is also activated. Furthermore, *hit* and *golpear* are linked to the same category node, "Verb," and the same combinatorial nodes, so activation of *hit* (in the production of either an active or a passive) will lead to further activation of *golpear*. Hence, it is possible that the Spanish verb will be selected instead of the English one. Similar arguments hold for nouns that are translation equivalents (e.g., *magnet* and *imán*). Thus, our account naturally predicts the occurrence of code switching, and moreover does not require any apparatus beyond the grammar and lexical entries of the two languages to account for its existence (cf. MacSwan, 2000).

Our account can also explain the tendency for even proficient bilinguals to "borrow" constructions from their first language when using their second. For example, De Bot (1992) quoted an example in which, during simultaneous interpreting, the French argument structure of *voter* ("to vote"), which takes a noun phrase object, was used with the Dutch translation equivalent (*stemmen*), which takes a prepositional object. In our account, this happened because the conceptual node "VOTE (X, Y)" activated both *voter* and *stemmen*, and even though the speaker used *stemmen*, the combinatorial node associated with noun phrase objects was activated as a result of its link with *voter*. On this occasion, this node was selected rather than the "correct" combinatorial node associated with prepositional objects. Simultaneous interpreting may be a situation in which such borrowings are particularly likely, as the speaker is using both languages simultaneously. Indeed, as our experiment shows, recent use of a structure in one language will lead to repetition of that structure in another language.

Our demonstration of syntactic priming across languages provides support for a view of syntactic representation as integrated between languages, as well as between production and comprehension. Of course, we have considered only one type of construction, one pair of languages, and one type of bilingual. However, this study provides both a demonstration of priming and a methodology that can be expanded to investigate new constructions, new languages, and other types of bilinguals.

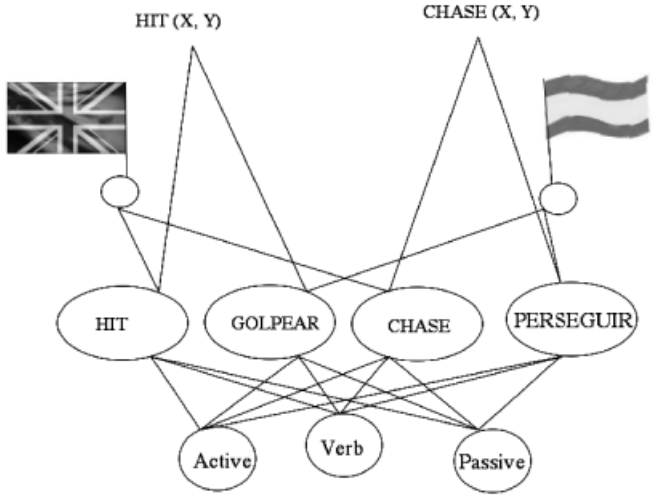

Fig. 2. Example of lexical entries for ''to chase'' and ''to hit'' in an integrated (shared lexicon, shared syntax) account of bilingual language representation. Each lemma node (e.g., HIT, GOLPEAR) is connected to a conceptual node (HIT (X, Y)), a category node (Verb), combinatorial nodes (Active and Passive), and a language node (indicated with a British or Spanish flag).

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