SEMANTIC AND CONCEPTUAL FACTORS IN SPANISH-ENGLISH BILINGUALS' PROCESSING OF LEXICAL CATEGORIES IN THEIR TWO LANGUAGES

Virginia C. Mueller Gathercole, Hans Stadthagen-González, Rocío Pérez-Tattam, Feryal Yavaş

Florida International University, University of Southern Mississippi-Gulf Coast, Swansea University

Address for correspondence:

Dr. V. C. Mueller Gathercole
Linguistics Program
English Department
Florida International University
Miami, FL 33199

email: vmueller@fiu.edu

Tel: 305-348-6390

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This study examines possible semantic interaction in fully fluent adult simultaneous and early L2 bilinguals. Monolingual and bilingual speakers of Spanish and English (N=144) were tested for their understanding of lexical categories that differed in their two languages. Simultaneous bilinguals came from homes in which Spanish or Spanish and English were spoken when they were children, and L2 bilinguals entered the US as children. Accuracy data show higher ultimate attainment of language-specific semantic knowledge in English than in Spanish, but in both languages the interaction of the semantic categories with conceptual knowledge is observable. The data reveal subtle differences in early bilinguals' extensions of words, but only in some types of categories, and modified by level of proficiency.
SEMANTIC AND CONCEPTUAL FACTORS IN SPANISH-ENGLISH BILINGUALS’ PROCESSING OF LEXICAL CATEGORIES IN THEIR TWO LANGUAGES

The question of convergence between a bilingual's languages has long been of interest, with the focus on a wide range of linguistic areas, including phonology, morphosyntax, and syntax. Recently, the interest in how bilinguals represent the semantics of their languages and how the semantic systems relate to conceptual understanding has intensified. We provide further evidence here on such issues from a population of fully-fluent adult simultaneous and early-L2 bilinguals. The data provide evidence on the ultimate attainment of language-specific semantic knowledge, the potential long-term convergence of the semantic systems, and the role of cognitive knowledge (i.e., knowledge of the world independent of language) in such convergence.

BACKGROUND

In this work, we use the term semantic to refer to the language-specific ways in which meaning is encoded in language. No two languages carve up the semantic space in identical fashion (Jarvis and Pavlenko, 2008; Malt, Gennari, Imai, Ameel, Saji, and Majid, in press), so how do bilingual speakers manage differences between their two languages? Non-isomorphic relations between words in the two languages are common and pervasive: A word in one language can have more than one translation equivalent in the other (Spanish dedo - English finger, toe), the categories can cross-cut each other (as in the case of Korean verbs of placement distinguishing acts according to the tight or loose fit of the objects, versus the English focus on containment versus support, Bowerman and Choi, 2001), or a category in one language may be absent in the other (English nut has no generic equivalent in Spanish) (Elston-Güttler and Williams, 2008; Prior, Kroll and MacWhinney, 2013; Prior, MacWhinney, and Kroll, 2007; Tokowicz, Kroll, De Groot, and Van Hell, 2002).

Corresponding to these differences in inter-language lexical correspondences, the internal semantics of words can vary dramatically, both across languages and within a language. On one end of the continuum some words can be relatively homogeneous/consistent in application, in that members in
the category share necessary and sufficient conditions of application -- e.g., square refers to any four-sided geometrical figure with right angles and equally long sides. Such words can be viewed as having "classical" semantic structure (Lakoff, 1987), with defining characteristics for membership.

Another possibility is that a word shows a prototype-type structure (Rosch, 1975) or radial structure (Lakoff, 1987), in which a central usage has become extended, conventionally, to uses linked via metaphor, analogy, metonymy, and the like (Lakoff & Johnson, 1980). For such words, the full range of application is not definable in terms of necessary and sufficient conditions. For example, sister may apply centrally to a female sibling, but it can also refer to a nun, by metaphorical extension (the relations between nuns are LIKE those of female siblings) or to a node of a syntactic tree, on the basis of analogy of structure (i.e., that node is on the same hierarchical level as another one, and lower than a common linking node, much like a sister and her sibling are). For classical categories, the shared elements of meaning indicate a similarity in the conceptualization of the category members, even despite superficial differences, whereas for radial categories, the disparity between members is bridged via a link based on metaphor or other process. Words with radial structure are often referred to as polysemous.

In fact, most words are much more complex than either of these alone suggests and often exemplify aspects of both -- sometimes classical-like structure at the core, with radial extensions beyond that. For example, wall in English refers centrally to a structure of a certain durability, expanse, and height that divides two spaces from each other. It doesn't matter whether that wall is located in a house, or around a garden or a city. In these central uses, wall can be thought of as having a classical-type meaning. Beyond this, wall can refer, by metaphorical extension, to a psychological barrier between two people. This and other uses of the word give it a radial character.

Differences in the applications of words, like non-isomorphisms between words, become highlighted in cross-language comparisons. Thus, while Spanish hermana is much like English sister in its range of usage (with a core meaning referring to a female sibling and extensions to nuns and syntactic nodes), Spanish pared is unlike wall. Pared can only refer to internal walls holding up a roof (it
contrasts with *muro*, which refers to an external wall, e.g., a garden wall), and it cannot be used metaphorically to denote a psychological barrier between people (while *muro* can be').

Such differences across languages in the internal semantics of words may affect word use in bilinguals in cases where their two languages differ. Research on word meaning in first language acquisition shows that children commonly make errors of overextension and underextension in development (Bowerman, 1982; Clark, 1993; Dromi, 2009), indicating that the boundaries for semantic categories must be learned. Persons acquiring two languages from a young age may face special challenges. When their languages differ in the range of application of comparable words, do they learn and respect those differences, or will their categories ultimately differ from those of their monolingual peers? Recent work on semantic knowledge in bilingual adults and children suggests indeed that their performance differs from that of monolinguals, wherein the semantics of the two systems "converge," or influence each other, in such diverse areas as classifications of containers (Ameel, Malt, Storms, and Van Assche, 2009; Ameel, Storms, Malt, and Sloman, 2005; Malt and Sloman, 2003), abstract and social words (Jiang, 2002, 2004), the expression of emotions and power (Pavlenko, 2003), causal expressions (Wolff and Ventura, 2009), verbs of placement (Alferink and Gullberg, 2014), and the expression of motion events (Brown & Gullberg, 2012; Filipovic, 2011; Miller, Furman, and Nicoladis, submitted).

There is some disagreement on whether such convergence leads to a system that is "between" the two languages or one in which both languages adapt to the system of one of them. Ameel et al. (2009) and Ameel, Storms, Malt & Sloman (2005), for example, found that simultaneous Dutch–French bilinguals showed semantic groupings of bottles and dishes that were distinct in both languages from what was observed for monolinguals. Alferink and Gullberg (2014), on the other hand, found in a study of Belgian speakers' use of verbs of placement of objects in French and Dutch that bilinguals followed the French pattern. Dutch makes an obligatory distinction between horizontal placement (*leggen* 'lay') and vertical placement (*zetten* 'sit'); French does not, using verbs like *poser* 'place' and *mettre* 'put' for both. In Dutch, the bilinguals did not make the obligatory Dutch distinctions, and, instead, used *leggen* for both
horizontal and vertical placement, following the broader French verb pattern. The bilinguals did not mark the distinction in Dutch in some other way in the sentence (e.g., in prepositional phrases) either, so the authors conclude that the bilinguals were "not attending to the orientation information at all" (p. 33). In research on bilinguals' descriptions of motion events (which hinge on the inclusion of manner and path information in sentences through the main verb or satellites of the verb (Talmy, 1985)), some researchers have found a merging of cross-linguistic patterns to something between the two languages (Hohenstein, Eisenberg, & Naigles, 2004), and others convergence towards the pattern of one of the languages (Filipovic, 2011). Still others have found little evidence of convergence (Miller, Furman, and Nicoladis, submitted; Nicoladis and Gynane, submitted).

The present study aims to examine semantic knowledge in bilinguals further, in particular in the language of fully-fluent adult Spanish-English bilinguals in Miami. We focus on two main questions: (1) to what extent can semantic convergence be observed in fully-fluent bilinguals, and is this modulated by early exposure or overall proficiency, and (2) what are the conditions for such convergence in terms of the semantic and conceptual content of the categories in question?

With regard to the first question, we examine fluent bilingual adults who grew up in homes in which the exposure to Spanish and English varied. We group them according to their early exposure to the two languages in the home. If early exposure and greater input in a language modulate the level of semantic convergence, we could predict distinct patterns of semantic convergence for bilinguals who grew up in homes in which only Spanish was spoken, who grew up in homes in which both Spanish and English were spoken, and who were early-L2 bilinguals (Spanish L1, English L2). Proficiency fosters increased performance in other realms (Kroll, Michael, Tokowicz, and Dafour, 2002; Kroll and Stewart, 1994) and in translating ambiguous words (Prior, Kroll and MacWhinney, 2013), so it is possible that increased proficiency will also correspond to less evidence of crosslinguistic effects in semantic processing (Pavlenko, 2009).
To examine the second question, we explore obligatory semantic distinctions in cases in which the bilinguals' two languages differ, and we chose word types that differed in internal semantic structure across the two languages. In some cases, a word in one of the languages has a "classical" structure [at least for the subcomponent of meaning examined here], and it corresponds to two (or more) obligatorily contrasting words in the other language (e.g., wall - pared/muro; Spanish reloj - English clock/watch). In other cases, words that in one language have a radial structure correspond to two separate words in the other (e.g., English horn - Spanish cuerno (animal 'horn')/trompeta (musical 'horn'); Spanish pico - English beak/pick-axe).

In the case of both classical and radial words, there is some conceptual link between the referents. In classical categories the members can be seen as close in the conceptual space, since they share some criterial components of meaning or features that link them; in radials, the referents are farther apart, but there is at least some link between them, although they are not the same "kind" of thing.

These two types of words are contrasted with homophones (often referred to as “ambiguous words”; see Sennet, 2011), which can be defined as two words that sound the same, but whose referents bear no conceptual relationship whatsoever -- e.g., bat in English for the baseball stick and for the flying animal, vela in Spanish for "candle" and for a boat "sail". The referents are so distant conceptually that they will never be considered to belong to the same "category".

By examining this range of types in the same speakers, we can obtain a clearer picture of the role of language vs cognition in bilinguals' converging systems. The conceptual similarity underlying the members of a category has been shown in some work to influence the degree of transfer between bilinguals' two languages. The more closely the referents in question are related conceptually, the more probable that any convergence in semantic categorization may be observed. For example, Elston-Göttler et al. (2008) examined learners' judgments of distinct L2 words that were translations of polysemous L1 words--e.g., English bag and pocket for German Tasche; English snake and queue for German Schlange.
showed more interlanguage interference in L2 speakers' use of the corresponding English words than polysemous L1 words whose uses were judged to be more distant (Schlange). Similarly, Gathercole and Moawad (2010), in an examination of early vs late L2 speakers of English in Saudi Arabia, argued that the type of category mattered in the level of interaction, with classical categories exemplifying a greater level of interaction than others. Radial words and homophones were less susceptible to interaction.

The focus here on semantic and conceptual transfer in bilinguals builds on a tradition of work in this field (see, e.g., Tokowicz's (2015) chapter 4 for a concise review). However, in some work, semantics and concepts have been more or less equated, either implicitly or explicitly (e.g., Costa, Colomé, and Caramazza, 2000; Francis, 1999, 2005; Santos & Caramazza, van Hell & de Groot, 1998), so that words are taken as indicators of concepts or of bundles of conceptual units. Some work has addressed the question of the relationship between words and meanings in a bilingual’s languages on the basis of this assumption. For example, van Hell & de Groot (1998) examined the degree of overlap in L2ers' word associations in their languages, in order to explore whether the two languages share a common representation storage -- the "language-independent" view, that there is a "common conceptual (i.e., semantic) representation" (van Hell & de Groot, 1998: 193, emphasis added) -- or are stored in two separate, language-specific stores -- the "language-dependent" position, under which "Each of the words in a translation pair has its own conceptual representation" (van Hell & de Groot, 1998: 193). Based on the assumption that overlap in conceptualization will be reflected in overlap in word associations, they compared within- and between-language word associations. These authors argued from their data that meaning is represented by patterns of activation across a network of units or features, and that the level of shared activation across a bilingual’s languages depends on word type, with nouns participating in greater shared conceptual stores than, e.g., abstract words and verbs. But it is not clear that overlap in the explicit word associations given by speakers to different words is a reliable means of judging the semantic content or conceptual store of those words, whether for monolinguals or bilinguals. Word associations clearly
provide evidence on lexical access and lexical organization (Fitzpatrick, Playfoot, Wray, and Wright, 2013), but the list of word associations elicited does not necessarily equate with a comprehensive or unambiguous representation of the meanings of individual words. Speakers provide word associations based on a number of factors that include not only meaning but also positional/collocational elements and form/phonological similarity, among others (Fitzpatrick et al., 2013). For example, an English speaker may respond "post" to "fence" on collocational grounds, or "hence" to "fence" on the basis of a phonological link (Fitzpatrick et al., 2013: 18), but a Spanish speaker is unlikely to similarly provide "poste" ('post') for "cerca" ('fence') because the collocational link is weak or "entonces" ('then'/"hence") to "cerca" ('fence') because there is no phonological link between those two. But they might provide "lejos" ('far away') in response to "cerca," on the basis of the fact that cerca 'fence' is homophonous in Spanish with cerca ('near'). Furthermore, as Fitzpatrick et al (2013) note, "participants are particularly quick to respond when the cue and the response are linked in more than one aspect (Fitzpatrick and Izura, 2011)" (p. 17), as in the case of "fork" in response to "knife" (both collocational and lexical set links). Thus, even those word-association responses that appear to provide information on semantic/conceptual organization can be influenced by non-semantic factors. It is then unlikely that the word associations provided for translational equivalents in any two languages are ever going to overlap completely, so this method will not reveal well whether the conceptual stores for the two languages are the same or not.  

The position that equates conceptual underpinnings and semantic meaning has been challenged as problematic (e.g., Jarvis and Pavlenko, 2008; Paradis, 1997; Pavlenko, 1999, 2009; Prior, Kroll and MacWhinney, 2013). Malt et al. (in press) recently provide an eloquent exposition of reasons why the two should be considered separate: First, words in any language are highly selective with regard to which conceptual elements they encode, encoding only a fraction of the richness of experience. Second, speakers have conceptual understanding of the domain in question that goes beyond what is encoded in single words. Malt et al. (2014, in press) asked speakers of four different languages to describe videos depicting diverse bipedal human locomotion. The conventional words available in each language under-
specified the locomotion in varying ways, so there was considerable diversity in the surface forms produced, both crosslinguistically and within languages. But speakers made many more distinctions in describing events than those reflected in the conventional names in their respective languages. The authors thus distinguished between what is encoded linguistically by the language and a possible set of shared conceptual dimensions that provide the basis on which the distinct language-specific linguistic encoding is based. Across the languages, two dimensions were relevant in their study: impact-and-recoil motion, and pendulum motion. Languages package categories in language-specific ways for economy and as the outcome of historical accident: In some languages, members that are perceptually or conceptually different are treated as "the same": dog for boxers, spaniels, etc.; uncle for a male sibling of the father OR the mother; techo in Spanish for a house covering, whether one sees it from above/outside ("roof") or from below/inside ("ceiling"). The semantics of the language in each case is "under-specified" or "vague" with regard to the conceptual distinction (Sennet, 2011).4 In another language, in contrast, the perceptual or conceptual distinction might be explicitly specified--e.g., Hindi chacha (a paternal uncle) contrasts with mama (a maternal uncle); English roof contrasts with ceiling.5

Furthermore, research on impairments shows that perceptual associations can go well beyond semantic/naming associations. Leek (2005) notes that, while some work shows that word naming impairments can selectively affect living vs non-living things, several researchers have observed that impairments in naming living things sometimes show concomitant impairments in naming musical instruments. He says, "impairments with musical instruments might be more likely to co-occur with deficits for living than non-living things, because musical instruments, like objects from animate categories, arguably tend to be distinguished from one another largely on the basis of sensory attributes, such as by their visual appearance and the sound that they make" (p. 184). Such work provides support for a distinction between conceptual representations and semantic representations. This distinction is followed in this work.

THE STUDY
The key issues addressed here are the following. As noted above, the two main questions are:

1. To what extent is semantic convergence observed in highly fluent simultaneous and early-L2 bilinguals? Relatedly, to what extent does relative exposure to the two languages matter in performance?

2. What are the relative roles of language and cognition in influencing interaction? In this regard, is interaction more evident with some types of categories than with others, and to what extent can we predict semantic convergence on the basis of the type of category involved?

And subsidiary to these main questions, we ask:

3. Where there is convergence, is it the case that the wider language always "wins out," as suggested by Alferink and Gullberg (2014)? Perhaps this depends on the type of category examined. Previous research has often focused on one or two words in a single semantic field, so it is hard to judge the generality of such effects across a range of semantic/lexical items.

We were also interested in finding out if we can draw the same conclusions regarding convergence whether we examine behavioral evidence (picture choices) or reaction times. It is possible that bilinguals could perform behaviorally like monolinguals, but they might show differences in responses in terms of reaction times, especially in relation to referents that are unique to only one of their two languages. RTs might provide some insight on the level of confidence or hesitancy in choices of the non-overlapping aspects of the two languages.

The present study uses a format similar to that used in Gathercole and Moawad (2010). As noted above, that study examined some of these issues with early and late L2 bilinguals who spoke Arabic and English in Saudi Arabia. But that study included only L2 bilinguals, so it is not informative on the extent of these effects in fully-fluent simultaneous bilinguals. In addition, it did not have direct measures of speakers' knowledge of English, their L2, so it was impossible to know the extent to which level of proficiency might have played a role in performance. Finally, that study only measured behavioral performance of participants, their choices of referents for words they heard. It did not make use of RT measures, so it could not examine evidence on, e.g., whether bilinguals were more certain about their
responses for referents that were common to their two languages than for the referents that were non-overlapping.

METHOD

PARTICIPANTS

We tested 108 English-Spanish bilinguals, plus 18 monolingual English (MonE) and 18 monolingual Spanish (MonS) speakers. Table 1 shows their distribution and demographic characteristics. The bilinguals participated in several additional tasks (reported elsewhere, e.g., Stadthagen-González, Gathercole, Pérez-Tattam, and Yavas, 2013; Pérez-Tattam, Gathercole, Yavas, and Stadthagen-González, 2013). All participants had at least some tertiary education. The monolinguals had very little or no knowledge of the other language.

TABLE 1 HERE

Bilingual participants were divided into "home language" groups according to their self-report of language input from their parents up to the age of 6. (From that age, home input in the South Florida context begins to change dramatically as children begin to bring more English into the home, Stadthagen-González et al., 2013; Bridges and Hoff, 2014). Each home language group consisted of 36 participants, half of whom took part in the English Semantic Categorization Task and half the Spanish Semantic Categorization Task. The home language groups were as follows:

• English and Spanish at home (ESH). Participants born in the U.S. with balanced input in English and Spanish from parents in early childhood (40% to 60%, each language).
• Only Spanish at home (OSH). Participants born in the U.S. who heard mostly Spanish (80% or more) input from their parents in early childhood.
• Early L1 Spanish–L2 English (L1S-L2E). Participants born in a Spanish-speaking country but who migrated to the U.S. between the ages of 2 and 12 years (mean age at time of migration = 5;10). At the time of testing, participants in this group had lived in the U.S. an average of 25:10 years (8 to 61 years).

All individuals gave informed consent for participation, were paid for their participation, and were
asked to complete a background questionnaire regarding language exposure and usage over their life spans.

**STIMULI**

Each participant completed the Semantic Categorization task in one language only. Bilingual participants were also administered vocabulary tests for both English and Spanish (PPVT-4, Dunn and Dunn, 2007, and TVIP-H, Dunn, Padilla, and Dunn, 1986). Stadthagen-González, et al. (2013) report on the vocabulary performance of these participants. That study revealed that all groups performed at or above the norms for each language, indicating a high level of proficiency in both languages. Further, performance on receptive vocabulary in English was in general equivalent across the home language groups, indicating native-like proficiency in English for all of them. Performance on Spanish vocabulary, in contrast, showed some differences across groups, with the ESH and OSH participants differing from the MonS and L1S-L2E groups. (See Stadthagen-González, et al. (2013) for details on group performance.)

Words chosen for the Semantic Categorization Task differed in range of application in the two languages. Participants had to decide which of several pictures could be labeled by a given term. The choices included referents that were appropriate for one or both languages, plus entities that were related in systematic ways with the appropriate referents.

**Linguistic Stimuli**

Half of the words had “wider” application in English, half in Spanish; these words corresponded to two separate lexical items in the other language. For example, Spanish *reloj* includes both English *clock* and *watch*; English *bell* encompasses both Spanish *campana* "(church) bell" and *cascabel* "(jingle) bell". For each word, we focused on just two aspects of usage that were pictureable and that differed across the two languages.

Words fell into four category types, defined according to their usage in the ‘wider’ language and the internal characteristics of the category in that language, using the *zeugma* test for ambiguity (Sennet,
2011: 17) as follows.

'Classical' cases: In the wider language, the word is under-specified in relation to the difference between the two referents; the word can be defined in terms of necessary and sufficient conditions (Spanish dedo = small appendage, one of five, emanating from a human limb (i.e., fingers and toes); English brush = a small instrument with bristles).

'Radial' cases: A 'central' use of a word is linked conventionally via 'motivated' extensions to related uses. E.g., English leg refers centrally to a human limb used for standing and walking, but is also used for pieces (usually long and thin, but not necessarily) for tables and chairs to stand on; Spanish pintura refers centrally to paint, but is conventionally used for the product of paint, i.e., paintings, as well.

We divided radial categories into two types: radials with taxonomic links – links that are based on similarity of shape, function, or metaphorical status (e.g. leg for both human and table legs), and radials with thematic links -- words in which uses are linked on the basis of the association of items in real-world schemas in which those items are used or produced (e.g. pintura, extended from paint to the product of the paint).

Both classical and radial categories consist of a SINGLE category with a single label (and, therefore, single form). They differ in terms of the relation between the members of the category to which they refer. The fourth group of words, homophones, acted as a control; homophones consist of a single form that applies to two conceptually distant categories:

Homophones: Two (DISTINCT) words that happen to have the same form (i.e., sound alike) in one of the languages but refer to clearly distinct categories; in the other language the two distinct concepts correspond to unrelated words-- e.g., English bat (stick used for hitting baseballs, a flying nocturnal animal) - Spanish bate and murciélago; Spanish vela - English sail and candle. Classical, radial, and homophonic types might be thought of as lying on a continuum, when viewed in terms of their application to two or more distinct referents. In each case, there is a single surface form. But across the three types, there is increasing conceptual distance between the two referents – classical:
conceptually close; radial: more distant, but linkable; homophones: conceptually so distant that they are not linkable (Gathercole & Moawad, 2010).

We tested 12 word sets in which English was wider and 12 in which Spanish was wider. The words and categories are those shown in the left-hand columns in Table 2. The words used as stimuli are shown in bold.

TABLE 2 HERE

Nonlinguistic Stimuli

Each stimulus set consisted of six pictures on a slide: two 'target' stimuli, two taxonomically-linked distractor items, and two thematically-linked distractor items. The two 'target' stimuli were items that could be named by the (single) word in the wider language (tree) and by the two words in the narrower language (e.g., árbol, a deciduous tree, and palmera, a palm tree). The two taxonomically-linked distractors corresponded to superordinate categories containing each of the target item (a flower in a pot; a desert plant). The two thematically-linked distractors had associative links with the target items (a leaf, a coconut). Each set consisted of either only clipart pictures or only photographs. Pictures were distributed in two rows with three items each, and were marked by large capital letters (from A to F) underneath.

The pictures shown for each item set are indicated in the right-hand columns of Table 2. Figure 1 shows sample stimulus picture sets for leg – pierna/pata and pintura – paint/picture.

FIGURE 1 HERE

PROCEDURE

Each participant was tested individually. The Semantics Categorization Task was always administered before the vocabulary tests. Order of language presentation for the vocabulary tests alternated between participants with the two languages separated by other experimental tasks unrelated to the present task, and lasting approximately half an hour.

A given participant heard only the English or the Spanish stimuli. The word used was always the term for the first target ("T1." Table 2) whether the wider or narrower language was being tested (e.g., leg
and *pierna* for the leg-pierna/pata stimulus; *brush* and *cepillo* for the brush-cepillo/brocha stimulus).

Verbal stimuli were digitally recorded by female native speakers and were presented over headphones. We used DMDX 3.0 (Forster and Forster, 2003) to administer the timing of stimuli presentation and the digital recording of spoken responses, captured with a Sennheiser mb40 headset.

Participants were first told that they would be seeing a series of slides with 6 pictures each. They would hear a word three times, and they should find any pictures that could be named by that word and give the letter under that picture. When they could not find any more pictures that corresponded to the word, they should say “No more”/“No más”. They were told to respond as quickly as they could.

Each trial started with an asterisk at the center of the screen for 1000 ms, after which the visual stimulus was presented for 4000 ms so that participants became familiar with the pictures. The visual stimulus was then replaced by a blank screen and participants heard the target word twice, with an intervening pause of 2000 ms; the asterisk reappeared for 2000 ms. At the onset of a third presentation of the target word, the visual stimulus was displayed for 10 seconds. Afterwards the visual stimulus disappeared and the word “next”/“siguiente” was displayed and participants pressed the space bar for the next trial. There were 9 practice trials, involving categories that did not differ in English and Spanish and in which correct target choices in both languages ranged from 0 to 4. Additionally there were 10 filler items interspersed throughout the experiment equally divided into 0, 1, 2, 3, & 4 targets in both languages.

Across participants, the items were presented in 4 randomized orders, and each target item was placed in two different positions on slides, for a total of 8 variants of presentation which were counterbalanced across participants in each condition (language group X task language.)

**RESULTS**

Participants' responses were analyzed primarily in relation to the accuracy of choices of target items, and separately for English and Spanish. Preliminary analyses examining distractor choices revealed very few overextensions in both languages (out of a possible 6 per cell per type, means of 0.89 in
English and 0.825 in Spanish), so those are not reported here. Additionally, an ancillary analysis examined performance regarding accuracy of target choices relative to participants' receptive vocabulary in the two languages. Finally, we analyzed the reaction time data, but our analyses yielded few significant results, so these are reported in a condensed form below.

**ACCURACY OF TARGET CHOICES**

The first analyses examined participants' choices of the target items. A choice of both T1 and T2 for wide categories and of only T1 with narrow categories were scored as correct (ignoring choices of distractor items).

*English*

Analysis of Variance examined performance with category type (classical, homophonic, radial-taxonomic, radial-thematic), width (English wider than Spanish (E>S), Spanish wider than English (S>E)), and home language (MonE, OEH, ESH, OSH) as independent variables, and responses consistent with expected choices as the dependent variable.

The analysis revealed significant main effects of width, $F(1,68) = 6.74, p = .012$, category type, $F(3, 204) = 7.403, p < .001$, and home language, $F(3, 68) = 2.97, p = .039$. Generally, items in which English was wider were easier than those in which English was narrower, with means of 2.66 and 2.52 (out of 3), respectively, but this depended on category type (see below). The effect of category type revealed that performance was lower on the radial-thematic categories (2.42) than on classical (2.60), homophonic (2.70), and radial-taxonomic (2.63) types, $p = .013, .001, .012$, respectively [with Bonferroni correction]. The main effect of home language revealed that in general, ESH and OSH participants tended to have lower scores than MonE participants, $p = .068; p = .093$, respectively (MonE 2.80, ESH 2.49, OSH 2.51, L1S-L2E 2.56).

These main effects were modified by significant interactions of Width X Category Type, $F(3, 204) = 9.78, p < .001$, and of Width X Home Language, $F(3, 68) = 3.04, p = .035$. Performance by Category Type, Width, and Home Language is shown in Figure 2. Follow-up analyses examining each
category type revealed that on classical categories, E>S items (2.69) were easier than S>E items (2.51), \( F(1, 68) = 3.78, p = .056 \); on homophonic categories, S>E items (2.79) were easier than E>S items (2.61), \( F(1, 68) = 5.67, p = .020 \); for radial-taxonomic items, width was non-significant; and for radial-thematic items, E>S items (2.67) were easier than S>E items (2.17), \( F(1, 68) = 19.78, p < .001 \). Thus, classical and radial-thematic items were generally easier when English was wider, and homophonic items were easier when English was narrower.

Follow-up analyses examining performance by each home language group revealed that for MonE and L1S-L2E speakers, width was non-significant (MonE: 2.79 vs 2.81, L1S-L2E: 2.54, 2.57); for ESH participants, width was significant, \( F(1, 17) = 7.18, p = .016 \), with E>S items (2.65) easier than for S>E items (2.33), \( F(1, 17) = 7.18, p = .016 \). Similarly, for OSH participants, width was significant, \( F(1, 17) = 6.21, p = .023 \), again with E>S items (2.64) generally easier than S>E items (2.38). These findings indicate that the result showing that the classical and radial-thematic items were easier when English was wider can be attributed to the ESH and OSH participants. Separate t-tests comparing performance by width at each home language for each category type support this: MonE and L1S-L2E participants performed similarly across widths (except that MonE tended to be better on S>E homophonic items than E>S homophonic items, \( t(17) = 2.05, p = .056 \)). In contrast, OSH participants performed significantly better on E>S than S>E classical and radial-thematic items: \( t(17) = 2.36, p = .030 \), and \( t(17) = 2.37, p = .030 \), respectively; ESH participants performed significantly better on E>S than S>E radial-thematic items, \( t(17) = 3.01, p = .008 \), and near-significantly better on E>S classical and radial-taxonomic items, \( t(17) = 1.84, p = .083 \), and \( t(17) = 1.94, p = .069 \), and on S>E homophonic items, \( t(17) = 1.84, p = .083 \).

**FIGURE 2 HERE**

*Spanish*

Analysis of Variance again examined performance with category type (classical, homophonic, radial-taxonomic, radial-thematic), width (E>S, S>E), and home language (OEH, ESH, OSH, MonS) as independent variables, and responses consistent with expected choices as the dependent variable.
The analysis revealed significant main effects of category type, $F(3, 204) = 8.98, p < .001$, and of home language, $F(3, 68) = 9.16, p < .001$. For category type, performance on radial-thematic categories was lower (1.74) than all others, $p = .007, .000, .037$ (classical (2.02), homophonic (2.16), and radial-taxonomic (1.99)), respectively. For home language, both ESH and OSH participants performed lower than MonS participants, $p < .001, p = .039$, respectively, and ESH also performed below L1S-L2E participants, $p = .001$ (ESH 1.60, OSH 1.85, L1S-L2E 2.20, MonS 2.26).

These main effects were modified by interactions of Width X Category Type, $F(3, 204) = 86.56, p < .001$, and of Category Type X Home Language, $F(9, 204) = 3.62, p < .001$. Performance by width, category type, and home language is shown in Figure 3. To explore these interactions, each category type was examined separately.

FIGURE 3 HERE

For classical categories, both width, $F(1, 68) = 63.42, p < .001$, and home language, $F(3, 68) = 2.97, p = .038$, were significant. In general, Spanish wider, S>E, items (2.57) were easier than E>S (1.47), and MonS tended to outperform OSH participants, $p = .051$ (ESH 1.94, OSH 1.72, L1S-L2E 2.17, MonS 2.25). Follow-up analyses for E>S and S>E items separately revealed no difference in performance by home language on the E>S classical items, but significant difference on the S>E items, $F(3,68) = 2.81, p = .046$. On those, the MonS participants tended to outperform the OSH participants, but this was marginally significant, $p = .079$.

For homophonic categories, both width, $F(1, 68) = 86.42, p < .001$, and home language, $F(3, 68) = 5.09, p = .003$, were significant, as was Width X Home Language, $F(3, 68) = 3.06, p = .034$. In general, Spanish narrower, E>S, items were easier than S>E items, 2.76 v 1.56, and ESH participants performed below both L1S-L2E and MonS participants, $p = .004, p = .032$, respectively (ESH 1.78, OSH 2.06, L1S-L2E 2.47, MonS 2.33). The interaction revealed that while the differences between groups on the E>S homophones was non-significant, there were significant differences on the S>E homophones, $F$
(3, 68) = 4.73, \( p = .005 \), with ESH participants scoring lower than every other group, \( p = .046, .000, .021 \), when comparing ESH with OSH, L1-L2, and MonS, respectively.

For radial-taxonomic items, again width, \( F(1, 68) = 25.86, p < .001 \), and home language, \( F(3, 68) = 12.20, p < .001 \), were significant. Spanish narrower, E>S, items (2.31) were easier than S>E items (1.68), and both ESH and OSH participants performed below MonS participants, both \( p's < .001 \), and ESH also performed below L1S-L2E participants, \( p = .008 \). (ESH 1.47, OSH 1.75 L1S-L2E 2.14, MonS 2.61). Follow-up analyses for the E>S and S>E items separately confirmed home language differences for both widths, \( F(3, 68) = 7.3, p < .001 \), and \( F(3,68) = 6.95, p < .001 \), with MonS outperforming both OSH and ESH participants at both widths, \( p's < .013 \), and L1S-L2E tending to outperform ESH as well on the E>S items, \( p = .052 \).

Finally, for radial-thematic items, both width, \( F(1, 68) = 8.85, p = .004 \), and home language, \( F(3, 68) = 5.35, p = .002 \), were significant. Spanish wider, S>E, items (1.97) were easier than E>S items (1.51), and ESH participants performed below all the others, \( p = .019, .003, .040 \), in comparison with OSH, L1S-L2E, and MonS, respectively (ESH 1.22, OSH 1.89, L1S-L2E 2.03, MonS 1.83). Follow-up analyses indicated that this latter result was largely confined to the S>E items, \( F(3,68) = 6.82, p < .001 \).

**Summary of Results, Accuracy**

To summarize: first, in both languages, homophonic forms that were narrower (e.g., pecho, sail) were easier than those that were wider (chest, vela) -- i.e., for homophones, it was easier to pick one item when that was correct than to pick two items when both were correct choices. In contrast, in both languages, classical forms and radial-thematic forms were easier when they were the wider forms (e.g., bell, letters, escalera, cuello) -- i.e., when two referents were relevant instead of when only one referent was relevant. The radial-taxonomic forms appeared to be more like homophonic forms in this regard -- they were either equally difficult regardless of width (English) or easier if the form had narrow reference rather than wide reference. These results alone suggest that radials with thematic links may lie closer on the semantics-cognition continuum to classicals, and radials with taxonomic links may lie closer to
homophones. This suggests that the referents of radials with taxonomic links may be seen as conceptually more distinct than the referents of radials with thematic links.

There were home language differences in the performance in each language. In English, participants from the various home language backgrounds tended to perform in similar fashion, except for a few ways in which OSH and ESH responses differed from primarily MonE responses. First, ESH and OSH participants performed at a lower level on S>E classical and radial-thematic items than on E > S classical and radial-thematic items. This finding is consistent with the finding that the wider categories are "easier" in these cases, but suggests perhaps some influence of the wider Spanish categories in the case of S>E classicals and radial-thematic forms for these two home language groups.

In Spanish, the ESH and OSH participants both performed at a lower level than MonS participants and ESH below L1S-L2E participants in several contexts. ESH had lower scores than MonS participants both on E>S radial-taxonomic categories and on S>E homophonic, radial-taxonomic, and radial-thematic items (for the S>E homophonic and radial-thematic items, their performance was in fact inferior to all the other groups). OSH performed below MonS participants on both E>S and S>E radial-taxonomic items. E>S items in Spanish require a "narrower" response than the corresponding items in English, so the difficulty of OEH and OSH participants on E>S radial-taxonomic items suggests perhaps some influence from English wider categories there. The S>E items in Spanish require a "wider" response than the corresponding items in English. The fact that the OEH participants had difficulty in Spanish with all the S>E items except the classical items is of note, and will be discussed below.

These results indicate the following:

1. The home language groups generally have greater parity in performance on the semantics of English, while performance on the semantics of Spanish differs more consistently according to home language group. This result is parallel to previous research showing that in a bilingual context like that of Miami, differences across home language groups become indistinguishable in the majority
language, whereas differences across groups persist in performance on the minority language (Gathercole and Thomas, 2009).

2. For both languages, it is the ESH and OSH participants whose responses differed from monolinguals'. In English, the variation was more restricted, on S>E classical and radial-thematic forms for OSH, and on S>E radial-thematic for ESH. In Spanish, differences were more widespread, and particularly affected S>E forms, especially homophonic, radial-taxonomic, and radial-thematic items, but also radial-taxonomic E>S items. Both ESH and OSH participants differed in performance from monolingual Spanish speakers on the radial-taxonomic items, and ESH differed from all groups on the S>E homonyms and radial-thematic items.

3. Degree of difficulty in relation to width differed by category type. For both languages, narrower homophonic forms were easier than wider ones, and classical and radial-thematic categories that were wider were easier than those that were narrower. For Spanish, radial-taxonomic categories that were narrower were easier. This suggests that the category types pattern into two sets -- classical and radial-thematic, for which the wider categories elicited better responses, on the one hand, and homophonic and radial-taxonomic items, for which the narrower categories were easier, on the other. The narrow categories required a single choice of target, the wider categories required choices of two targets. This difference in response patterns by width for these two sets appears to correspond to the semantic-cognitive linkages for the distinct types of categories, with the referents in the cognitive space more distant with homophonic and radial-taxonomic categories and closer in the cognitive space with classical and radial-thematic categories. This effect is rather surprising for the radial-thematic forms, and this will be explored in the final discussion section.

One final set of analyses examined the performance on the target items: correlational measures of this performance in relation to individuals' vocabulary scores. As noted, all bilinguals were administered the PPVT and TVIP to assess receptive vocabulary in both languages. For the correlations, raw vocabulary scores were compared with a composite score for the Semantic Categorization Task (a "Total
Semantic Score`). There was a significant positive correlation of the total semantic scores in each language with vocabulary scores for the corresponding language, English ($r = .317, p = .020$) and Spanish ($r = .426, p = .001$). This indicates that semantic knowledge among the bilingual participants was highly related to level of vocabulary knowledge in that language. This conclusion supports the findings related to origin home language, suggesting that greater overall knowledge of the language coincides with better overall semantic performance.

REACTION TIMES

A final set of analyses examined the reaction times in participants' choices. It had been hypothesized that differences in the performance of monolinguals and bilinguals might be reflected in RTs even if the participants did not differ in accuracy. RTs were calculated from the onset of the third iteration of the stimulus word and the simultaneous appearance of the picture array. For each language, we performed an array of analyses of covariance (ANCOVA) on those reaction times exploring the effect of category width, choice order, word category (classical, homophonic, radial-taxonomic, radial-thematic), and home language. Contrary to our expectations, most analyses did not yield any significant effects. This was particularly true for English. For Spanish, the most robust finding had to do with a significant difference in the RTs between MonS participants and ESH and OSH participants in relation to their initial choices. In the Spanish wider conditions, these groups differed significantly, $F (3, 67) = 4.12, p = .010$. MonS participants were faster (2377 ms.) overall than both the ESH (3054 ms.) and the OSH (3075 ms.) participants, pairwise comparisons $p = .023$ and $p = .018$, respectively (cf. L1S-L2E: 2833 ms.). This result suggests differences in the initial access to the words in question in the MonS group versus the ESH and OSH groups.

It is in general difficult to draw conclusions from the RT data, however, because, in retrospect, we believe that the windows of time for RTs were much too great to enable us to draw confident conclusions about potential differences in processing between the different groups. Further research is needed in
which the windows of time for responding would be more limited, forcing respondents to reply quickly, instead of allowing them to possibly mull over their responses before reacting.

DISCUSSION

What do these results indicate in relation to the broad questions regarding possible semantic convergence across the bilinguals' two languages? In order to answer this, we need to consider the following:

Accuracy:

1. There were clear differences in accuracy performance between the monolinguals and the ESH and OSH speakers in both languages.
   a. For English, with narrower classical and narrower radial-thematic categories, MonE speakers outperformed ESH and OSH participants.
   b. For Spanish, with wider radial-taxonomic, radial-thematic, and homophonic categories, and with narrower radial-taxonomic categories, MonS speakers outperformed ESH and OSH participants, and, in places L1S-L2E speakers outperformed ESH participants.

   These findings, taken alone, could indicate either some type of semantic convergence in the bilinguals, leading to poorer performance in each of their languages, or some effect of exposure to the languages, with those having less exposure at early ages performing differently from monolinguals in either language (and from L1S-L2E speakers in Spanish).

2. Accuracy in each language is correlated with general (vocabulary) knowledge of the given language.

3. Relative accuracy of performance by width for each word type is dependent on which word type is in question:
   a. For classical and radial-thematic categories, performance in both languages is better with wider categories than with narrower categories.
   b. For homophonic categories, performance in both languages is better with narrower categories than with wider categories.
c. For radial-taxonomic categories, the evidence is mixed: for Spanish, performance is better with narrower categories than with wider categories; for English, performance in the two widths is comparable.

The patterns of response in the two languages do not appear to be "inverses" of each other, with bilinguals treating, e.g., dedo as if it MEANS "finger," or finger as if it MEANS "dedo"; otherwise we could expect that what appears as good performance in one language (e.g., good performance on wider categories in the case of classicals in language A) to lead to poor performance on the corresponding item in the other (leading to poor performance on the narrower categories in the case of classicals in language B).

These findings together are suggestive of an explanation for performance that rejects a simple semantic convergence between the two linguistic systems of the bilinguals, if "semantic convergence" means that comparable expressions come to be taken as more similar in meaning than they are for monolinguals speaking those two languages. Instead, they argue for a view in which level of exposure, language-specific categorization, and the conceptual underpinnings interact. Instead of simple semantic convergence, these data suggest that the cognitive underpinnings of categories can either boost or inhibit broadened or narrowed categories, as follows.

In those categories linking items that are close in the conceptual space [as in classical categories], it appears that wider categories are established relatively easily. Our inference is that this is because of the conceptual plausibility of those referents being associated with one another. Furthermore, in such cases, when items are subsumed under a broad category in one language, it is relatively harder to distinguish two narrower categories in the other language.

At the same time, linkages are relatively harder for items that are far apart in the conceptual space [as in the case of homophones]. Our inference is that this is because there is no conceptual plausibility for those two being brought together. Such broader linkages must be learned one by one.
For radial-taxonomic categories, which are between these two extremes, there may be loose conceptual plausibility for the linkage between items, but they are conceptually distinct enough that the linkages have to be learned, as they are for homophones.

For items that are near together in the conceptual space because they coincide in a mental or contextual schema, a different type of processing may be involved in the search for category membership under a linguistic label. While the other types may involve the application or presence of some sort of similarity metric [or understanding that such a metric does not apply, in the case of homophones], radial-thematics may involve some sort of searching of the mental schematic scene in which the two items are associated with each other.

The results reported here appear to reflect two major components in bilinguals' acquisition: First, learning the meanings of words entails learning language-specific uses of words from the input, with better performance growing as exposure, and, hence, proficiency in the language, increases. Second, this combines with the relative conceptual plausibility of the mapping of this particular lexical term onto the two given referents in the conceptual space. When the two referents are close in the conceptual space, the semantic stance that treats them as "the same" category is easy -- i.e., the conceptual space fosters or supports the uniting of those items into a "single" unit. When the two items are more distant in the conceptual space, the imposition of the "same" label is more of a conceptual stretch.

These together lead to (1) better adoption of the broad categories in the case of classical categories (in both of the bilinguals' languages) than the separation of a broad classical category into two competing categories; (2) relatively easier adoption of a "narrow" category when the items are farther apart in the conceptual space, as for homophones, at the extreme, or for radial-taxonomic categories, at the less extreme. In such cases, broader categories need to be established on a case-by-case basis. (3) Radial categories that have thematic links may rely on a search or reference to the schematic frame in which the items occur in order to be processed.
What do these results reveal about potential semantic convergence in fully fluent adult bilinguals?

It is clear that both semantic factors (i.e., language-specific structuring of meaning) and conceptual factors (i.e., the proximity of referents in conceptual space) matter. Neither one in isolation can explain the findings here. Semantics alone would predict parity across word category types. This is not what is observed here. Instead, classical and radial-thematic categories act in one way (favoring wider categories), and homophones and radial-taxonomics act in another (favoring narrower categories). Conceptual underpinnings alone cannot explain these results either. If the conceptual understanding of the relationships between referents were the only thing that determined usage of the words here, we would expect similarity in the treatment of the corresponding words in the two languages. That is, one could expect either the broadening of the range of application in one language to fit that of the other, or the narrowing of the range of application to achieve that. We find neither of these -- as noted, the response patterns are not inverses of each other in the two languages.

These data, then, do not provide any support for a simple account of semantic convergence between a bilingual's two languages, but, instead, an interaction of semantics and conceptual processing in the ultimate use of such words. At one extreme, one of the languages is suggesting the pulling together of conceptually similar referents, and the conceptual basis of that linkage supports that union. At the other extreme, one of the languages is suggesting the pulling together of conceptually disparate referents, but the conceptual basis of such a linkage is so foreign to humans' understanding of those items that it is not as natural to group them together.

A second implication of these data has to do with differences across groups. The question arises as to whether crosslinguistic influence and the interaction of semantics with the conceptual base is more likely to occur in bilinguals with less proficiency in the language or according to timing of acquisition, with early bilinguals showing more interaction than later bilinguals. These data seem to favor the latter. For Spanish, it is impossible to tease apart these two elements: the bilinguals showing less proficiency, as judged by vocabulary scores, are the early bilinguals (ESH and OSH); the L1S-L2E bilinguals showed
greater proficiency in Spanish but they began English in later childhood. For English, all groups show similar proficiency, as judged by vocabulary scores, but we can differentiate timing of acquisition: the ESH and OSH bilinguals were early bilinguals, the L1S-L2E later. Even though all groups performed at an extremely high level in English on the semantic categorization task, the groups showing the most divergence from the monolinguals were the ESH and OSH participants, particularly in relation to the narrower classical and radial-thematic categories. This suggests that these early simultaneous bilinguals were influenced from an early age by the competing packaging of semantic content in their two languages in precisely those realms in which the conceptual underpinnings served to promote linking referents into a single semantic unit. The data here are suggestive in this regard, and these issues should be investigated more closely in children acquiring the two languages simultaneously vs sequentially.

There are some clear limitations of this study that we recognize. First, the windows of time for RTs were much too great here to enable us to draw confident conclusions about potential differences in processing between the different groups. In future research, it would be beneficial to modify the RT time frames and also to examine the processing of categories like those examined here through more direct measures. We are currently examining processing through eye tracking. We also hope to examine processing through direct electrophysiological measures, such as ERP measures, particularly through an examination of effects in relation to the N400 component (Kutas & Federmeier, 2009; Kutas & Iragui, 1998).

In conclusion, our findings provide a perspective on convergence in bilinguals that suggests that a more comprehensive examination of the range of usage of corresponding words in the bilinguals' two systems is needed in order to fully understand lexical organization in bilinguals. They further point to a need to be cautious in the future in drawing generalizations about lexical organization in bilinguals from performance in just a few cases -- whether those generalizations concern direction of influence, dominance of the more complex or less complex form, number of translation equivalents, and the like. We can surmise, from these data, for example, that it is not always the wider language that "wins out" in
bilinguals' lexicons; rather, it depends on category types. In future research, we need to be alert to the
types of categories examined in bilingual studies. Finally, we were only able to assess comprehension in
this study; comparable investigations need to examine production of many of these same types of items to
see whether the general results here hold in production as well (e.g., whether bilinguals are more likely to
overgeneralize broad classical categories from their wider language to the narrower language than they
are to overgeneralize other types of categories).
FOOTNOTES

1 E.g., there is a song by Enrique Iglesias called "El Muro," in which there is a line "Hay un muro entre tú y yo" ('there is a wall between you and me'), and an Argentinian film entitled "Un muro de silencio" ('a wall of silence').

2 In our classification scheme, Tasche would most likely be classified as classical, much like pouch in English (for a pouch on a garment versus a pouch, e.g., on a piece of furniture) and Schlange would be radial, much like cola in Spanish (for a 'tail' and a 'queue').

3 Note that we are not necessarily challenging the overall notion that meanings of lexical items in a language are related to their patterns of activation within that linguistic system; we are just questioning the value of using a word association task to provide a comprehensive or meaningful picture of those levels of activation in bilinguals.

4 A classic test for under-specification is the coordination test for zeugma, or "the use of a word to modify or govern two or more words usually in such a manner that it applies to each in a different sense or makes sense with only one (as in “opened the door and her heart to the homeless boy”) " (http://www.merriam-webster.com/dictionary/zeugma). Without zeugma, the word is considered under-specified. Thus,"we painted one wall green and another blue," in relation to an indoor wall and an outdoor wall, or "we gave one uncle a book and another one a tie" do not create zeugma. Compare with, e.g., the homophonic bow (of a ribbon and of a bow and arrow): "We used one bow to tie the package and the other to shoot an arrow."

5 One reviewer commented, "So is this considered an example of conceptual space for words that do not exist? If so, it is not evidence for the separability of conceptual vs semantic space for words that do exist." We do not dispute the possibility that language helps "shape" the conceptual space for those who speak that language; quite the contrary. Our point is that conceptual space and semantic space are not one and the same.
ACKNOWLEDGEMENTS

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Nicoladis E and Gynane H (under review) French-English bilinguals' motion encoding in speech and gesture.


<table>
<thead>
<tr>
<th></th>
<th>English-Spanish Bilinguals</th>
<th>English Monolinguals</th>
<th>Spanish Monolinguals</th>
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<td>N</td>
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<tr>
<td>N Women</td>
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<tr>
<td>Mean Age (Range)</td>
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<td>34.8 (25–62)</td>
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<td>Managua, Nicaragua</td>
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<td>OSH: 4.5%</td>
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<td>L1S-L2E: 0%</td>
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<td>Heritage Background</td>
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<td>American, 16% mixed</td>
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TABLE 2. Linguistic and Non-Linguistic Stimuli used for the Semantic Categorization Tasks  
(Words used as stimuli are shown in bold.)

Width: English > Spanish

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FIGURE 1. Sample slides.

leg-pierna/pata slide

pintura - paint/painting slide
FIGURE 2. Choices of Target Items, ENGLISH

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- E wider than S
- S wider than E
FIGURE 3. Choices of Target Items, SPANISH