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The role of language proficiency, cognate status and word frequency in the assessment of Spanish–English bilinguals' verbal fluency

HENRIKE K. BLUMENFELD[1], SUSAN C. BOBB[2] & VIORICA MARIAN[3]

[1]*School of Speech, Language, and Hearing Sciences, San Diego State University, San Diego, CA, USA,* [2]*Department of Psychology, Gordon College, Wenham, MA, USA, and* [3]*Department of Communication Sciences and Disorders, Northwestern University, Evanston, IL, USA*

Abstract

Purpose: Assessment tools are needed to accurately index performance in bilingual populations. This study examines the verbal fluency task to further establish the relative sensitivities of letter and category fluency in assessing bilingual language skills in Spanish–English bilinguals.
Method: English monolinguals and Spanish–English bilinguals had 1 minute to name words belonging to a category (e.g. *animals*) or starting with a letter (e.g. *A*). Number of words retrieved, proficiency, cognate and frequency effects were examined.
Result: In their dominant language (English), bilinguals and monolinguals showed similar fluency patterns, generating more words in category than letter tasks. This category advantage disappeared for bilinguals tested in their non-dominant language (Spanish). Further, bilinguals retrieved a higher percentage of cognates (e.g. *lagoon-laguna*) than monolinguals across tasks and languages. In particular, as proficiency increased in their non-dominant language, bilinguals were more likely to produce cognates (including cognates with lower word frequencies).
Conclusion: While bilinguals and monolinguals performed largely the same, bilinguals showed fine-grained differences from monolinguals in both their dominant and non-dominant languages. Based on these results, it is recommended that clinicians evaluate findings from bilinguals' verbal fluency tasks with attention to language proficiency, cognate words produced and relative to normative data that match their clients' language histories.

Keywords: *Verbal fluency*, *bilingual assessment*, *language proficiency*

Introduction

On the verbal fluency task (*Controlled Oral Word Association Task*, Benton & Hamsher, 1976) participants must name as many words as possible within 60 seconds that either start with a specific letter (*letter fluency*, e.g. words that start with *A*) or that belong to a certain semantic category (*category fluency*, e.g. names of *animals*). These linguistic-cognitive tasks have been widely used as part of diagnostic batteries for developmental disorders (e.g. Begeer, Wierda, Scheeren, Teunisse, Koot, & Geurts, 2014; Kenett, Wechsler-Kashi, Kenett, Schwartz, Ben-Jacob, & Faust, 2013) and acquired disorders (e.g. Catani et al., 2013; Delis et al., 2004; Folstein et al., 1975; Helm-Estabrooks, 2001; Monsch et al., 1992; Nasreddine et al., 2005; Paradis & Libben 1987; Shewan & Kertesz, 1980). Although verbal fluency (henceforth, VF) performance is widely used as a diagnostic tool, relatively little is known about the underlying processing differences on VF tasks in bilinguals with various language proficiencies relative to monolinguals. There is a growing need for measures that accurately and efficiently contribute to the assessment of linguistic or cognitive impairments in bilingual populations (e.g. Roseberry-McKibbin, Brice, & O'Hanlon, 2005). This is particularly true for English and Spanish, as English/Spanish bilinguals constitute a growing segment of the US student (e.g. Goldstein, 2012) and ageing populations (Shin & Kominski, 2010). Here, we examine the influence of language experience and lexical overlap on the quantity and quality of words produced on letter and category VF tasks in adult Spanish–English bilinguals.

A number of differences have emerged between Spanish–English bilinguals and monolinguals on letter and category VF tasks (see Figures 1 and 2). On a *letter fluency* task, bilinguals who were matched with monolinguals on English proficiency were

Correspondence: Dr Henrike K. Blumenfeld, PhD, San Diego State University, School of Speech, Language, and Hearing Sciences, 5500 Campanile Dr., San Diego, CA 92182-1518, USA. E-mail: hblumenf@mail.sdsu.edu

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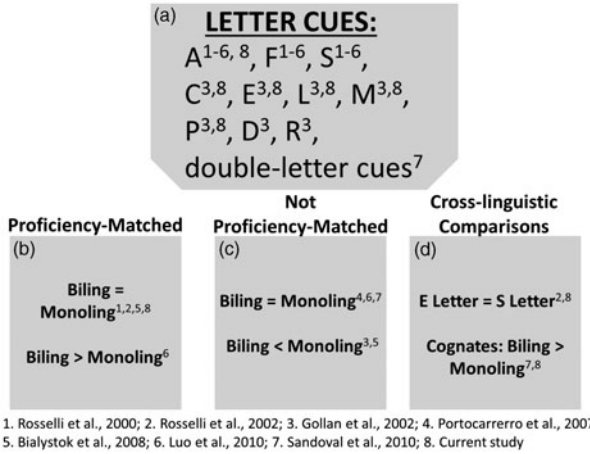

Figure 1. Summary of previous findings with English letter fluency tasks in Spanish–English bilinguals and monolinguals. Box (a): Participants were asked to generate words starting with these letters. Box (b): studies where bilinguals and monolinguals were matched on English proficiency; Box (c): studies where monolinguals had higher English proficiency than bilinguals. In Boxes (b–d), groups were compared on number of words produced (>, <, =); cognate comparisons in Box (d) were on proportion of cognates produced.

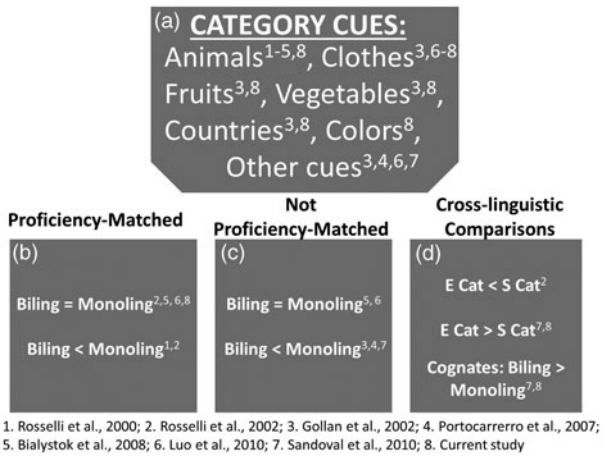

Figure 2. Summary of previous findings with English category fluency tasks in Spanish–English bilinguals and monolinguals. Box (a): Participants were asked to generate words that belonged to these categories. Box (b): studies where bilinguals and monolinguals were matched on English proficiency; Box (c): studies where monolinguals had higher English proficiency than bilinguals. In Boxes (b–d), groups were compared on number of words produced (>, <, =); cognate comparisons in Box (d) were on proportion of cognates produced.

shown to perform on par with monolinguals (Bialystok, Craik, & Luk, 2008; Rosselli & Ardila, 2002; Rosselli et al., 2000) and, at times, to even outperform monolinguals (Luo, Luk, & Bialystok, 2010). In comparison, bilinguals with lower language proficiencies than monolinguals were shown to perform either on par with (e.g. Portocarrero, Burright, & Donovick, 2007) or worse than monolingual peers (e.g. Gollan, Montoya, & Werner, 2002). The reason for the bilingual advantage may be due to the recruitment of executive function in the letter fluency task: In order to retrieve words that start with the same letter, semantically related words with different onsets must be ignored, which calls on conflict-resolution skills (e.g. Luo et al., 2010; Troyer, Moscovitch, & Winocur, 1997). Conflict-resolution processes regulate task demands in the presence of competing information (e.g. ignoring semantically related items) and are thought to play a central role in executive function (Botvinick, Braver Barch, Carter, & Cohen, 2001). Bilinguals may outperform monolinguals on non-linguistic tasks that target conflict resolution, perhaps as a result of bilingual processing demands (e.g. Hilchey & Klein, 2012).

On the *category fluency* task, where participants rely on category-specific vocabulary depth (e.g. *animals*), bilinguals seem more likely to show disadvantages relative to monolinguals, even when they are proficiency-matched on overall vocabulary or self-reported language skills (e.g. Portocarrero et al., 2007; Roselli & Ardila, 2002; Rosselli et al., 2000, Sandoval, Gollan, Ferreira, & Salmon, 2010; but see for example, Bialystok et al., 2008). One reason for such bilingual disadvantages is lower exposure to words within each language, resulting in less robust and, thus, less accessible representations than in monolinguals (e.g. Gollan & Acenas, 2004; Gollan, Slattery, Goldenberg, Van Assche, Duyck, & Rayner, 2011; Portocarrero et al., 2007). Semantic fluency relies more on specific word knowledge (or vocabulary depth) within a relatively small search space, while letter fluency can draw on broader lexical knowledge across a larger search space (Bialystok et al., 2008). In general, when bilinguals are tested on tasks that reflect specific vocabulary knowledge or lexical access, they frequently show poorer performance relative to monolinguals, including slower picture naming (e.g. Gollan, Montoya, Fennema-Notestine, & Morris, 2005; Ivanova & Costa, 2008), naming fewer pictures on standardised tests (e.g. Roberts, Garcia, Desrochers, & Hernandez, 2002) and smaller language-specific receptive vocabularies (e.g., Bialystok & Luk, 2010; Bialystok, Luk, Peets, & Yang, 2010).

Thus, previous findings regarding bilinguals' performance on letter and category fluency tasks suggest that language proficiency shapes VF performance, with category performance more affected by lower proficiency than letter performance. Consequently, the relation between letter and category performance may also be modulated by bilingual proficiency. The relation between letter and category performance has been employed as one diagnostic marker for cognitive-linguistic impairments, because reduced category fluency has been associated with semantic deficits and reduced letter fluency has been associated with executive function deficits (e.g. Moscovitch, 1994). It is, thus, likely that bilingual proficiency influences VF performance in clinically relevant ways.

In addition to modulating the relation between letter and category fluency, bilingual experience may also modulate the lexical content of VF productions. Bilinguals may compensate for weaker language-specific knowledge by relying more on lexical representations that are shared across languages and provide cross-linguistic scaffolding. Cognate words (translation equivalents that have form overlap in the two languages, such as English *lagoon* and Spanish *laguna*) are named more quickly and reliably than non-cognate words (e.g. Costa, Santesteban, & Caño, 2005; Hoshino & Kroll, 2008; Rosselli, Ardila, Jurado, & Salvatierra, 2014; Sánchez-Casas & García-Albea, 2005). Sandoval et al. (2010) found that Spanish–English bilinguals retrieved more cognates than monolinguals during an English VF task. These initial findings suggest that bilinguals may be more likely to retrieve cognates during free retrieval, perhaps because cognates have lower retrieval demands.

Word frequency effects may also drive cognate use in bilinguals. Specifically, use of cognate equivalents in each language increases their subjective (functional) frequency, resulting in more successful retrieval. In addition, Schepens et al. (2013) showed that cognates in more closely-related languages have higher lexical frequencies (because the languages share core vocabulary) and cognates in less related languages have lower lexical frequencies (because cognates underwent independent change after the divergence of the two languages from their common roots). For example, Spanish–Italian cognates had relatively higher lexical frequencies, while Spanish–English cognates had relatively lower lexical frequencies. Indeed, Sandoval et al. (2010) found that cognates produced in English had lower lexical frequencies than non-cognates. In sum, for Spanish–English bilinguals, cognates in each language may have lower frequencies relative to non-cognates, suggesting that word frequency effects (where lower frequencies reduce lexical accessibility) may interact with cognate status.

In the *current study*, we examined the influence of proficiency on number of words produced, the relation between letter and category output and the lexical nature (cognate and word frequency effects) of VF productions in bilinguals. We compared not only English VF performance in bilinguals vs monolinguals, but also VF performance across the first language (L1) and second language (L2) of bilinguals. We also compared bilinguals with higher vs lower proficiency levels in their less dominant language (Spanish). To our knowledge, few studies on VF performance have looked at within-group effects for bilinguals (Roselli & Ardila, 2002; Sandoval et al., 2010). Rosselli and Ardila (2002) studied Spanish–English bilinguals in their early 60s on both category and letter VF, identifying lower performance only for English category VF. Sandoval et al. (2010) studied college-aged Spanish–English bilinguals who were either English-dominant or balanced and examined L1–L2 differences only for category fluency. They found that bilinguals produced fewer words in their less dominant language and retrieved them more slowly. These cross-linguistic comparisons suggest that category fluency may indeed be sensitive to language proficiency. Here, we seek to further establish the relative sensitivities of letter and category fluency tasks to language proficiency by comparing both of these cue types across languages in college-aged Spanish–English bilinguals. In addition, based on the hypothesis that bilinguals can scaffold retrieval on fluency tasks by relying on shared language representations, we examine the cognate status and lexical frequencies of words produced in each language. Of the studies specifically targeting bilingualism and deficits in VF, many have tested heritage speakers of Spanish who learned Spanish as their first language but switched dominance to English in early childhood (e.g. Gollan et al., 2002; Gollan, Montoya, Cera, & Sandoval, 2008). In the present study, we also focus on a group of early sequential bilinguals (age of acquisition of both languages between 0–11 years of age) who are English dominant. Importantly, they have attained different levels of Spanish proficiency, allowing us to examine how proficiency modulates VF performance. In sum, the current work's unique contribution is to examine the relation between letter and category performance across the two languages of young adult Spanish–English bilinguals, considering the role of proficiency, cognate status and word frequency. The current study will also add normative data to previous work examining verbal fluency performance in English-dominant Spanish–English bilinguals.

Predictions

Because we tested bilinguals who were comparable to monolinguals in English proficiency, we predicted that bilinguals and monolinguals would perform similarly in their dominant language (English) compared to monolingual English speakers. In comparing English and Spanish performance in bilinguals, we expected to see overall fewer words produced in Spanish (the weaker language), with category fluency more influenced by language proficiency than letter fluency. Finally, we predicted that, if cognates are indeed privileged during bilingual retrieval, then cognate effects would be observable across both languages and fluency tasks in bilinguals and such effects would interact with lexical frequency effects and be modulated by bilingual proficiency.

Method

Participants

Fifty-four monolingual and bilingual college students participated. Based on a language experience

Table I. Overview of monolingual and bilingual participants.

Measure	Monolinguals ($n = 24$)		Bilinguals ($n = 25$)		
	M	SE	*M*	SE	*p*-value
Age (years)	20.88	0.73	21.96	1.05	0.400
Self-rating for spoken English	9.46	0.16	9.17	0.17	0.210
Self-rating for spoken Spanish/L2	1.45	0.21	7.38	0.29	<0.001*
Average English self-rating(0 = none; 10 = perfect)	9.50	0.13	9.23	0.16	0.200
Average Spanish/L2 self-rating (0 = none; 10 = perfect)	1.50	0.18	7.85	0.27	<0.001*
Age of English acquisition (years)	0.42	0.13	1.79	0.53	0.015*
Age of Spanish/L2 acquisition (years)	13.55	0.77	1.96	0.57	<0.001*
Current % English exposure	94.40	4.08	75.33	3.51	0.001*
Current % Spanish/L2 exposure	1.31	0.38	22.83	3.32	<0.001*
Total Years of Education(regardless of language environment)	15.27	0.50	15.38	0.56	0.890
Number of years in an English school/working environment	19.17	1.02	17.32	1.06	0.05
Number of years in a Spanish school/working environment	0.82	0.38	7.16	1.59	<0.001*
PPVT (English)	116.96	1.99	114.48	2.63	0.460
WASI	108.86	2.89	110.81	2.40	0.610
Digit Span (CTOPP)	17.71	0.48	17.26	0.51	0.530

Average self-ratings reflect average combined ratings on comprehension and speaking proficiency levels, where 0 = none and 10 = perfect. Note that, for monolinguals, age of acquisition and proficiency scores in Spanish are provided because some participants had minimal exposure to Spanish (on average less than a year). None of the monolinguals were proficient in Spanish.

PPVT, Peabody Picture Vocabulary Test (Dunn & Dunn, 1997); WASI, Wechsler Abbreviated Scale of Intelligence (PsychCorp, 1999); CTOPP, Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999).

*$p < 0.05$.

and proficiency questionnaire (*LEAP-Q*, Marian, Blumenfeld, & Kaushanskaya, 2007), native speakers of English with no or limited proficiency in an L2 were considered monolinguals. Participants who reported being English-dominant with high proficiency in Spanish were considered bilingual. We included 24 monolinguals and 25 bilinguals in final analyses after excluding (a) one bilingual for whom L2 self-report ratings were missing and (b) four participants whose performance on the VF task was more than 2.5 SD above or below their respective group's mean.[1]

Monolinguals did not differ from bilinguals on age, years of education, self-reported English speaking and comprehension proficiency, scores on the performance sub-tests of the *Wechsler Abbreviated Scale of Intelligence*, the forward digit span sub-test of the *Comprehensive Test of Phonological Processing*, or English receptive vocabulary indexed by the *Peabody Picture Vocabulary Test* (all $ps > 0.1$, see Table I). Groups differed on self-reported percentages of English and Spanish/L2 exposure, age of English acquisition, age of Spanish/L2 acquisition and self-reported proficiency speaking Spanish/L2 or understanding Spanish/L2 (all $ps < 0.05$).

Materials and procedure

For the letter task, we chose letters that commonly appear as the initial letter of words in both English and Spanish (*E*, *P* and *M* (Set 1) or *A*, *L* and *C* (Set 2)). For the category task, we chose categories common to other verbal fluency studies (see Figures 1 and 2) consisting of the categories *Animals*, *Fruits* and *Clothes* (Set 1) or *Vegetables*, *Colours* and *Countries* (Set 2). Because one of our objectives was to investigate the percentage of cognates, the country category was omitted from analyses given an extremely high cognate production rate, even in monolinguals (73.3% of countries produced were cognates). For letter cues, the percentage of cognates produced by monolinguals ranged from 16.8% (*L*) to 45.1% (*E*); for category cues, the percentage of cognates in monolinguals ranged from 22.0% (*Vegetables*) to 35.7% (*Animals*). Cues were counterbalanced across groups, languages and proficiency levels: bilinguals received each prompt only once, with similar proportions of monolinguals and bilinguals receiving each cue set, and with similar proportions of each set per language and per proficiency group.[2] Participants completed the letter and category tasks in the same session

[1]The four excluded participants, who were outliers in verbal fluency performance beyond 2.5 SD of the mean, included one monolingual and three bilinguals. The bilinguals also differed from other bilinguals' linguistic profiles because one had learned Gujarati as a child, one spoke Yucatecan Spanish and one spoke Venezuelan Spanish. The monolingual did not deviate from other monolinguals' background profiles and no other demographic characteristics of the excluded participants deviated from characteristics of included participants. Examination of means suggested similar patterns in the excluded participants as in the overall sample. Because outliers tend to skew the distribution, it is common practice to exclude individuals who deviate from the group mean by more than 2.5 SD to reduce the impact of the outlier in data-sets. The practice of removing outliers has been shown not to artificially inflate *p*-values across experiments (Bakker & Wicherts, 2014).

[2]After exclusion of outlying participants, comparable yet slightly uneven distributions in counterbalancing remained. For letter sets, 12 bilinguals (48%) and 10 monolinguals (42%) received the *EPM* set in English; 13 bilinguals (52%) and 14 monolinguals (58%) received the *ALC* set. For category sets, 13 bilinguals (52%) and 15 monolinguals (62.5%) received *Animals-Fruits-Clothes* cues; 12 bilinguals (48%) and nine monolinguals (37.5%) received *Vegetables-Colours* cues. Finally, of the higher-proficiency bilinguals, five (42%) received the *EPM* cues in English, seven (58%) received the *ALC* cues, seven (62.5%) received the *Animals-Fruits-Clothes* cues and five (48%) received the *Vegetables-Colours* cues. Of the lower-proficiency bilinguals, six (50%) received the *EPM* cues, six (50%) received the *ALC* cues, six (50%) received the *Animals-Fruits-Clothes* cues and six (50%) received the *Vegetables-Colours* cues. Table II illustrates the similarity of performance across sets.

Table II. Mean number of words produced per verbal fluency cue in monolinguals and bilinguals in English and Spanish.

	Monolinguals (n = 24)		Bilinguals (n = 25)			
	English		English		Spanish	
Measure	*M*	SE	*M*	SE	*M*	SE
Mean VF Letter*	14.00	0.74	12.88	0.60	9.46	0.62
A-L-C	14.41	0.97	12.2	0.83	9.76	0.87
E-P-M	13.43	1.15	13.5	0.91	9.15	0.87
Mean VF Category*	16.70	0.91	15.81	0.54	9.32	0.68
Animals-Fruit-Clothes	18.1	0.89	16.6	0.96	9.95	0.96
Vegetables-Colours	14.44	1.15	15.0	0.99	8.69	0.96

*Mean VF values are the mean number of items produced across the ALC and EPM sets for letters and across the Animals-Fruits-Clothes and Vegetables-Colours sets for categories. Post-hoc analyses suggest relatively good equivalence in output generated across the sets. In monolinguals and bilinguals, no difference emerged in the number of items produced when prompted with the letter set consisting of *E*, *P* and *M* cues and the letter set consisting of *A*, *L* and *C* cues [monolinguals: $F(1,23) = 0.42$, $p = 0.53$, $\eta_p^2 = 0.02$; bilinguals: $F(1,24) = 0.25$, $p = 0.63$, $\eta_p^2 = 0.012$]. Further, there was no interaction between letter set and Spanish proficiency group, $F(1,24) = 1.48$, $p = 0.229$, $\eta_p^2 = 0.032$. For English categories, monolingual data revealed marginally higher mean productions across the *Animals-Fruits-Clothes* set than the *Vegetables-Colours* set, $F(1,23) = 4.2$, $p = 0.052$, $\eta_p^2 = 0.16$. However, the bilinguals produced a similar number of items across these sets in both English, $F(1,24) = 1.95$, $p = 0.178$, $\eta_p^2 = 0.09$, and Spanish, $F(1,24) = 0.87$, $p = 0.36$, $\eta_p^2 = 0.042$, and no interaction was present between category set and Spanish proficiency in English, $F(1,24) = 0.01$, $p = 0.91$, $\eta_p^2 = 0.001$, while in Spanish an interaction emerged between category set and proficiency, $F(1,24) = 7.06$, $p = 0.015$, $\eta_p^2 = 0.26$. In the lower Spanish proficiency group, no difference was found across sets in mean number of Spanish productions, $t(10) = -1.4$, $p = 0.183$; however, the higher Spanish proficiency group produced more items in the *Animals-Fruits-Clothes* than the *Vegetables-Colours* set, $t(10) = 2.25$, $p = 0.048$.

and named as many words as possible within 1 minute for each cue, while being audio-recorded. Monolinguals completed the task in English only; bilinguals completed the task in both English and Spanish. English prompts were always administered first, within the context of other English tasks; Spanish prompts were presented later in the session and within the context of other Spanish tasks.

Response coding

Consistent with previous VF studies (e.g. Sandoval et al., 2010; Troyer, Moscovitch, Winocur, Alexander, & Stuss, 1998), we excluded repetitions of words within each cue of the letter and category tasks as well as proper names and places for the letter task. A trained and highly proficient Spanish–English bilingual coded responses as cognates when words were near-identical in form with their translation equivalents. Cognate words had to share enough phonemes across languages to be recognisable to individuals without Spanish knowledge (e.g. *elephant-elefante* but not *cat-gato*). While words would not function as cognates in monolinguals' productions, both bilingual and monolingual productions were coded for cognate status to establish if bilinguals produced more of these items than monolinguals. To evaluate inter-rater reliability, two additional trained coders independently coded all productions for cognate status. All three coders agreed on 98.5% of judgements; for the remaining 1.5% of words, discussion led to consensus decisions among the three coders.

Overview of analyses

The average number of correct responses and the percentage of cognates produced were analysed to address three aims: (1) to assess the degree to which monolinguals and bilinguals resembled each other in English, (2) to assess potential differences across bilinguals' dominant (English) and non-dominant (Spanish) languages and (3) to examine the interaction between frequency and cognate effects in a lexical frequency analysis of word productions. Spoken frequencies for all words produced were obtained from the Corpus of Contemporary American English (*COCA*, Davies, 2008) and the Corpus del Español (Davies, 2002).

Result

Number of words produced

Between-group analyses. We first ran a 2×2 ANOVA assessing the number of correct responses for each group (monolingual, bilingual) and task (letter, category) for English performance, see Table II and Figure 3. A main effect of task emerged (letter, category) [$F(1,47) = 24.41$, $p = 0.0001$, $\eta_p^2 = 0.34$], with all participants producing fewer words for letter ($M = 13.44$, SE = 0.47) than category cues ($M = 16.25$, SE = 0.52). Consistent with prior work suggesting equivalent performance in proficiency matched bilinguals and monolinguals (Bialystok et al., 2008; Rosselli & Ardila, 2002), we found no main effect of group [$F(1,47) = 1.5$, $p = 0.22$, $\eta_p^2 = 0.031$] and no interaction between

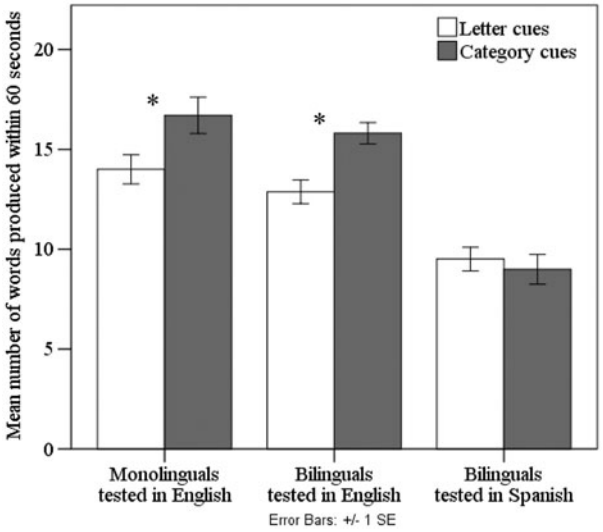

Figure 3. Number of words produced in English by monolinguals (left) and bilinguals (middle), and in Spanish by bilinguals (right), when given letter cues and category cues. *$p < 0.01$, error bars +/- 1 SE.

task and group [$F(1,47) = 0.040$, $p = 0.843$, $\eta_p^2 = 0.001$], suggesting that the English-dominant bilinguals performed similarly to monolinguals in English.

Bilingual within-group analyses. A 2 × 2 ANOVA comparing bilinguals' performance across languages (English, Spanish) and tasks (letter, category) yielded a main effect of language [$F(1,24) = 96.96$, $p = 0.0001$, $\eta_p^2 = 0.80$], with bilinguals performing better in English ($M = 14.34$, SE = 0.42) than Spanish ($M = 9.25$, SE = 0.60). We also found a main effect of task [$F(1,24) = 5.23$, $p = 0.031$, $\eta_p^2 = 0.18$] and an interaction between language and task [$F(1,24) = 14.90$, $p = 0.001$, $\eta_p^2 = 0.38$], see Figure 3. While bilinguals generated more words for English category ($M = 15.81$, SE = 0.54) than English letter cues ($M = 12.88$, SE = 0.60) [$t(24) = -3.90$, $p = 0.001$, Cohen's $d = 1.03$], they generated an equivalent number of words for Spanish category ($M = 8.99$, SE = 0.75) and letter cues ($M = 9.51$, SE = 0.59) [$t(24) = 0.82$, $p = 0.42$, Cohen's $d = -0.16$]. Indeed, larger differences between English and Spanish were found for category cues ($M_{\text{difference}} = 6.81$, SE = 0.85) than letter cues ($M_{\text{difference}} = 3.37$, SE = 0.45), $t(24) = -3.86$, $p = 0.001$. In sum, as expected for bilinguals, category performance was more markedly reduced in the less dominant language, removing the category vs letter advantage in Spanish.

Cognate retrieval on verbal fluency tasks

Between-group analyses. To establish whether words categorised as Spanish–English cognates were preferentially produced by bilinguals, we next investigated the percentage of cognates in VF productions in bilinguals relative to monolinguals. Monolinguals may unknowingly produce words that are also Spanish–English cognates because they are typically better than bilinguals at processing lower frequency words (e.g. Ivanova & Costa, 2008). A proportion of these lower frequency words are likely to have Latin roots and form similarity across English and Spanish. A 2 × 2 ANOVA comparing task (letter, category) and group (monolingual, bilingual) showed a main effect of task [$F(1,47) = 26.25$, $p = 0.0001$, $\eta_p^2 = 0.358$]. Participants produced a higher percentage of cognates in the letter ($M = 39.1\%$, SE = 1.7) than the category task ($M = 28\%$, SE = 1.0). There was also a main effect of group [$F(1,47) = 4.80$, $p = 0.033$, $\eta_p^2 = 0.093$], with bilinguals producing a higher percentage of cognates than monolinguals (bilinguals: $M = 35.6\%$, $SE = 1.3$, monolinguals: $M = 31.5\%$, SE = 1.3). The interaction between task and group was not significant ($p > 0.1$), suggesting the distribution of cognates was consistent across tasks for the two groups.

Bilingual within-group analyses. To compare bilingual performance across languages, a task (letter, category) × language (English, Spanish) ANOVA was conducted and showed a main effect of task [$F(1,24) = 22.04$, $p < 0.0001$, $\eta_p^2 = 0.48$]. Bilinguals produced a higher percentage of cognates in the letter ($M = 38.7\%$, SE = 1.7) than the category task ($M = 28.7\%$, SE = 1.2). We also found a main effect of language [$F(1,24) = 4.77$, $p = 0.039$, $\eta_p^2 = 0.17$]. Bilinguals produced a higher percentage of cognates in their dominant language, English ($M = 35.6\%$, SE = 1.2), than in Spanish ($M = 31.8\%$, SE = 1.4). The interaction between task and language was not significant ($p > 0.1$), suggesting the distribution of cognates was consistent across languages and tasks.

Bilinguals' proficiency and cognate productions. To examine whether bilingual proficiency increased the number of cognates produced, we divided bilinguals into two equal-sized groups ($n = 12$) by proficiency based on their composite score of self-rated L2 Spanish comprehension and speaking scores (lower-proficiency group: $M = 6.9/10$, SE = 0.34; higher-proficiency group: $M = 8.8/10$, SE = 0.17, $t(22) = -4.9$, $p < 0.001$, Cohen's $d = 2.16$). Self-reported proficiency based on the *Language Experience and Proficiency Questionnaire* (Marian et al., 2007) has also been found to strongly correlate with objective measures of performance, including auditory comprehension, grammaticality judgements and receptive vocabulary. It should be noted that "higher" and "lower" proficiency are intended to be relative terms, with both bilingual groups being functional bilinguals.

A task (letter, category) × group (higher, lower proficiency) × language (English, Spanish) ANOVA

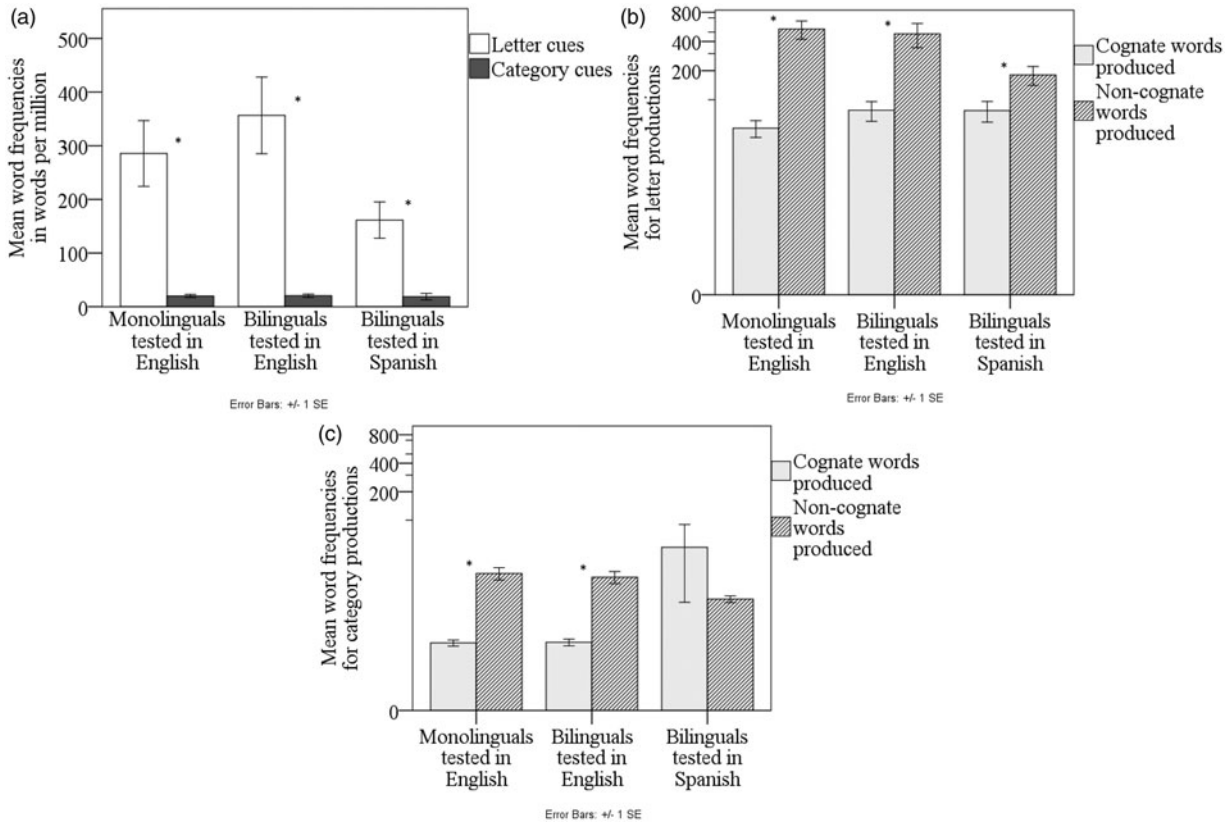

Figure 4. Frequency of words produced in English by monolinguals and bilinguals, and in Spanish by bilinguals, as measured by spoken words per million (Davies, 2002, 2008) across letter and category productions (a) and for cognates vs non-cognates given letter cues (b) vs category cues (c). To better compare cognate vs non-cognate frequencies given letter vs category cues (i.e. frequencies across a wide range), the axes for graphs (b) and (c) were converted to a logarithmic scale. *$p < 0.01$.

yielded the previously-identified main effect of task, $F(1,22) = 19.1$, $p < 0.001$, $\eta_p^2 = 0.47$, as well as a main effect of proficiency group, $F(1,22) = 10.0$, $p = 0.005$, $\eta_p^2 = 0.31$, where bilinguals who were more proficient in Spanish (their non-dominant language) produced more cognates in *both* languages ($M = 36.6\%$, SE = 1.2) than bilinguals who were less proficient in Spanish ($M = 31.1\%$, SE = 1.2).

The role of word frequency on verbal fluency tasks

Between-group analyses. Finally, to examine possible interactions between cognate status and word frequency, we entered English frequency counts for words produced into a mixed task (letter, category) × cognate (cognate, non-cognate) × group (monolingual, bilingual) ANOVA. Results showed main effects of task [$F(1,47) = 37.64$, $p = 0.0001$, $\eta_p^2 = 0.445$] and cognate status [$F(1,47) = 26.60$, $p = 0.0001$, $\eta_p^2 = 0.361$] and an interaction between task and cognate status [$F(1,47) = 21.22$, $p = 0.0001$, $\eta_p^2 = 0.311$], see Figure 4. No other main effects or interactions were significant ($ps > 0.1$). Follow-up comparisons for the letter task showed a significant difference between cognate and non-cognate frequencies, with cognates showing *lower* frequency counts than non-cognates [cognates: $M = 64.10$ words per million, SE = 10.49; non-cognates: $M = 507.46$ words per million, SE = 88.62; $p = 0.001$]. For the category task, there was also a significant, albeit smaller, difference between cognate and non-cognate frequencies in the same direction [cognates: $M = 4.18$ words per million, SE = 0.29; non-cognates: $M = 25.54$ words per million, SE = 2.77; $p = 0.001$]. These results confirm that, across bilinguals and monolinguals, cognate productions had lower word frequencies than non-cognate productions.

Bilingual within-group analyses. We also examined word frequency effects across languages in bilinguals.[3] A language (English, Spanish) × task (letter, category) × cognate (cognate, non-cognate) ANOVA with word frequencies confirmed similar main effects of task, $F(1,24) = 22.5$, $p < 0.001$, $\eta_p^2 = 0.48$, and cognate status, $F(1,24) = 10.7$, $p = 0.003$, $\eta_p^2 = 0.41$, an interaction between task and cognate status, $F(1,24) = 12.0$, $p = 0.002$, $\eta_p^2 = 0.33$, as well as between task and language, $F(1,24) = 6.8$, $p = 0.016$, $\eta_p^2 = 0.22$, and between

[3]Frequencies were drawn from comparable English and Spanish corpora, making such an analysis possible (English spoken words based on a 450 million word corpus and Spanish spoken words based on a 100 million word corpus, with similar sources for both, Davies, 2002, 2008).

cognate status and language, $F(1,24) = 5.9$, $p = 0.023$, $\eta_p^2 = 0.20$. Pairwise follow-up *t*-tests yielded significantly higher word frequencies for English ($M = 251.7$ words per million, SE = 66.7) than Spanish ($M = 97.3$ words per million, SE = 20.1) *non-cognate* productions, $t(24) = 2.3$, $p = 0.032$. However, for cognate productions, no frequency differences were identified between languages (English: $M = 40.9$ words per million, SE = 9.1; Spanish: $M = 64.2$ words per million, SE = 22.8), $t(24) = -0.93$, $p = 0.36$.

Bilingual proficiency and cognate frequencies. To examine whether frequency effects were driven by proficiency and to what extent Spanish knowledge might support cognate selection in English, we examined whether proficiency in Spanish modulated the word frequency of cognates produced in English. If Spanish knowledge supports English retrieval, then bilinguals with higher Spanish proficiency might retrieve lower-frequency cognates in English. A one-way ANOVA was run with group (lower-Spanish-proficiency bilingual, higher-Spanish-proficiency bilingual, monolingual) as the independent variable and word frequency of *cognates produced during the English letter fluency task* as the dependent variable. Findings yielded a main effect of group, $F(2,45) = 3.39$, $p = 0.042$. Post-hoc LSD contrasts showed that bilinguals with *higher* Spanish proficiency showed significantly lower word frequency counts for cognates produced during the English letter task ($M = 38.7$ words per million, SE = 11.7) than bilinguals with lower Spanish proficiency ($M = 104.0$ words per million, SE = 31.3), $p = 0.02$, or monolinguals ($M = 50.6$ words per million, SE = 10.1), $p = 0.03$, with no differences between higher-Spanish-proficiency bilinguals and monolinguals, $p = 0.62$.

Discussion

The current study builds on previous examinations of verbal fluency performance in young adult English-dominant Spanish–English bilinguals and, for the first time, provides comparison of letter *and* category performance across the bilinguals' two languages. Our results reveal fine-grained differences between how monolinguals and bilinguals access their lexicons and generate words in response to fluency cues that are frequently used as part of assessment protocols. We hypothesised that bilinguals and monolinguals would perform similarly in a proficiency-matched dominant language (English) but that, despite similarity in the number of English words produced, bilinguals would show some differences in word retrieval patterns relative to monolinguals (e.g. Ivanova & Costa, 2008). We predicted that these differences would be evident in terms of cognates retrieved and word frequency effects.

When bilinguals were compared to proficiency-matched monolinguals in English, we (1) confirmed previous findings that monolinguals and bilinguals show a similar advantage for category over letter VF tasks in their dominant language (e.g. Gurd & Ward, 1989); and (2) showed that, despite this overall similarity, bilinguals retrieved a higher percentage of cognates than monolinguals in their dominant language, English (also see Sandoval et al., 2010). Thus, even bilinguals who perform on par with monolinguals may follow a different underlying retrieval process. When VF performance was compared in bilinguals' dominant (English) vs non-dominant (Spanish) languages, we found that (1) as expected, fewer words were generated in bilinguals' non-dominant language than their dominant language; (2) the relation between letter and category output changed across bilinguals' dominant vs less dominant languages, with the category advantage disappearing in the less dominant language; and (3) word frequencies for non-cognates were lower in the less dominant than in the more dominant language, while word frequencies for cognates did not differ across languages.

Proficiency effects in verbal fluency performance

The current findings suggest a modulatory role of language proficiency on VF tasks. Similar to participants in Sandoval et al. (2010), our participants learned both languages early and became dominant in English. Despite this English dominance, participants' L2 proficiency influenced how they generated words when given VF cues. In the *dominant language*, previous findings have yielded reduced category fluency for bilinguals vs monolinguals (e.g. Gollan et al., 2002; but see Bialystok et al., 2008; Luo et al., 2010). In the current study, bilingual disadvantages were absent in our more English-dominant bilinguals as compared to the bilinguals in Gollan et al. (2002), who were less proficient in English than their monolingual controls, and as compared to Rosselli et al. (2000) and Rosselli and Ardila (2002), whose participants were proficiency matched with English monolingual controls but were in their early sixties. Note that Rosselli et al.'s participants were L1 Spanish speakers tested in their L2 English environment. Previous work in a younger population has shown decreased category VF performance in the L1 while immersed in the L2 (Linck, Kroll, & Sunderman, 2009), an effect that may be more pronounced with age given greater age-related decline in category than letter fluency (Brickman et al., 2005).

When bilinguals were tested in their *non-dominant language* (Spanish), the category vs letter advantage that was present in the dominant language disappeared and bilinguals' performance differences between English and Spanish were larger for category than letter cues. Cross-linguistic differences in

category performance are consistent with previous findings (e.g. Rosselli & Ardila, 2002; Rosselli et al., 2000; Sandoval et al., 2010). It is possible that category performance is more sensitive to proficiency because category cues have a smaller set of possible responses (e.g. clothes) than letter cues (e.g. all words that start with A). In their dominant language, speakers benefit from greater lexical depth and can retrieve a vast number of items from a semantic category, while letter fluency is constrained by phonemic search skills, thus resulting in more category than letter responses in highly proficient languages.

However, an individual with more limited vocabulary may lack category-specific lexical depth, resulting in a reduced set of items to draw from. Letter fluency may also be affected by this reduction in retrieval options, but perhaps to a lesser extent because words with certain phonemic onsets are more distributed across the lexicon. This may result in equivalent performance on letter and category tasks in less proficient languages.

It has also been suggested that bilinguals may experience more retrieval difficulties on semantic fluency tasks in their non-dominant language because of cross-linguistic interference (Gollan et al., 2002; Michael & Gollan, 2005). During a semantic lexical search, concepts and, thus, translation equivalents are more likely to be co-activated and translation equivalents in the more dominant language may compete for selection with translation equivalents in the less dominant language, thus slowing lexical access. On letter fluency tasks, however, translation equivalents frequently do not share word onsets and bilinguals may, thus, experience less cross-linguistic interference.

In clinical populations, reductions in letter and category fluency may also be due to cognitive or semantic impairments. It is, thus, critical that language proficiency and cross-linguistic effects are considered when cognitive or semantic deficits are inferred based on verbal fluency tasks in bilinguals. In post-hoc analyses, we also considered the potential influence of age of acquisition, even though it was not specifically examined in the current work. Despite the relatively small range of age of acquisition values, results showed that a later age of English acquisition correlated with more category exemplars produced in Spanish ($r = 0.70$, $p < 0.001$), with a marginal correlation suggesting that earlier Spanish acquisition was associated with more category exemplars produced in Spanish ($r = -0.4$, $p = 0.08$). No other correlations were significant. These patterns suggest that category knowledge may be partly influenced by age of acquisition, likely driven by years of intensive Spanish exposure, and language dominance. Together, the current findings echo calls for normative data and diagnostic criteria for monolinguals and bilinguals (e.g. Kohnert, 2010). Such normative data are especially necessary because cross-linguistic effects may vary across language-pairs and given a wide range of proficiencies and language histories.

The current findings provide normative data for the letter and category stimulus sets employed in the current study, which can be used as a reference for clinical work with bilinguals of similar language profiles. Based on post-hoc analyses (see Table II), the number of words produced across the two letter sets in both languages were equivalent, suggesting that responses generated with these sets are comparable and that the sets can be interchanged for assessment purposes. However, for category fluency, monolinguals produced marginally higher output in the *Animals-Fruit-Clothes* set than the *Vegetables-Colours* set, a pattern also found in Spanish for higher proficiency bilinguals (see Table II). By counterbalancing the sets across groups and languages, we minimised the potential influence of category set size differences on word production. Despite these efforts, a somewhat higher proportion of monolinguals than bilinguals received the *Animals-Fruits-Clothes* set, so that we cannot rule out that the category fluency score is slightly over-estimated for monolinguals relative to bilinguals. Even if such an over-estimate were present, our findings would remain consistent with our hypothesis that proficient bilinguals don't under-perform relative to monolinguals on the category task. When using these stimuli in clinical practice or for future research, it should be taken into consideration that the *Animals-Fruits-Clothes* set could yield slightly more productions in both languages, especially in higher proficiency individuals.

Cognate status, lexical frequency and proficiency in verbal fluency performance

When the lexical content of productions was examined, we confirmed that Spanish–English bilinguals retrieve a higher percentage of cognates in English than monolinguals (also see Sandoval et al., 2010). Critically, as proficiency increased in the less dominant language, a higher percentage of cognates was retrieved (including cognates with lower English frequencies). These findings suggest that proficiency in the non-dominant language may modulate the number and type of cognates retrieved on VF tasks. A promising line of future research may be to more systematically investigate the role of L2 proficiency in lexical access across the L1 and L2 in a larger sample with a broader range of proficiency. Using a variety of measures, including language history questionnaires and online measures of proficiency such as naming and comprehension tasks, could provide a more detailed picture of how proficiency changes the way bilinguals access cognate words in their lexicons.

As a group, the bilinguals also retrieved more cognates in their dominant than in their non-dominant language. This finding differs from Sandoval et al. (2010), who found equivalent cognate productions in both languages on a semantic fluency task, perhaps because their bilinguals had more balanced language profiles, with somewhat lower English proficiency than their monolingual control group, but with somewhat higher Spanish proficiency than the bilinguals in the current study. Therefore, the current findings provide preliminary support for the possibility that cognate production is driven by both knowledge of another language (providing cross-linguistic scaffolding) *and* proficiency in the target language (perhaps increasing awareness of available cognates). In the less proficient language (Spanish), category fluency was particularly reduced relative to the dominant language and the percentage of cognates produced was lowest in this condition.

In addition, a frequency-based account may explain the finding of more cognates produced in English than Spanish. Bilinguals with *higher* Spanish proficiencies produced English cognates with *lower* word frequencies. That is, Spanish vocabulary knowledge may boost access to lower-frequency cognates in English by increasing their functional frequency. In addition, bilinguals are likely to learn a wider range of lower-frequency words when they become more proficient in a target language and may, at that time, become aware of them as cross-linguistic cognates. Indeed, Spanish–English cognates are generally lower frequency words based on monolingual frequency corpora in each language (Schepens et al., 2013). This suggests that bilinguals' cognate use may be constrained by both proficiency in the non-target language and by word frequency in the target language. Therefore, for language pairs where cognates are lower-frequency words, bilinguals may have more robust access to a wider range of cognates in their more proficient language.

However, other findings suggest that verbal fluency output in less proficient individuals is *also* associated with lower lexical frequencies (Sandoval et al., 2010; also see Prior, MacWhinney, & Kroll, 2007). Indeed, our within-subject findings for *non-cognate productions* suggest higher word frequencies for non-cognates produced in English than in Spanish. It is possible that, when bilinguals produced non-cognates in their less dominant language, they did not choose words that are part of the core linguistic repertoire in proficient speakers who are represented in frequency corpora. Therefore, interactions between lexical status, word frequency, and proficiency are likely complex, with lower lexical frequencies also potentially indexing less conventional word knowledge. Lexical frequency, if measured in bilinguals' output, should, therefore, be interpreted with caution.

Finally, an interference account may also explain our findings of more cognates produced in English than Spanish. If cognate translation equivalents are primarily used in English rather than Spanish or do not have full form overlap, it is possible that they are treated more like English than Spanish words during lexical processing, resulting in interference from English translations during Spanish retrieval. In fact, while there is overwhelming evidence for cross-linguistic cognate facilitation in normal processing as well as in treatment studies (e.g. Kohnert, 2004), some evidence suggests that cognates can at times be more resistant to treatment than non-cognates (Kurland & Falcon, 2011; also see Grasso, Peña, & Bedore, 2014).

The likelihood of producing cognates in each language can be further explored across language pairs, fluency tasks (letter, category) and proficiency profiles and is likely to have implications for the use of cognates during treatment. Specifically, to understand to what extent languages may mutually support each other during VF tasks, normative data for specific language pairs and stimuli are needed, including percentages of cognates vs non-cognates produced. Such knowledge may allow the clinician to understand the extent to which bilinguals' lexicons are integrated and available, which may in turn be useful in planning treatment. For example, in individuals who produce a sizeable percentage of cognates in each language, cognate treatments in one language may be particularly effective in yielding benefits in both languages (e.g. Kohnert, 2004). Cognate status provides a promising assessment and treatment focus for bilingual children and adults (e.g. Dressler, Carlo, Snow, August, & White, 2011; Kohnert, 2004; Pérez, Peña, & Bedore, 2010; Roberts & Deslauriers, 1999).

In sum, the finding of bilingual–monolingual differences in cognate use for the dominant language suggests that even dominant languages can dynamically change in response to experience with a less proficient language (also see similar findings for syntax: Dussias & Sagarra, 2007; semantic structure: Degani, Prior, & Tokowicz, 2011; vocabulary: Linck et al., 2009; and phonology: Chang, 2013). The current findings indicate a fundamental permeability across languages and suggest that bilingual performance differs from monolingual performance, even when highly proficient languages are tested. The VF task is one case where interpretation is closely tied to proficiency, making it particularly informative when administered in both languages. Our findings suggest that, during assessment, closer examination of cognates produced as part of VF tasks may provide valuable insights about language interaction and dominance.

Conclusion

One difficulty in documenting differences between bilinguals and monolinguals, and in establishing normative data for bilinguals across letter and

category tasks, is the diversity of bilinguals (e.g. Paradis, 2011). Therefore, it is important to examine how factors such as language proficiency, lexical status and word frequency interact to shape performance on bilingual VF tasks and to generate baseline data for specific bilingual groups. The current work builds on a series of VF studies that have tested Spanish–English bilinguals who are dominant in English. To our knowledge, this study is the first to provide letter and category performance data in both languages, as well as cognate and word frequency characteristics across the letter and category tasks. Results show that bilingual experience, proficiency level, cognate status and word frequencies influence performance in the letter and category tasks. These findings suggest that language proficiency must be taken into consideration when letter and category verbal fluency performance is used for diagnostic purposes, e.g. as part of the assessment of potential executive function or memory deficits. Our findings also reiterate the need to test bilinguals in both of their languages and the inadequacy of applying monolingual norms to bilingual assessment. Further, coding of cognates may provide an index of language-specific vs cross-linguistically bootstrapped knowledge. Lexical frequencies of generated English cognates may also provide an index of the degree of influence from the non-target language. In sum, while care must be taken in the interpretation of VF measures in bilinguals, these measures can serve as useful assessment tools, particularly when administered in both languages. Future research will need to more fully explore the role that the relative strength of each language plays in modulating bilingual proficiency effects. Finally, lexical analysis of bilinguals' performance can provide additional valuable information about the inter-play between the two languages and lexical knowledge.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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