Asymmetries in Gender and Number Agreement Processing in Late Bilinguals

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1. Introduction

Although gender agreement is covered in the first lessons of gendered second languages (L2), adult learners demonstrate a persistent difficulty acquiring this linguistic feature (Bartning, 2000; Carroll, 1989; Dewaele & Véronique, 2001). Late bilinguals' reduced sensitivity to morphosyntactic information has been associated with several factors, including age of acquisition (Hawkins & Chan, 1997; Clahsen & Felser, 2006), language proficiency (Ojima, Nakata, & Kakigi, 2005), similarity of linguistic structures in the L1 and the L2 (Sabourin, 2003; Tokowicz & MacWhinney, 2005), reliance on semantic rather than morphophonological and syntactic cues (Lew-Williams & Fernald, 2007; Ojima, Nakata, & Kakigi, 2005), and limitations of cognitive resources such as working memory (McDonald, 2006; Miyake & Friedman, 1998). Despite much research, the relative importance and interaction of these factors is still unclear and online studies examining these issues with noun-adjective agreement are scarce. The present study examines the role of age of acquisition (whether late bilinguals can show native-like processing patterns); level of proficiency (whether bilinguals with more L2 experience behave qualitatively more like native speakers than those with less L2 exposure); and working memory (whether higher span bilinguals are more sensitive to agreement violations than lower span. Our working memory (WM) experiment also reveals whether gender disagreement consumes more attentional resources than number disagreement for late bilinguals compared to monolinguals. To investigate these variables, we measured the reading times (RTs) of adult native speakers of an ungendered language (English) reading sentences with noun-adjective gender and number agreement/disagreement in a gendered second language (L2), Spanish.

2. Gender and number agreement in Spanish

In Spanish, nouns are marked morphologically for number and gender features (Carroll, 1989; DeWaele & Véronique, 2000, 2001); the canonical inflectional morphemes for gender are /-o/ for masculine (M) nouns (*carro* 'car-M') and /-a/ for feminine (F) nouns (*casa* 'house-F') (transparent gender) (Green, 1988). However, there are numerous exceptions such as masculine *día* 'day-M', or feminine *radio* 'radio-F', or nouns ending in other vowels or consonants (e.g. /-e/ (*puente* 'bridge-M,' *fuente* 'fountain-F'), or *cartel* 'poster-M,' *pared* 'wall-F'). In addition to being [+/- feminine], Spanish nouns are [+/- plural], almost invariably formed by adding /-s/ to singular (S) nouns (*libros* 'books-MP'), and /-es/ to nouns ending in a consonant (*paredes* 'walls-FP').

Gender and number are indicated through agreement (Corbett, 1991), and in Spanish this surfaces in Determiners (D) and Adjectives (A), a procedure called agreement or concord (Carroll, 1999; Zagona, 2002) (*el carro blanco* 'the-MS white-MS car-MS,' *los carros blancos* 'the-MP white-MP cars-MP,' *la casa blanca* 'the-FS white-FS house-FS,' *las casas blancas* 'the-FP white-FP houses-FP'). In contrast, English has no grammatical gender marking on nouns and no gender-number agreement between nouns, determiners and adjectives. English has animate gender interpretation, but nouns like *waiter/waitress* bear no grammatical gender feature and denote a female in the same way that the proper name Alice conventionally does. English determiners show limited number concord (*this-these, that-those*).

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3. Grammatical representation of gender and number agreement

Given a Minimalist framework, (Chomsky, 1995, 2002), grammatical features of D, A trigger agreement with the head noun and also characterize the morphosyntactic differences between the DP of Spanish and English (Bosque & Picallo, 1996, Mallen, 1997). Spanish D, A have grammatical features of [gender] and [number] that must be copied or matched with the [+/- feminine], [+/- plural] features of N in close enough proximity (Carstens 2000, 2003). In contrast, English has a number feature on N that may be matched by a [number] feature on D (*this, these*), a semantic gender feature on animate nouns, but no grammatical [gender] or [number] feature on adjectives. English and Spanish DP also differ in canonical word order, N-A for Spanish and A-N for English (irrelevant for the current study). Summarizing, Anglophone L2 Spanish learners must gain grammatical gender and concord for inanimate nouns and agreement on D, A.

Spanish gender and number concord have been evaluated with offline and online data (described below). Some offline studies argue that proficient late bilinguals of an L1 without gender are less accurate perceiving and producing gender agreement than those of a gendered L1 (Franceschina 2001; Hawkins & Franceschina 2004), whereas others suggest that learners can achieve competence comparable to native speakers of a gendered language (Bruhn de Garavito & White 2002; White, Valenzuela, Kozlowska-Macgregor & Leung, 2004). The evidence from offline studies does not provide a definitive picture of whether or not L2 learners achieve grammatical representation that is qualitatively similar to that of native speakers of gendered languages with respect to gender and number concord.

4. Processing of gender and number concord

Native speakers show *congruency* effects demonstrated by shorter RTs when they process syntactic items that agree as opposed to items that have no agreement; items that have incorrect agreement (e.g. *mesa*-F *blanco*-M 'white table') induce even longer RTs, an *incongruency* effect. Studies using lexical decision, eyetracking, electrophysiological and neuroimaging techniques indicate that natives and early bilinguals of gendered languages have demonstrated congruency/incongruency effects with gender and number marking on D and A (e.g., Antón-Méndez, Nicol, & Garrett, 2002; Barber & Carreiras, 2005; Grosjean, Dommergues, Cornu, Guillelmon, & Besson, 1994; Jacubowicz & Faussart, 1998; Guillelmon and Grosjean, 2001; Osterhout, Bersick, & McLaughlin, 1997). Similar studies also reveal advanced late bilinguals' sensitivity to L2 gender and number discord in DPs (e.g., Alarcón, 2006, 2009; Foucart, 2008; Gillón-Dowens, Barber, Vergara, & Carreiras, 2008; Herschensohn & Frenck-Mestre, 2005; Keating, 2009; Lew-Williams & Fernald, 2007; Osterhout, Poliakov, Inoue, McLaughlin, Valentine, Pitkanen, Frenck-Mestre, & Herschensohn, 2008; Rossi, Gugler, Friederici, & Hahne, 2006; Sabourin, 2003; Sabouin, Stowe, & Haan, 2006; Sagarra, 2007; Tokowicz & MacWhinney, 2005). This sensitivity to L2 gender/number agreement violations is absent in low proficient late bilinguals (e.g., Alarcón, 2009; Keating, 2009; Osterhout et al., 2008; Sagarra, 2007; Sagarra & Herschensohn, 2008; Tokowicz & MacWhinney, 2005), implying that sensitivity to grammatical gender and number discord is modulated by L2 proficiency level.

A range of comprehension and production studies indicate that processing gender agreement is more cognitively effortful than number agreement in monolinguals, (e.g., Barber & Carreiras, 2005; Antón-Méndez et al., 2002; Bruhn de Garavito & White, 2002; Faussart, Jakubowicz, & Costes, 1999; Franceschina, 2001, 2005; Gillón-Dowens et al., 2008; McCarthy, 2008; Nicol & O'Donnell, 1999; Vigliocco, Hartsuiker, Jarema & Kolk, 1996; White et al., 2004). Lexical accounts of gender posit that gender discord forces the processor to return to the lexical identification stage (gender is a stem inherent feature) but number failure merely requires checking of the final processes of syntactic recognition (number is affixal) (e.g., Domínguez, Cuetos, & Ségui, 1999; Igoa, García-Albea, & Sánchez-Casas, 1999). Syntactic models consider that both gender and number are affixal (e.g., Sereno & Jongman, 1997; Sicuro Correa, Almeida, & Sobrino Porto, 2004) but that gender's large variability (many words have irregular endings) makes it more demanding than more regular number agreement (Hernández, Hofmann, & Kotz, 2007). If processing gender agreement consumes more attentional resources than number agreement, it is important to determine the working memory capacity of the late

bilinguals under investigation. Working memory is the simultaneous processing and storage of incoming information during complex cognitive tasks, is limited, and varies from person to person (Just & Carpenter, 1992; Baddeley, 2003). Using an L2 imposes additional demands on the already limited working memory system (Hasegawa, Carpenter, & Just, 2002). Working memory influences L2 lexical access and morphosyntactic processing (e.g., Havik, Roberts, van Hout, Schreuder, & Haverkort, 2009; Miyake & Friedman, 1998), including processing of gender agreement in L2 Spanish DPs (Sagarra, 2007).

5. Research questions

The present study used a self-paced moving window test to investigate (1) whether beginning and intermediate adult Anglophone learners can gain native-like responses to gender and number agreement in L2 Spanish adjectives as indicated by longer RTs in gender/number discord than concord; and (2) whether they process N-A gender and number agreement differently. We assume that learners whose RTs are qualitatively similar to those of Spanish monolinguals have gained processing and grammatical representations comparable to native speakers. Based on previous research, we hypothesize that beginning learners will be insensitive to agreement violations but that intermediates may gain sensitivity to concord violations. We also expect the intermediates to process number better than gender agreement violations as a function of WM.

6. The study

6.1. Participants

Sixty-three Spanish monolinguals, and 69 beginning and 64 intermediate late bilinguals participated in the study, having scored above 60% in experimental tasks. The monolingual control group included Spaniards with university education in areas other than linguistics. They were born and raised in Andalucía, had spent less than one month in a non-Spanish speaking environment, and did not speak any foreign language other than English. Furthermore, they had a self-reported low functional proficiency in English (the means for the four skills ranged between 3.13 and 4.21 out of 10). The bilingual groups were comprised of English native speakers enrolled in third- (beginners) or eighth-semester (intermediates) Spanish courses. They began learning Spanish post puberty, spoke no other languages, and had not lived in a Spanish-speaking country for more than three months. An independent-samples *t* test on the scores obtained in a Spanish proficiency test indicated that the intermediates ($M = 20.65$, $SD = 3.00$) were more proficient in Spanish than the beginners ($M = 7.04$, $SD = 2.89$): $t\ (125) = -22.667$, $p < .01$ (Levene's $F = .000$, $p > .05$). Finally, the chosen bilinguals had scored 100% on a gender test and a vocabulary test to guarantee that unfamiliar grammar or vocabulary would not hinder comprehension or sensitivity to gender or number violations.

6.2. Materials and procedure

Participants performed seven tests in two, one-hour sessions completed one week apart:

Session 1:

Language background questionnaire: monolingual and bilingual versions

Spanish proficiency test: based on the grammar section of the *Diploma de Español como Lengua Extranjera* (DELE) (intermediate level).

Moving window test: created using the experimental package e-Prime (Psychology Sofware Tools, Inc).

Session 2 (one week later):

Grammaticality judgment test: reported in another paper (Sagarra & Herschensohn, in press).

Grammar test: measured L2 knowledge of gender and number agreement and required bilinguals to read MS, MP, FS, and FP nouns and identify their gender and number.

Vocabulary test: assessed lexical knowledge of the target L2 nouns and adjectives and asked bilinguals to match nouns and adjectives in Spanish to their translation in English.

L1 reading span test (based on Waters & Caplan, 1996): evaluated working memory capacity and required participants to read sets of sentences in their native language one-by-one at a fast pace, and indicate whether or not each sentence was plausible, and recall the final word of each sentence at the end of each set.

The moving window test was written and self-paced, following research suggesting that late learners perform better on written than oral tasks (Montrul, Foote & Perpiñán, 2008) and on self-paced than timed tasks (Sabourin, 2003). This is important to ensure that task complexity does not consume attentional resources needed to attend to the redundant and not perceptually salient information encoded in adjectival morphology. Participants read plausible sentences in Spanish at their own pace one word at a time (non-cumulative display) and answered yes-no comprehension questions after each sentence to ensure that reading latencies were caused by grammatical violations rather than lack of understanding. Instructions emphasized the importance of accuracy in responding to the comprehension questions. Each participant read 114 sentences: 4 practice trials, 70 well-formed fillers, 10 fillers with semantic gender discord reported elsewhere, and 30 experimental sentences. A Latin square design was used to distribute sentences into blocks and avoid experimental sentences appearing too closely. The order of the blocks and the sentences within each block were counterbalanced, with a different order for each participant. All sentences were similar in length (9 to 15 words) and vocabulary.

Experimental sentences were structured NP1-VP-NP2-PP (2-4 syllable noun with transparent masculine gender, 2-3 syllable regular present tense verb, 3-4 syllable inanimate NP with adjective, PP). Each experimental sentence had three conditions: (1) gender/number concord, (2) gender discord, and (3) number discord. This is an example: *El padre quiere el trabajo perfecto/*perfecta/*perfectos para su hija* 'The father wants the job-MS perfect-MS/*perfect-*FS/*perfect-*MP for her daughter.' The nouns of the experimental sentences were [+count] in both languages, avoiding interpretive issues with mass nouns lacking the number feature. Sentences were novel in that the subjects had virtually no likelihood of previous encounter with the identical sentence; the subjects' responses then indicate a reaction to a grammatical phenomenon (concord/discord), not to a chunked string. Nouns that formed part of gender-inflected pairs (e.g., *fruto-fruta* 'fruit-M,F') (Câmara, 1970) were excluded, to avoid conceptual relationships with the opposite gender. Finally, nouns were transparent unmarked masculine singular ending in /-o/ (masculine, Harris, 1991; transparent, Antón-Méndez, 1999; singular number, Eberhard, 1997) based on research indicating that Spanish nouns' gender/number does not affect RTs of D, A (e.g., Alarcón, 2009; Antón-Méndez et al., 2002; Keating, 2009). We used these nouns in order to create a solid baseline for exploring gender/number congruency that excludes irrelevant comparisons (e.g., masculine/feminine, transparent/opaque, singular/plural or marked/unmarked). To avoid ungrammaticality being confounded with markedness, 20 filler sentences contained FS and MP noun-adjective well-formed combinations.

6.3. Scoring

For scoring, correct answers received 1 point and incorrect answers zero points for all tests but the moving window test. The moving window test generated two scores: accuracy on comprehension questions (rated 1 or 0) and mean RTs at the adjectives (i.e., the mean of all word RTs within a condition) in sentences with a correct answer to the question. Word RTs below 200 and above 2000 ms were excluded because monolinguals need between 225 and 300 ms to process single words (Rayner & Pollatsek, 1989). Finally, to receive 1 point for a sentence in the reading span test, both the plausibility judgment (processing) and the recalled word (storage) had to be accurate.

7. Results

7.1. Moving window test

We carried out statistical analyses on the mean RTs at the adjective and the words before and after it (Table 1), as well as on accuracy of the comprehension questions (Table 2). Table 2 shows that all participants had a good level of understanding (the lowest mean was 8.29 over 10).

Mean RTs at the word preceding the adjective were analyzed to ensure that longer RTs at the adjective were not due to variables extraneous to the study. A repeated-measures ANOVA with a 3 (Condition: gender agreement, gender violation, number violation) x 3 (Group: beginners, intermediates, Spanish monolinguals) factorial design showed no main effect for condition ($F(2,386) = 2.910$, $p > .05$) and no interaction of condition x group ($F(4,386) = 1.813$, $p > .05$), but there was a main significant effect for group ($F(2,193) = 84.992$, $p < .01$). Bonferroni post hoc tests showed that beginners were slower readers than intermediates and that beginners and intermediates were in turn slower than Spanish monolinguals (all $p < .01$) (see Clahsen & Felser, 2006, for similar findings). Identical between-group differences were found at the adjective, the word after the adjective, and accuracy of the comprehension questions.

Table 1
Mean RTs at the adjective and the words before and after the adjective

	Gender/Number Agreement		Gender Violation		Number Violation	
	M	*SD*	*M*	*SD*	*M*	*SD*
Word before the adjective:						
Beginners	1,033.03	450.69	1,020.69	375.66	956.92	368.42
Intermediates	890.84	314.95	835.41	291.43	819.15	287.70
Spanish monolinguals	469.35	168.09	492.75	175.23	495.15	174.81
Adjective:						
Beginners	901.32	332.83	911.36	310.13	952.47	359.71
Intermediates	708.83	207.43	823.82	276.62	855.64	258.98
Spanish monolinguals	465.34	115.06	554.96	189.89	546.39	166.88
Word after the adjective:						
Beginners	550.52	144.00	530.54	120.70	521.27	138.85
Intermediates	445.70	85.48	536.43	137.73	514.80	120.42
Spanish monolinguals	385.97	70.99	449.71	111.25	433.78	80.65

Note- $n = 69$ for beginners, $n = 64$ for intermediates, and $n = 63$ for Spanish monolinguals.
Note - $K = 10$

Table 2
Accuracy on the comprehension questions of the moving window test

	Gender/Number Agreement		Gender Violation		Number Violation	
	M	*SD*	*M*	*SD*	*M*	*SD*
Beginners	8.67	1.23	8.57	1.05	8.32	1.18
Intermediates	8.80	1.28	8.72	1.19	8.75	1.20
Spanish monolinguals	9.49	.64	8.84	.99	9.44	.64

Note- $n = 69$ for beginners, $n = 64$ for intermediates, and $n = 63$ for Spanish monolinguals.
Note - $K = 10$

Repeated-measures ANOVAs conducted for these three variables revealed a significant main effect for Condition (adjective: $F(2,386) = 16.608$, $p < .01$; adjective + 1: $F(2,386) = 11.887$, $p < .01$; questions: $F(2,386) = 4.282$, $p < .05$) and Group (adjective: $F(2,193) = 54.995$, $p < .01$; adjective + 1: $F(2,193) = 27.129$, $p < .01$; questions: $F(2,193) = 16.258$, $p < .01$), as well as a significant interaction of Condition x Group (adjective: $F(4,386) = 2.407$, $p < .05$; adjective + 1: $F(4, 386) = 7.923$, $p < .01$; questions: $F(4,386) = 4.075$, $p < .01$). Bonferroni post hoc tests revealed no significant differences in any of the variables for beginners (all $p > .05$). Intermediates and Spanish monolinguals, however, spent more time on sentences with gender or number violations than with gender/number agreement (all $p < .01$), and Spanish monolinguals were more accurate in answering questions about sentences with gender/number agreement than gender disagreement ($p < .01$). Also, only the monolinguals showed gender-number differences: they were better at answering questions about sentences with number than gender discord ($p < .01$), suggesting that gender agreement is more difficult.

To rule out the possibility that the reading latencies found in intermediates are caused by markedness (use of F-S or M-P), an additional 5 (Condition) x 3 (Group) repeated-measures ANOVA was conducted on the mean RTs at the adjective in the following conditions: MS-MS (correct experimental sentences), FS-FS and MP-MP (correct fillers), and MS-*FS, MS-*MP (incorrect experimental sentences). The results showed a significant main effect for Condition ($F(4,756) = 31.793$, $p < .01$) and Group ($F(4,756) = 31.793$, $p < .01$), and a significant interaction of condition x group ($F(4,756) = 31.793$, $p < .01$). Bonferroni posthoc tests revealed no significant differences for beginners but longer RTs in conditions MS-*FS, MS-*MP than MS-MS, FS-FS, and MP-MP, regardless of whether the gender and number of the noun was marked or not, implying that intermediates' reading latencies in sentences with gender/number violations were a result of sensitivity to disagreement.

7.2. Reading span test

Multiple bivariate correlations revealed that working memory (higher span) positively correlated with intermediates' mean RTs (longer RTs) at adjectives in sentences with gender discord (: $r = .334$, $p < .01$). These findings indicate that higher working memory capacity increases sensitivity to L2 gender discord in intermediates, and that gender concord is cognitively more demanding than number concord (WM did not correlate with number discord). No significant correlations were obtained for Spanish monolinguals and beginners due to ceiling effects and low WM span of the group, respectively.

8. Discussion and conclusion

This study investigated whether or not Anglophone learners of L2 Spanish can gain sensitivity to gender and number agreement, indicating acquisition of L2 grammatical features of gender and number on adjectives, and whether they process N-A gender and number agreement differently. The results show that beginners are insensitive to gender and number agreement violations but that intermediates and Spanish monolinguals are sensitive to such violations. The findings also reveal no significant differences between gender and number agreement violations for any of the groups.

The first research question asked whether beginning and intermediate English-Spanish late bilinguals can gain native-like sensitivity to gender and number concord/discord for adjectives in the L2. Our results bore out our hypothesis that beginners would not be sensitive to gender or number agreement violations but that intermediates and Spanish monolinguals would be: indeed, the last groups showed sensitivity to both violation types (i.e., longer RTs for adjectives that disagreed than for those that agreed). The lack of significant differences in beginners could be due to factors other than initial L1 transfer, including slower processing speed, limited L2 knowledge, and a shortage of processing resources. However, beginners' high accuracy on the comprehension questions and the grammar and lexical tests suggests that their L2 knowledge was adequate for the experimental task and stimuli.

We interpret the longer RTs in incongruent sentences of the intermediates as a reaction to discord, not as a reaction to the marked form of gender (feminine) and number (plural) in the adjective for two reasons. First, many studies (cited above) indicate that a noun's gender or number does not influence

RTs of congruent/incongruent D/A in L1 or L2 Spanish. More pertinently, we found no reading latencies in feminine and plural adjectives in congruent filler sentences, which we would expect if non-default forms were responsible for reading latencies in feminine and plural adjectives in incongruent sentences. Statistical analyses comparing adjectives presented in the non-default form (feminine for gender, plural for number) in both congruent and incongruent sentences proved latencies to be a function of discord, not of non-default status. Indeed, the analyses showed longer RTs in adjectives that disagreed with the noun than with those that agreed with it for both intermediate learners and Spanish monolinguals.

The intermediate group is qualitatively similar to the Spanish native speakers in showing longer latencies to both gender and number disagreement than to agreement conditions on the adjective. One might attribute L2 sensitivity to gender and number concord/discord on A to lexical learning, knowledge that should be evident as explicit memorization of morphological rules. Indeed, deficit approaches attribute accuracy in L2 gender production or perception to either lexical memorization or inference by phonological pattern (Hawkins & Franceschina 2004). However, the intermediates clearly show implicit command of gender/number agreement on A, disconfirming the declarative knowledge/explicit learning idea. The sensitivity to gender agreement documented by the moving window test is indicative of implicit morphosyntactic knowledge, not lexical memorization.

The second research question examined whether or not these subjects would process grammatical gender and number agreement differently. The data revealed no significant differences for any of the three groups, results that could be attributed to ceiling and floor effects for the natives and beginners respectively. These findings contradict models claiming that gender agreement is cognitively more demanding than number agreement (Faussart et al., 1999). In the case of intermediate learners, the similarity between gender and number agreement could be due to imprecision of the instrument, which was not sensitive enough to replicate differences between gender and number concord recorded in earlier studies of monolinguals. Another possible reason is that the intermediate learners had developed equal sensitivity to both gender and number violations due to frequent pedagogical feedback.

Finally, we found that while working memory was insignificant for monolinguals (ceiling) and beginners (floor), it was indeed significant at the intermediate level and also mediated differences between number and gender processing. Recall that working memory positively correlated with their capacity to notice gender disagreement but not number disagreement, suggesting that gender disagreement is cognitively more taxing than number disagreement. This intermediate group—the one demonstrating an emerging computation of gender concord—is also the one showing working memory effects, whereas it is essentially irrelevant at ceiling.

In conclusion, we found that beginners are insensitive to gender and number concord/discord distinctions, while intermediates, as monolinguals, demonstrate sensitivity to number and gender concord and discord. At the relatively early level of L2 development documented here, the intermediate Anglophone learners (without gender or concord in their L1) give evidence of processing responses that are qualitatively similar to those of natives. Furthermore, they seem to rely partially on working memory capacity since intermediates with higher memory span show greater sensitivity to gender over number disagreement. More generally, the beginners do not differ in reactions to gender or number, nor do the monolinguals (contrary to some earlier studies), suggesting that our instrument may not be sensitive enough to test this distinction. Finally, from the pattern of development of computation, we infer that L2 grammatical representation may qualitatively similar to that of monolinguals.

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