

Fluency in Using Morphosyntactic Cues to Establish Reference: How Do Native and Non-Native Speakers Differ?

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In Spanish, all nouns are either feminine or masculine, and gender agreement is marked on preceding determiners, such as the definite articles *la*_[fem] and *el*_[masc]. Despite substantial regularity between articles and nouns, grammatical gender systems are difficult for second language (L2) learners to master. In our previous eye-tracking research, we found that native Spanish speaking children and adults, took advantage of informative gender-marked articles to more rapidly identify objects in the visual field, but that L2 adults did not show such efficiency in processing (Lew-Williams & Fernald, 2007a, 2007b). The research reported here pursued two primary goals. First, we investigated whether L1 and L2 adults could take advantage of gender-marked articles when processing sentences with newly learned Spanish nouns. Second, we explored whether L1 and L2 adults could exploit articles that were informative about biological gender or number information about subsequent nouns. In four experiments, we examined differences in how L1 and L2 speakers process Spanish articles indexing membership in arbitrary noun classes as opposed to information that is more semantically relevant to referents.

Research on the processing of grammatical gender converges on the finding that adult native speakers use gender information to identify subsequent words more rapidly (Grosjean, Dommergues, Cornu, Guillelmon, and Besson, 1994; Bates et al., 1996; Dahan, Swingley, Tanenhaus, & Magnuson, 2000). Lew-Williams and Fernald (2007a) explored whether young children might show such efficiency in processing. In the looking-while-listening procedure (see Fernald, Zangl, Portillo, & Marchman, 2008), Spanish-learning 2- and 3-year-olds and their monolingual Spanish-speaking parents viewed pairs of pictures with names of either the same (e.g., *pelota*, 'ball', *galleta*, 'cookie') or different grammatical gender (*pelota*, *zapato*, 'shoe'), as they heard a Spanish sentence referring to one picture (*Encuentra la pelota*, 'Find the ball'). Eye movements were used to calculate how long it took listeners to locate the target referent. Both children and their parents were faster to orient to the target on different-gender trials, where the short, unstressed article was informative, than on same-gender trials, where the article was not informative about the subsequent noun. With only 500 words in their vocabulary, Spanish-learning children already demonstrated a processing advantage characteristic of adult L1 speakers.

Can L2 adults take advantage of gender information to more rapidly identify nouns? Guillelmon and Grosjean (2001) found that participants who had learned French as young adults were less able to make efficient use of

morphosyntactic cues in an auditory naming task, as compared to native French speakers and early L2 learners—a surprising finding given that all participants had been immersed in French for at least 20 years. In a related study in German, L2 speakers showed the same insensitivity to gender marking, while L1 speakers used gender agreement to facilitate lexical access (Scherag, Demuth, Rösler, Neville, & Röder, 2004). Lew-Williams and Fernald (2007b), in an eye-tracking procedure, found that L2 learners of Spanish did not take advantage of informative gender-marked articles to more rapidly identify familiar objects.

Rather than concluding that L2 learners are fundamentally different from L1 speakers in how they represent and process grammatical gender information, we designed four experiments that further investigate how listeners understand article-noun sequences in real time. Experiments 1 and 2 asked whether L1 and L2 Spanish-speaking adults would show a processing advantage when tested on newly learned nouns preceded by informative gender-marked articles. When listeners first learn a novel object name paired with a particular article, can they generalize to a different article they have never before heard paired with that noun? Or is experience with a specific article-noun sequence required for the listener to use the article as a predictive cue?

2. Experiment 1

2.1. Participants

L1 adults were 12 Spanish/English bilinguals who had learned Spanish from birth ($M = 20.1$ years). L2 adults were 12 native English-speakers ($M = 19.7$ years) exposed to Spanish at a mean age of 12.2 years (range = 7-18), with a mean 5.2 years of classroom exposure to Spanish (range = 1-9). All participants were university students. Mean self-reported proficiency in understanding Spanish was 4.8 (out of 5) for L1 adults and 3.2 for L2 adults.

2.2. Stimuli and Procedure

L1 and L2 adults were exposed to four unfamiliar objects paired with four novel nouns, half feminine and half masculine. On Teaching Trials, the speech stimuli consisted of a simple sentence frame (*¡Mira, es*, ‘Look, it’s’) followed by one of four novel nouns, each preceded by an unstressed definite article (*la catela*_[f], *la pifa*_[f], *el durino*_[m], or *el tebo*_[m]). The novel nouns were designed to have little phonetic overlap with existing Spanish words. On Test Trials, the four nouns were paired with the same definite articles used in teaching, preceded by a different frame (*¿Dónde está*, ‘Where is’). Duration of sentence frames ($M = 1165$ ms, range = 1164-1165 ms), articles ($M = 281$, range = 277-283), and nouns ($M = 718$, range = 646-794) used on Test Trials were edited to closely parallel stimuli from Lew-Williams and Fernald (2007a, 2007b). All speech stimuli were recorded by a female native Spanish speaker. The visual stimuli were colorful digital pictures of novel objects as well as pictures of 12 familiar objects used on filler trials.

In the looking-while-listening procedure, participants were presented with 24 Teaching Trials, 32 Test Trials, and 24 filler trials in one of two counterbalanced orders. On Teaching Trials, each novel word was linked to a novel object. Each novel object was shown six times on a central screen, while participants heard a prerecorded sentence with the appropriate novel noun preceded by a definite article. On Test Trials, participants viewed pairs of the novel objects side by side and heard sentences containing the same sequences of definite articles and newly learned nouns. Each novel object served as target on eight Test Trials and as distractor on eight Test Trials. Half of the Test Trials were *same-gender trials*, on which the two pictures had names of the same grammatical gender (e.g., *catela, pifa*), and half were *different-gender trials*, on which the two pictures had names that differed in grammatical gender (e.g., *catela, durino*). On each trial, pictures were visible for 2 s prior to the speech signal, for the duration of the 3-s sentence, and for 1 s after the speech signal.

Eye movements were video-recorded from a centrally located digital video camera. Using custom software, eye movements were coded offline, frame by frame, with 33 ms resolution. A digital time-code was time-locked to speech information independently for each trial, and coders blind to trial type indicated at each frame whether the participant was looking left, right, between the pictures, or to outer space. To assess the reliability of eye-movement coding, a second observer coded 25% of trials from 25% of participants in each group. Inter-coder agreement within a single frame was 99.8% for L1 adults and 99.1% for L2 adults.

2.3. Measures of speech processing efficiency

Since participants could not know in advance which picture would be named, they were by chance equally likely to be looking at the target or distractor picture at the onset of the target word. If they were already looking at the correct picture (target-initial trials), they should maintain fixation; but if they were looking at the distractor picture (distractor-initial trials), they should shift quickly to the named picture. Distractor-initial trials were used to calculate reaction time (RT), the latency to initiate an eye movement toward the target picture. RT was calculated from article onset—the first moment in the unfolding sentence where participants received relevant acoustic information. Shifts initiated in the first 300 ms were not included in analyses, because they were likely to represent random shifting that occurred prior to the possible influence of the article. RTs were included in analyses if they occurred between 300 and 1300 ms from article onset, corresponding to the length of the article and noun.

2.4. Results and Discussion

We found that both L1 and L2 adults took advantage of informative gender-marked articles to identify the correct referent more quickly on different-gender than on same-gender trials, as shown in Figure 1.

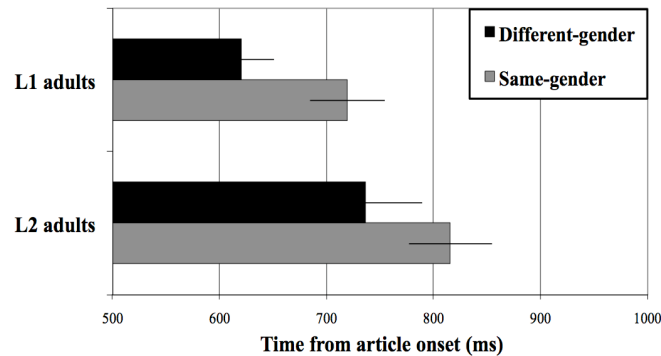


Figure 1. When the same gender-marked articles were used in teaching and testing, both L1 and L2 adults took advantage of informative articles to more rapidly identify newly learned nouns.

Mean RTs were analyzed in a 2 (group) x 2 (trial type) repeated-measures ANOVA. The main effect of group was significant, $F(1,22) = 4.5$, $p < .05$, with L1 adults showing faster absolute processing speed than L2 adults. Participants responded faster overall on different-gender trials than on same-gender trials, $F(1,22) = 10.9$, $p < .005$. The group x trial type interaction was not significant, $F(1,22) = .1$, $p = .72$, indicating a comparable effect of trial type across groups. Planned comparisons showed that the main effect of trial type was significant for L1 adults, $t(11) = 2.5$, $p < .03$, and marginally significant for L2 adults, $t(11) = 2.1$, $p < .055$. Among L2 adults, the self-report measures of Spanish experience, proficiency, and age of exposure were not significantly correlated with overall RT or efficiency in processing.

To what degree do these results reveal anything about processing grammatical gender? On the one hand, the verbal stimuli were in Spanish and listeners clearly took advantage of a potentially informative pronominal determiner to process newly learned nouns more rapidly. However, this study failed to capture an important property of grammatical gender in natural speech: that no noun is uniquely associated with a single determiner. For example, parental utterances from the Child Language Data Exchange System reveal that young Spanish-learning children hear the noun *pelota* preceded by a variety of determiners: the definite and indefinite articles *la* and *una*, the demonstrative *esta* ('this'), the comparative *otra* ('other'), and the plural forms of these and other determiners. However, in Expt. 1, *catela* and *pifa* were always preceded by *la*, and *durino* and *tebo* were always preceded by *el*.

In the next experiment, we modified the design of Expt. 1 such that successful performance required generalization between different article forms. Participants learned novel nouns in sentences with *indefinite* articles, and were subsequently tested on their processing of the nouns using sentences with *definite* articles.

3. Experiment 2

3.1. Participants

L1 adults were 18 Spanish/English bilinguals who had learned Spanish from birth ($M = 20.0$ years). L2 adults were 22 native English-speakers ($M = 19.9$ years) exposed to Spanish at a mean age of 12.1 years (range = 6-19). Among L2 adults, mean years of classroom exposure to Spanish was 5.6 (range = 1-9). All participants were university students. Mean self-rated proficiency in understanding Spanish was 4.9 (out of 5) for L1 adults and 3.5 for L2 adults.

3.2. Stimuli and Procedure

In Expt. 2, Teaching Trial sentences contained indefinite articles and Test Trial sentences contained definite articles. Thus, different determiner forms were used in teaching and testing, unlike Expt. 1. Otherwise, the methods used in Expt. 2 were identical to those used in Expt. 1. Waveforms were edited to control for the duration of sentence frames ($M = 1165$ ms, range = 1164-1165 ms), definite articles ($M = 280$, range = 278-283), and novel nouns ($M = 717$, range = 645-793). Reliability coding was conducted on 6.25% of trials: the proportion of frames on which two independent coders agreed within a single frame was 96.6% for L1 adults and 97.9% for L2 adults.

3.3. Results and Discussion

The important finding in Expt. 2 was that L1 adults took advantage of informative gender-marked articles to identify the referent more quickly, but L2 adults did not. That is, on different-gender trials, L1 adults made use of an article they had not heard paired with the novel noun during Teaching Trials to identify the referent more quickly, while L2 adults failed to take advantage of the gender-marked article as a predictive cue, as shown in Figure 2.

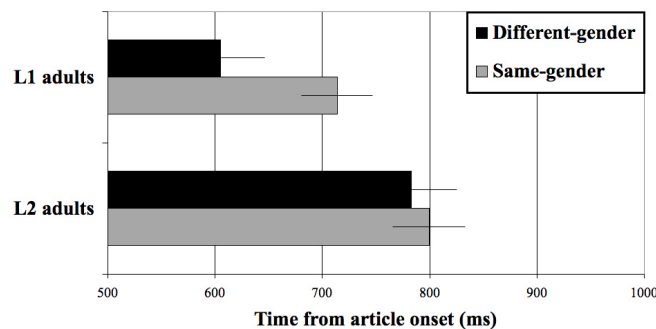


Figure 2. When different forms of gender-marked articles were used in teaching and testing, only L1 adults took advantage of informative articles to more rapidly identify newly learned nouns.

Mean RTs were analyzed in a 2 (group) x 2 (trial type) repeated-measures ANOVA. Participants responded faster overall on different-gender than on

same-gender trials, $F(1,38) = 14.9$, $p < .001$. A significant group x trial type interaction, $F(1,38) = 8.1$, $p < .01$, showed that this effect varied by group. The effect of trial type was significant for L1 adults, $t(17) = 4.6$, $p < .001$, but not for L2 adults, $t(21) = .8$, $p = .46$. The main effect of group was significant, $F(1,38) = 6.5$, $p < .02$, indicating that L1 adults were faster in absolute processing speed than L2 adults, consistent with results from Expt. 1.

Among L2 adults, overall RT was significantly correlated with self-reported Spanish proficiency, $r(21) = -.40$, $p < .04$, but not with number of years of Spanish classes or age of exposure to Spanish. Efficiency of processing, defined as a difference score between RT on same-gender and different-gender trials, was correlated with years of classroom exposure to Spanish with marginal significance, $r(21) = .38$, $p < .08$, suggesting that those with more Spanish experience were slightly faster in taking advantage of informative articles with newly learned words. The task of generalizing between article forms in rapid language processing in Expt. 2 may have differentiated more practiced L2 Spanish learners from those who had less experience with the Spanish language.

Although L1 and L2 adults had all heard the novel nouns the same number of times, equating for frequency of exposure, only L1 adults were able to generalize from the indefinite to the definite article form. L2 adults waited to hear the noun before initiating a gaze shift, just as they did with familiar nouns in Lew-Williams and Fernald (2007b). The findings from these studies could indicate that L2 adults lack 'ideal' knowledge of grammar (Bley-Vroman, 1990) or have less detailed representations of L2 structure that are difficult to compute in comprehension (Clahsen & Felser, 2006). But do non-native Spanish speakers have comparable difficulty processing determiners that also carry semantic information? For inanimate nouns in the Spanish grammatical gender system, the articles *la* and *el* index membership in largely arbitrary noun classes. However, the structure of the Spanish language presents an opportunity to explore the processing of grammatical morphemes that convey morphosyntactic and semantic information. Some nouns are clearly feminine or masculine based on biological gender, e.g., *niña-niño*, 'girl-boy.' Nouns can also convey semantically transparent number information, e.g., *caballo-caballos*, 'horse-horses,' and Spanish articles like *las* and *los* must be marked for number agreement. Children have been shown to learn morphosyntactic units that convey semantically transparent features like natural gender and number information prior to those that denote semantically arbitrary features like grammatical gender (Mulford, 1985; Pinker, 1984). These findings suggest that L2 adults may be able to efficiently process articles that convey semantically transparent features of the visual context.

4. Experiment 3

4.1. Participants

L1 adults were 20 Spanish/English bilinguals who had learned Spanish from birth ($M = 19.1$ years). L2 adults were 21 native English-speakers ($M =$

19.4 years) exposed to Spanish at a mean age of 11.7 years (range = 6-18). Among L2 adults, mean years of classroom exposure to Spanish was 4.9 (range = 2-8). All participants were university students. Mean self-rated proficiency in understanding Spanish was 4.7 (out of 5) for L1 adults and 3.8 for L2 adults.

4.2. Stimuli and Procedure

In the looking-while-listening procedure, participants heard sentences consisting of a sentence frame (*Encuentra*, 'Find') followed by one of four nouns referring to people, each preceded by a gender-marked article (*la niña*, 'the girl,' *el niño*, 'the boy,' *la señora*, 'the woman,' or *el señor*, 'the man'). The waveform of each sentence was edited to control for the duration of the sentence frames ($M = 909$, range = 900-918), definite articles ($M = 299$, range = 297-299), and nouns ($M = 750$, range = 718-786). Visual stimuli were digital pictures of female and male humans, half depicting children and half depicting adults.

On each trial, participants heard a sentence while viewing two pictures side-by-side, as in Expts. 1 and 2. Eight trials were *same-gender trials*, where each picture depicted a person of the same gender, and eight trials were *different-gender trials*, where pictures depicted one female and one male. Test sentences were interspersed among 40 filler trials in two counterbalanced orders. The proportion of frames on which two independent coders agreed within a single frame was 98.2% for L1 adults and 97.8% for L2 adults.

4.3. Results and Discussion

In our previous research (Lew-Williams and Fernald, 2007b), L2 adults failed to exploit informative gender-marked articles that preceded the names of familiar nouns belonging to grammatical gender categories. In Expts. 1 and 2 reported here, L2 adults failed to take advantage of gender-marked articles that preceded novel nouns unless the same article-noun pairs were heard throughout the experiment. However, in Expt. 3, L2 adults—like L1 adults—succeeded in using informative gender-marked articles when nouns and their referents belonged to biological gender categories.

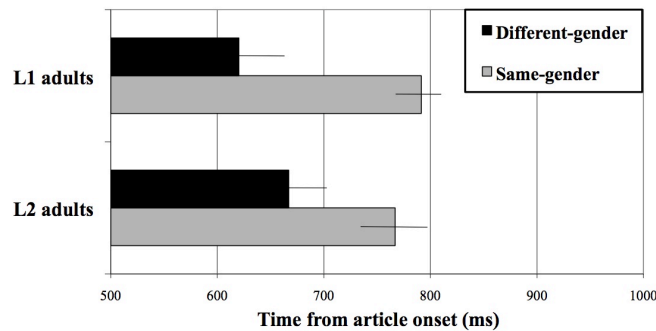


Figure 3. Both L1 and L2 adults took advantage of gender-marked articles to more rapidly identify pictures of females and males.

Like in Expts. 1 and 2, mean RTs were analyzed in a 2 (group) x 2 (trial type) repeated-measures ANOVA. Participants responded faster overall on different-gender than on same-gender trials, $F(1,39) = 22.2$, $p < .001$. The group x trial type interaction was not significant, $F(1,39) = 1.5$, $p = .22$, showing that the effect of trial type did not vary by group. Planned comparisons revealed that the main effect of trial type was significant for both L1 adults, $t(19) = 4.0$, $p < .001$, and for L2 adults, $t(20) = 2.6$, $p < .02$. Unlike Expts. 1 and 2, the main effect of group was not significant, $F(1,39) = 0.1$, $p = .79$, indicating that L1 and L2 adults showed comparable speed in processing article-noun sequences. This suggests that nouns referring to people of particular gender are processed with the same speed regardless of status as a native or non-native Spanish speaker. Correlational analyses indicated that speed and efficiency in processing were not significantly correlated with the self-report measures of proficiency, years of Spanish instruction, or age of exposure to Spanish.

This experiment uncovered a difference between making use of a subtle morphosyntactic cue that indexes membership in arbitrary noun classes vs. categories that are easily recognizable as feminine or masculine. L1 and L2 adults used Spanish articles to more rapidly orient to pictures of females and males. Our next experiment explored a variation of this experimental design: articles in Expt. 4 were not informative about biological gender, but about number information. On each trial, L1 and L2 adults viewed two pictures depicting either the same number of objects or a different number of objects. Will L1 and L2 adults be able to use informative number-marked articles to more rapidly identify pictures of single vs. multiple objects?

5. Experiment 4

5.1. Participants

L1 adults were 19 Spanish/English bilinguals who had learned Spanish from birth ($M = 18.9$ years). L2 adults were 21 native English-speakers ($M = 19.3$ years) exposed to Spanish at a mean age of 11.3 years (range = 5-20). Among L2 adults, mean years of classroom exposure to Spanish was 5.1 (range = 1-8). All participants were university students. Mean self-rated proficiency in understanding Spanish was 4.9 (out of 5) for L1 adults and 3.4 for L2 adults.

5.2. Stimuli and Procedure

In the looking-while-listening procedure, participants heard sentences consisting of a sentence frame (*Encuentra*, 'Find,' or *Mira*, 'Look at') followed by one of eight article-noun pairs, half singular and half plural (*el carro*, *los carros*, 'the_[sing]/the_[plu] car/s,' *el zapato*, *los zapatos*, 'the shoe/s,' *el caballo*, *los caballos*, 'the horse/s,' *el pájaro*, *los pájaros*, 'the bird/s'). Only masculine nouns were used in this experiment, since the masculine definite articles *el* and *los* diverge phonologically at article onset, unlike the feminine definite articles *la* and *las*. This ensured that participants had an equivalent amount of time to take advantage of relevant acoustic information prior to noun onset as in the

previous experiments. The waveform of each sentence was edited to control for the duration of the sentence frames ($M = 802$, range = 734-930), definite articles ($M = 293$, range = 280-299), and nouns ($M = 766$, range = 690-831). Visual stimuli were colorful digital pictures of the named objects. Half of the pictures showed one object (e.g., one car), and half of the pictures showed two objects (e.g., two cars).

Sixteen trials were *same-number trials*, where each picture depicted the same number of referents (e.g., one car vs. one shoe), and 16 trials were *different-number trials*, where pictures depicted different numbers of referents (e.g., two cars vs. one shoe). Test sentences were interspersed among 24 filler trials in two counterbalanced orders. The proportion of frames on which two coders agreed within a single frame was 96.9% for L1 adults and 97.6% for L2 adults.

5.3. Results and Discussion

Both L1 and L2 adults took advantage of articles that were informative about number information of the target referent(s), as shown in Figure 4.

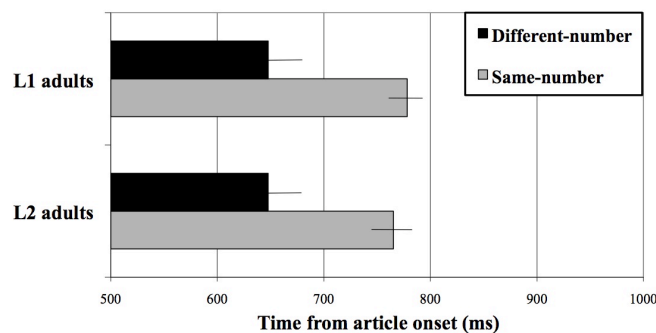


Figure 4. Both L1 and L2 adults took advantage of number-marked articles to more rapidly identify pictures showing single vs. multiple objects.

Mean RTs were analyzed in a 2 (group) x 2 (trial type) repeated-measures ANOVA. Participants responded faster overall on different-number than on same-number trials, $F(1,38) = 35.6$, $p < .00001$. The group x trial type interaction was not significant, $F(1,38) = 0.1$, $p = .76$, showing that the effect of trial type did not vary by group. Planned comparisons revealed that the main effect of trial type was significant for both L1 adults, $t(18) = 4.0$, $p < .001$, and for L2 adults, $t(20) = 4.5$, $p < .001$. Like Expt. 3, the main effect of group was not significant, $F(1,38) = 0.1$, $p = .85$, indicating that L1 and L2 adults showed comparable speed in processing the article-noun sequences used in this experiment. Among L2 adults, those individuals with a greater number of years of classroom exposure to Spanish showed faster overall RT, $r(20) = -.51$, $p < .02$, suggesting that speed in processing number-marked articles and nouns became faster as learners gained more exposure to Spanish.

Together, Expts. 3 and 4 showed that non-native Spanish speakers—like those who learned Spanish from birth—reliably succeeded in exploiting Spanish articles that were informative about the biological gender or number of upcoming referents. In our previous research (Lew-Williams & Fernald, 2007b), we found that non-native speakers also had success in taking advantage of informative verbs, as in *Cómete la galleta* vs. *Encuentra la galleta* ('Eat/Find the cookie'). Thus in three experimental designs exploring real-time language processing, we have found that L2 learners more effectively exploited cues that conveyed semantic information about the referential context.

6. General Discussion

This research explored differences in the speed and efficiency with which native and non-native Spanish-speakers process article-noun pairs in relation to novel objects, human females and males, and familiar objects. L1 Spanish-speaking adults consistently took advantage of informative gender-marked articles (*la*, *el*) to more rapidly establish reference. In contrast, L2 Spanish speakers showed more variable performance in exploiting articles as predictive cues. After learning novel nouns, they did not make use of gender-marked articles unless the same article-noun pairs were repeated throughout the experiment. However, they succeeded in using gender-marked articles to more rapidly initiate gaze shifts to pictures of females and males, and they also succeeded in taking advantage of number-marked articles to more rapidly identify single vs. multiple referents. Thus L2 adults interpreted the same grammatical units—short articles like *la* and *el*—more effectively when they indicated more meaningful information about the referential context.

In the field of second language learning, the conventional way to explain poorer performance by non-native speakers on language tasks is to posit a lack of 'nativelike' grammatical knowledge due to learning the L2 beyond a biologically determined period of maximal sensitivity to input (Bley-Vroman, 1990; Hawkins & Chan, 1997). Researchers have also proposed that L2 learners have difficulty accessing and retrieving grammatical knowledge in situations that demand rapid language processing (e.g., Sharwood Smith, 1986; Clahsen & Felser, 2006). Our experiments cannot distinguish between these two classes of arguments. However, we can begin to understand L1-L2 differences in learning about relations between articles and nouns by thinking critically about exposure to language in early home interactions vs. second language classrooms—particularly in combination with characteristics of younger and older learners.

L1 adults in these experiments presumably learned Spanish through dynamic interactions with caregivers who offered frequent exposure to articles and nouns for several hours per day. Child-directed speech of this nature provided data that highlighted co-occurrences between articles and nouns, and researchers from different theoretical backgrounds have proposed that children may initially perceive article-noun sequences as single lexical items and only gradually extract articles as distinct morphological units (J.B. Carroll, 1939;

MacWhinney, 1978; Pinker, 1984; S. Carroll, 1989; Wicha et al., 2005). In contrast, L2 adults likely began the process of language learning with top-down knowledge about relations between articles and nouns, since they are taught explicitly about rules for marking article-noun agreement. Their difficulty processing grammatical gender cues may be emergent from other important environmental factors: for example, L2 adults only heard Spanish during hour-long classes on weekdays, they learned language in classrooms with many other novices, and they overheard classmates committing gender and number agreement errors. Moreover, their first language, English, has no grammatical gender system, thus L2 adults may have transferred L1 processing strategies and simply waited for noun onset before initiating a search for the target referent (see Sabourin, Stowe, & de Haan, 2006). L1-L2 transfer may also explain L2 adults' successful performance in Expts. 3 and 4: L2 had gained substantial experience hearing English pronouns in reference to females and males (e.g., *she, he, her, him*) and hearing singular and plural demonstratives in reference to single vs. multiple referent (e.g., *this, that, these, those*). L2 adults may have transferred this experience to processing in Spanish.

In the four experiments reported here, language stimuli were identical across trial types—it was the interplay of language knowledge with visual information that determined how components of the sentences could be used in rapid processing. Moreover, strategies used in language interpretation depended on world knowledge about similarities and contrasts between the referents visible at any given time. Native Spanish speakers took advantage of whatever linguistic information was useful in each context, which varied across trial types: on same-gender trials (or same-number trials), noun onset marked the first acoustic information that could help listeners determine the target referent, while on different-gender trials (or different-number trials), listeners could identify the referent at article onset. Non-native Spanish speakers took advantage of informative articles under more limited circumstances, when nouns were preceded by a single article form with such regularity that the sequence could be rote memorized as a single lexical item (Expt. 1), and when referents had obvious semantic properties, such as biological femininity vs. masculinity (Expt. 3) and singularity vs. plurality (Expt. 4).

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