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Young Children Learning Spanish Make Rapid Use of Grammatical Gender in Spoken Word Recognition

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Abstract

All nouns in Spanish have grammatical gender, with obligatory gender marking on preceding articles (e.g., la *and* el, the feminine and masculine forms of "the," respectively). Adult native speakers of languages with grammatical gender exploit this cue in on-line sentence interpretation. In a study investigating the early development of this ability, Spanish-learning children (34–42 months) were tested in an eye-tracking procedure. Presented with pairs of pictures with names of either the same grammatical gender (la pelota, "*ball [feminine]*"; la galleta, "cookie [feminine]") or different grammatical gender (la pelota; el zapato, "shoe [masculine]"), they heard sentences referring to one picture (Encuentra la pelota, "Find the ball"). The children were faster to orient to the referent on different-gender trials, when the article was potentially informative, than on same-gender trials, when it was not, and this ability was correlated with productive measures of lexical and grammatical competence. Spanish-learning children who can speak only 500 words already use gender-marked articles in establishing reference, a processing advantage characteristic of native Spanish-speaking adults.

To begin making sense of speech, young language learners must discern regularities in sequences of sounds used by speakers of their particular language. Months before speaking a word, infants become attuned to characteristic sound patterns in the ambient language (e.g., Kuhl, 2004), but early perceptual specialization in infancy is just the beginning of the process of "becoming a native listener" (Werker, 1989). Much less is known about how language-specific processing strategies develop beyond the first year, as children come to appreciate regularities in their native language and use this knowledge in interpreting sequences of words. Here we show how 2- to 3-year-old Spanish-learning children take advantage of morphosyntactic cues to grammatical gender to identify words in on-line comprehension.

In many languages, nouns have grammatical gender. In Spanish, all nouns are masculine or feminine; German and Russian have a third, neuter category, and some languages have four or more noun classes (Corbett, 1991). In many languages with grammatical gender, certain words associated with nouns (e.g., articles, adjectives) must be marked for gender agreement. In Spanish, the definite article matches the noun in gender and number—*la* [feminine] or *el* [masculine] in the singular form, and *las* or *los* in the plural. Given that a single form (e.g., *the* in English) suffices in other languages, grammatical gender might seem to be a potentially "costly" linguistic device in terms of both learning and processing demands. However, a possible benefit of this complexity is that consistent phonological and morphosyntactic marking of gender agreement within phrases and across sentences could help listeners keep track of multiple referents in discourse. Although the article *the* reveals

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little about the English noun that follows, hearing *la* or *el* in Spanish could inform the listener about the gender and number of the upcoming noun.

The idea that cues to grammatical gender might facilitate speech processing has been investigated using on-line methods to measure speed of identifying words with and without gender marking. Studies show that adults respond more rapidly to nouns preceded by valid cues to grammatical gender than to nouns without such cues; this pattern has been demonstrated in several languages, including French (Dahan, Swingley, Tanenhaus, & Magnuson, 2000; Grosjean, Dommergues, Cornu, Guillelmon, & Besson, 1994), Italian (Bates, Devescovi, Hernandez, & Pizzamiglio, 1996), Spanish (Wicha, Moreno, & Kutas, 2004), and German (Friederici & Jacobsen, 1999).

Can children just beginning to learn a language with grammatical gender take advantage of gender marking in interpreting spoken sentences? Studies using eye-tracking techniques have monitored the time course of sentence interpretation by very young children learning English (e.g., Fernald, Pinto, Swingley, Weinberg, & McRoberts, 1998; Swingley & Aslin, 2002) and Spanish (Hurtado, Marchman, & Fernald, 2007). Just as adults process speech incrementally, 2-year-olds can identify familiar words that are not yet complete (Fernald, Swingley, & Pinto, 2001; Swingley, Pinto, & Fernald, 1999) and attend to morphosyntactic regularities that enable them to identify upcoming content words more efficiently (Fernald & Hurtado, 2006). For example, English-learning 2-year-olds expect an object name to follow an article (Zangl & Fernald, in press) and are already skilled at integrating prosodic information with knowledge of the distributional patterns of determiners to anticipate what kind of word is coming next (Kouider, Halberda, Wood, & Carey, 2006; Thorpe & Fernald, 2006).

A prenominal determiner provides more specific information in Spanish than in English—not only that a singular or plural noun is coming up, but also whether that noun is masculine or feminine. In the study reported here, we investigated whether young Spanish-learning children can use gender-marked articles as an informative cue in interpreting noun phrases. Using an eye-tracking procedure, on each trial we showed children a pair of objects as they listened to speech naming one of the objects. On same-gender trials, the names of the pictures were either both masculine or both feminine; thus, the article could not be used to identify the referent before the noun was spoken. On different-gender trials, the object names differed in grammatical gender; in this case, the gender-marked article was potentially useful in predicting the referent of the subsequent noun. Our first question was whether young Spanish-learning children could take advantage of gender agreement in interpreting speech. If so, they would orient to the correct referent more quickly on different-gender trials than on same-gender trials. We also tested Spanish-speaking adults to determine how experienced listeners make use of grammatical gender cues in the same paradigm. Our second question was motivated by recent research showing that in English-learning 2-year-olds, greater efficiency in on-line comprehension is associated with more advanced lexical and grammatical development (Fernald, Perfors, & Marchman, 2006). To determine whether the ability of Spanish learners to exploit grammatical gender cues in on-line comprehension also varies with productive language skills, we examined children's processing efficiency in relation to their vocabulary size and level of grammatical complexity in speech production.

METHOD

Participants

Participants were 26 children (*M* = 37.7 months; range = 34–42 months) and 26 adults (*M* = 28.0 years; range = 21–42 years) from Latino families recently immigrated from Mexico.

The adults were monolingual speakers of Spanish and the parents of children in the study. A questionnaire assessing language input from diverse sources indicated that every child had more than 85% exposure to Spanish.

Stimuli

The speech stimuli were simple Spanish sentences ending in familiar object names (Table 1); all words in the sentences were spoken by the children in the study. Half the target nouns were masculine in grammatical gender, and half were feminine. A female native speaker of Mexican Spanish recorded each sentence, with the articles *la* and *el* unstressed. The sentences were acoustically analyzed using Peak waveform-editing software. Mean duration of the carrier phrase across sentences was 914 ms (range = 900–931), mean article duration was 280 ms (range = 268–299), and mean target-noun duration was 720 ms (range = 670–770). Eight filler trials were interspersed among the 32 test trials. The visual stimuli were colorful digitized pictures corresponding to the target words. Each picture served as target on 4 test trials and distractor on 4 test trials, with side of target picture counterbalanced.

Procedure

Prior to testing, the Spanish-speaking experimenter showed the children a picture book introducing the target object names, because some pictures could be named in different ways. For example, a picture of a frog might be labeled *rana*, “frog,” or *sapo*, “toad.” During familiarization, each object was labeled using only the indefinite article (*una* or *un*), never the definite article used in testing.

The looking-while-listening procedure (Fernald et al., 2006) used for testing was conducted in a booth with two monitors placed side by side. On each trial, one object appeared on each monitor 2 s prior to speech onset and remained visible during a 3-s vocalization period and a 1-s silent period. The child was tested first, seated on the parent's lap. The parent wore opaque sunglasses and sound-blocking headphones to prevent him or her from seeing or hearing the stimuli. After the 5-min test session, the child returned to the playroom while the parent was tested.

Participants’ eye movements were video-recorded with a digital time code accurate to 33 ms. Using custom software, highly trained observers, blind to trial type, coded each trial frame by frame, indicating whether the subject was looking left, right, between the pictures, or away. The time course of eye movements was coordinated with acoustic onsets of the article and noun. Two observers assessed reliability, independently coding eight trials for 25% of the participants. The proportion of frames on which observers agreed within a single frame was greater than 99% for children and adults.

Speech-Processing Efficiency

To test the hypothesis that participants would orient to the named object more rapidly if they could use information from the gender-marked article, we calculated reaction time (RT) to the target noun on those trials on which participants were looking at the distractor at article onset and shifted to the target picture by the end of the noun (Fernald et al., 2006). RT on each trial was the latency of the first shift to the correct picture within a 300- to 1,300-ms window from article onset. Shifts within the first 300 ms were excluded because they had presumably been initiated before the onset of the noun phrase (Haith, Wentworth, & Canfield, 1993).

Language Measures

Parents reported their child's language use on the Spanish-language version of the MacArthur-Bates Communicative Development Inventory (CDI; Jackson-Maldonado, Thal,

Marchman, Bates, & Gutierrez-Clellen, 1993). Given our interest in how children's receptive use of gender-marked articles relates to productive use of vocabulary and grammar, we focused on two widely used CDI measures: vocabulary size (parents indicated the number of words spoken out of 680 items) and grammatical complexity (parents chose which of two utterances differing in complexity—e.g., *rompió globo* vs. *se rompió el globo*, "the balloon popped"—was more typical of their child's speech). Each child's grammatical-complexity score was based on the number of items out of 37 on which the parent reported use of the more complex utterance.

RESULTS

Figure 1 shows the time course of orienting to the correct picture on same-gender and different-gender trials, for both children and adults. The curves depict changes in the mean proportion of trials on which participants looked at the correct picture, across 33-ms intervals measured from article onset. At the beginning of the noun phrase, looking to the target was at chance; then, as the article and noun unfolded, children and adults began to orient to the target picture as they identified the correct referent. Although adults responded more quickly and accurately overall, the difference between the curves within each group suggests that Spanish speakers at both ages responded faster on different-gender trials than on same-gender trials.

Mean RT was calculated for each subject for each trial type. A 2 (age) × 2 (trial type) mixed analysis of variance revealed main effects of age and trial type. As shown in Figure 2, adults responded more rapidly (M = 653 ms, SD = 120 ms) than children (M = 887 ms, SD = 141 ms), $F(1, 48) = 51.8$, $p_{rep} = .999$, $\eta_p^2 = .50$, and responses were faster on different-gender trials (M = 724 ms, SD = 176 ms) than on same-gender trials (M = 806 ms, SD = 174 ms), $F(1, 48) = 21.3$, $p_{rep} = .998$, $\eta_p^2 = .31$. There was no age-by-trial-type interaction, indicating that the main effect of trial type was similar in children and adults, $p_{rep} = .339$, $\eta_p^2 = .01$. Further, this effect was observed for both feminine target nouns, $t(41) = 5.27$, $p_{rep} = .999$, $d = 0.77$, and masculine target nouns, $t(46) = 2.48$, $p_{rep} = .933$, $d = 0.30$. Thus, children, like adults, used gender-marked articles to establish reference more quickly, a surprising finding given that these 2- to 3-year-olds could speak only 500 words on average.

We next evaluated whether the extent to which the children made use of gender information was predicted by their age, vocabulary size, and level of grammatical development. We calculated difference scores by subtracting mean RT on different-gender trials from mean RT on same-gender trials. A larger difference score reflected greater benefit on different-gender trials. Multiple regression analyses indicated that age accounted for less than 1% of the variance in RT difference scores. In contrast, vocabulary size accounted for 37.4% of the variance, $F(1, 21) = 12.7$, $p_{rep} = .980$, and grammatical complexity contributed 30.1% of the variance, $F(1, 21) = 9.1$, $p_{rep} = .960$, after age was taken into account. Vocabulary and grammar scores were highly intercorrelated, $r(24) = .68$, $p_{rep} = .995$, and neither factor accounted for unique variance. Thus, the variation in RT difference scores was attributable to the variance shared by these two factors, over and above chronological age.

DISCUSSION

Young Spanish-learning children identified the referent of a familiar noun more rapidly when the gender-marked article preceding the noun was potentially informative than when the article provided no cue to the correct referent. Previous research on children's mastery of determiners in languages with grammatical gender has focused on competence in speech production (e.g., Brisk, 1976; Pérez-Pereira, 1991). Here we focused instead on receptive competence, providing the first experimental evidence that 2- to 3-year-olds can exploit their

emerging knowledge of grammatical gender to interpret the noun phrase as it unfolds. We also tested a control group of monolingual Spanish-speaking adults in the same procedure. As expected given previous findings from studies using lexical-decision and auditory naming tasks (e.g., Bates et al., 1996), adults also identified the referent more rapidly when the gender-marked article was informative.

Whereas many developmental studies of spoken word recognition focus on identification of particular content words, this study explored how adjacent grammatical words influence referent identification by young language learners. What kinds of knowledge might this processing capacity reflect? Three explanations have been proposed. First, a semantic account posits that gender-marked prenominal words activate the semantic category of the subsequent noun (see Corbett, 1991; Mirković, MacDonald, & Seidenberg, 2005). Second, a grammatical account posits that rule-based syntactic knowledge accounts for faster processing of nouns preceded by gender-marked articles (Friederici & Jacobsen, 1999; Levelt, Roelofs, & Meyer, 1999). Under this account, the article *la* primes all feminine nouns, leading to more rapid recognition of *pelota*. A third perspective highlights listeners' attention to probabilistic properties of spoken language. This distributional account posits that children attend to co-occurrences between neighboring words in specific article-noun pairs and use these regularities in processing language (Mintz, 2003; Pine & Lieven, 1997). In Spanish, hearing *la* in combination with *pe* reduces the number of possibilities for potential nouns, and children could use this probabilistic information to rapidly identify *pelota*. Further research is needed to distinguish among these alternative explanations.

Consistent with recent findings by Fernald et al. (2006), these results provide further evidence for a connection between processing efficiency and other measures of linguistic competence. Spanish-learning children who were faster in exploiting gender-marked articles in establishing reference were also those who had larger vocabularies and used more grammatically complex utterances in their own speech productions. However, the nature of the relation between receptive and productive competence is not clear. A child who is more efficient in speech processing may have more resources available for learning new words and constructions, expediting both early vocabulary growth and learning of the grammatical gender system. Or it could work the other way around: More advanced skill and greater experience in speech production could strengthen connections between gender-marked articles and particular nouns, contributing to more efficient processing of article-noun sequences.

The finding that adults make use of gender marking on prenominal articles to facilitate lexical access is robust. However, it is noteworthy that this ability may be characteristic only of native adult speakers who learned their gender-marking language as their first language. Guillelmon and Grosjean (2001) found that word recognition was significantly faster when gender information was present than when it was absent for adult native speakers of French, but not for fluent speakers who learned French as a second language in adolescence. Adults who learned French as a second language were slower altogether and showed no advantage on trials on which gender was informative. Scherag, Demuth, Rösler, Neville, and Röder (2004) obtained similar results in German. Such findings are consistent with observations that grammatical gender is one of the more difficult aspects of language for second-language learners to master (Carroll, 1989). The observed asymmetries between adult first- and second-language speakers in efficiency of processing grammatical gender cues highlight an important implication of the present research: Although young Latino children learning Spanish are much slower overall in speech processing than Spanish-speaking adults, these children already demonstrate a significant processing advantage that is characteristic of adult native speakers of languages with grammatical gender, but not of adults who learned such languages later in life. With only a few hundred words in their productive lexicon, 2- to 3-

year-old Spanish learners are able to identify familiar nouns 90 ms faster when a gender-marked article gives them an edge. This ability to exploit morphosyntactic information in the process of establishing reference reveals how the young child learning a richly inflected language makes progress in becoming a native listener.

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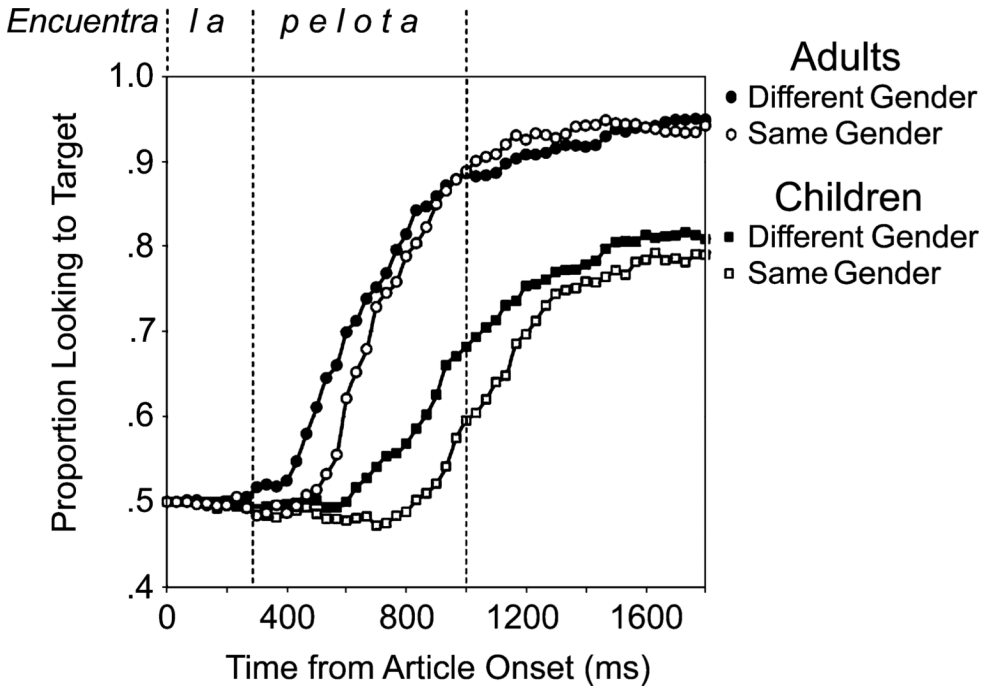

Fig. 1.

Time course of adults' and children's looking to the target picture on same-gender and different-gender trials. The curves depict changes in the proportion of looking to the picture as the article and noun unfolded, measured from article onset (in milliseconds). The vertical dashed lines indicate acoustic offsets of the article and target word.

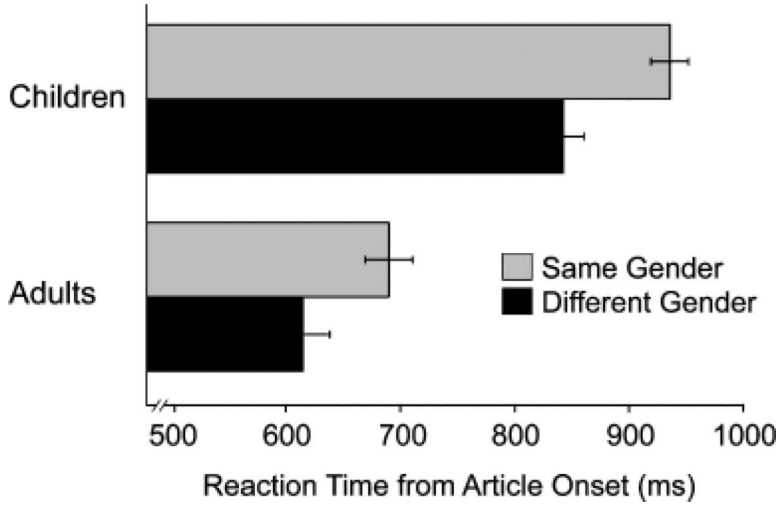

Fig. 2.

Children's and adults' mean reaction times in shifting from the distractor picture to the target picture on same-gender and different-gender trials. Error bars indicate standard errors of the means.

TABLE 1

Auditory Stimuli

Stimulus	English translation
Encuentra la pelota. ¿La ves?	Find the ball. Do you see it?
Encuentra la galleta. ¿Te gusta?	Find the cookie. Do you like it?
Encuentra el zapato. ¿Lo ves?	Find the shoe. Do you see it?
Encuentra el carro. ¿Te gusta?	Find the car. Do you like it?
¿Dónde está la vaca? ¿La ves?	Where is the cow? Do you see it?
¿Dónde está la rana? ¿Te gusta?	Where is the frog? Do you like it?
¿Dónde está el pájaro? ¿Lo ves?	Where is the bird? Do you see it?
¿Dónde está el caballo? ¿Te gusta?	Where is the horse? Do you like it?