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Partial Word Form Learning in the Written Mode in L2 German and Spanish

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Previous research on second language (L2) vocabulary learning has examined the relationship between word properties and learnability (e.g. Ellis and Beaton 1993). Few studies, however, have examined patterns in partial word form learning as a method of assessing learnability and improving our understanding of allocation of processing resources during word-level input processing. Expanding on the research of Barcroft (2000b, 2008), the present study examined partial word form learning in L2 German and Spanish while testing for effects of number of syllables in target words. Production data from an L1-to-L2 translation task (administered after a learning phase) were analyzed to determine percentage of partial versus fully produced words; amount of word produced in partial words; fragment length in partial words; and word-internal location of target letters. Results indicated production of approximately 49 percent more partial words than whole words, a high percentage of one-letter fragments, and privileging for word-initial position for both languages.

INTRODUCTION

Studies on the second language (L2) lexicon have demonstrated repeatedly that form-meaning connections following initial lexical form encoding are incomplete, regardless of whether words are learned in an explicit learning condition (e.g. Nation 1982; Meara and Ingle 1986; Hulstijn 1991; Ellis and Beaton 1993) or through contextualized input (e.g. Wesche and Paribakht 1996; Schmitt 1998; Rott 1999). Consequently, researchers have outlined how word knowledge develops across multiple continua involving different aspects of word knowledge, such as the development from receptive to productive, partial to precise, and shallow to deep (e.g. Wesche and Paribakht 1996; Melka 1997; Henriksen 1999; Qian 1999). VanPatten *et al.* (2004) expanded the description of continua by addressing cognitive processes, such as overgeneralization of word use on the way to native-like lexical use, the relationship between the strength of initial encoding and long-term retention, and the accommodation of multiple word meanings in one lexical entry. While these continua describe the development of the semantic component of word knowledge (word meaning) only, VanPatten *et al.* also mentioned the dimensions of phonological and orthographic word knowledge, which develop from partial to complete levels of productive ability. Finally, Boogards (2001) found that multiword expressions containing known words were more easily learned than

completely new words, once again emphasizing the critical role of developing word form knowledge within the larger process of L2 vocabulary acquisition.

With few exceptions (Meara and Ingle 1986; Schmitt 1998; Barcroft 2000b, 2008), little research has addressed the issue of patterns in partial word form learning. This shortfall in the data may be attributable, at least in part, to an assumption or an unquestioned implied default position that one's knowledge of complete or whole word forms develops 'automatically' as one's L2 knowledge increases.

Theoretical work and empirical evidence suggest otherwise. Studies have demonstrated, for example, that in L1 and L2, words are often retrieved and can be produced only partially (in both the written and spoken modalities). This phenomenon is sometimes connected to the tip-of-the-tongue (TOT) state (e.g. Brown and McNeill 1966; Aitchinson and Straf 1981; Meyer and Bock 1992), which is generally explained as the result of partial word encoding or incomplete activation in memory during usage. These two explanations correspond to two distinct categories of the TOT state, the classic TOT state being for words that are fully encoded but infrequently used. The present study, on the other hand, concerns partial word encoding, which has, as one of its possible consequences, a situation in which learners may be able to retrieve word-initial and word-final segments of words because other (word-medial) segments have not been encoded to a sufficient degree so as to be able to be retrieved. Likewise, research on the learnability of L2 word forms has identified word length, degree of sound-script correspondence, and sequential letter probabilities as key factors during lexical encoding and predictors of subsequent lexical retrieval (e.g. Ellis and Beaton 1993; Laufer 1997).

In light of this background, new research on partial word form learning may help to advance our understanding of the process of partial word form encoding during L2 lexical learning. Identifying characteristics of L2 word fragments that learners produce when they produce only part of a target word can help to explain why some parts of words are processed differently than others during the learning process and why word learning results in only partial word form knowledge. The present investigation is an exploratory study aimed to gain new insights into the allocation of processing resources, the relative perceptual salience of word parts, and the potential privileging of different word parts during the word-level form-meaning encoding process. The study focused on word form learning in the written mode. By comparing partial L2 word learning in L2 learners of German and L2 learners of Spanish in a translation-based learn-and-test paradigm, the present study also sought to explore the extent to which identifiable patterns in word-level input processing may be specific to one language as opposed to being more universal.

REVIEW OF LITERATURE

Numerous studies on L2 lexical learning have identified aspects of words that may affect the ease or difficulty of learning a new word form, including word

length (e.g. Ellis and Beaton 1993); pronounceability (e.g. Rodgers 1969); phonotactic regularity (Ellis and Beaton 1993); sound-script incongruence and difference in writing systems (e.g. Koda 1999); word frequency (e.g. De Groot and Keijzer 2000); acoustic similarity between words (e.g. Henning 1973; Meara 1982); part of speech (Rodgers 1969; Ellis and Beaton 1993); concept imageability (Ellis and Beaton 1993); word concreteness and cognate status (e.g. De Groot and Keijzer 2000); and pronunciation time (Ellis and Beaton 1993).

Other studies on sentence-level input processing have provided information about the interrelated nature of perceptual saliency and the allocation of processing resources that may (or may not) be applicable to word form learning. In consideration of a general principle that learners' attentional resources are limited (see also Skehan 1998; Skehan and Foster 1999, 2001), for example, VanPatten (e.g. 1996, supported by Barcroft and VanPatten 1997; Rosa and O'Neill 1998) has included perceptual salience in his model of sentence-level L2 processing. Specifically, VanPatten posits that items in sentence-initial position are more perceptually salient and have precedence over items in other positions. This sentence-level primacy effect appears to extend to first-language (L1) word-level processing as well. Brown and McNeill (1966), for example, tested subjects in the tip-of-the-tongue state about words that came to their mind as they were attempting to retrieve L1 words. The researchers found that other words that the subjects reported as being similar in sound to the target word tended to share sounds at the beginnings and ends of the words. This finding provided evidence for what has been referred to as the *bathtub effect*, or the phenomenon that people tend to remember word parts at the beginnings and ends of words more than the middle parts of words.

In a subsequent study on memory for the correct parts of target words in malapropisms, Aitchinson and Straf (1981) found that the bathtub effect was influenced by word length. The researchers found that the beginnings of short words (one to two syllables) were remembered marginally better than the beginnings of long words (three or more syllables) and that the ends of long words were remembered substantially more than the ends of short words. Meyer and Bock (1992) also examined mechanisms of incomplete word form retrieval (tip-of-the-tongue state). Assessing the effect of phonological and semantic clues during retrieval, they found that incomplete word production was due to insufficient word-form activation.

Few lexical studies have assessed word form learning in L2 specifically, however. Lexical learning assessment measures have focused largely on the learning of word meaning, such as the comprehension of word meaning (e.g. Meara and Buxton 1987), the production of word meaning (e.g. Laufer and Nation 1995), or word associations (e.g. Riegel and Zivian 1972; Read 1993), although a few studies have attempted to measure multiple aspects of L2 word knowledge (e.g. Schmitt 1998) and how learners progress across multiple stages of knowledge from not having seen the word before to being

able to use it in a sentence as measured with the Vocabulary Knowledge Scale (Wesche and Paribakht 1996).

Addressing the limitations of previous word knowledge assessment tools, Laufer and Goldstein (2004) developed a computer adaptive test that measures size and strength of lexical knowledge. Although this test includes the active recall of word form, the scoring procedure does not account for partial word form knowledge. Instead, the procedure includes dichotomous scoring of 'correct' or 'incorrect'. Two other studies have established componential scales that address different degrees of word form knowledge on the partial-to-complete continuum. In a longitudinal study, Schmitt (1998) used a 4-point scale that measured the ability to spell target words correctly. A score of 0 indicated no word-form knowledge; a score of 1 was given for production of initial but not 'later letters' (p. 290) of the target word; a score of 2 was given for a phonologically correct but orthographically incorrect version of the target word; and a score of 3 was given if the word was spelled correctly. This scale did not allow Schmitt to detect any increase in the ability to spell words over the course of one year because the three advanced learners in Schmitt's study demonstrated knowledge Levels 2 and 3 at the first time of testing. Meara and Ingle (1986) isolated the learning of consonants by learners of French as a foreign language. Oral production data were scored for which consonants were produced correctly, in initial, medial or final position. The data revealed that these second-year students recalled more consonants correctly when they occurred at the beginning of the word than in medial or final position.

Barcroft (2000a) developed a lexical production scoring protocol (LPSP) that assesses partial word-form knowledge based on the number and the location of correctly produced letters. This scoring procedure further discriminates between letters produced and letters produced in the correct position. Following this protocol, a score of 1 is assigned to any completely produced word. Other scores are assigned as follows: .25 if approximately one-quarter of the word (or one correct letter) was produced; .50 if approximately half of the word was produced; .75 if approximately three-quarters of the word is produced; and 0 in all other cases.

Barcroft (2000b, 2008) has demonstrated the usefulness of scoring with the LPSP in two studies that assessed the nature of partial word form learning for L2 Spanish. In each of the two studies, English-speaking learners of L2 Spanish were asked to do their best to learn 24 new words in Spanish during a word-picture pair learning paradigm with each word-picture pair being repeated two times. After the learning phase in each study, the participants attempted to produce as much of each target word as they could, either in spoken or written form, when they were presented with pictures only. Barcroft analyzed all of the items that learners produced in order to identify (i) percentages of partially versus fully produced target words, (ii) the approximate amount of each word that they produced, (iii) lengths of segments that they tended to produce, and (iv) the location of the segments that they produced. The results of both studies revealed greater production of partial

words than whole words and other patterns in partial word form learning. Barcroft (2008), for example, found production of 69 percent partial words versus 31 percent of whole words, a high percentage of one-letter fragments, and heavy privileging for word-initial position. These findings indicate that partial word form learning, as opposed to whole word learning, is the norm and not the exception. The study also demonstrated a word-internal primacy effect for initial word form learning but did not confirm the recency (word-final) component of the bathtub effect.

PURPOSE OF THE PRESENT STUDY

To summarize, the findings of previous research suggest that lexical learning depends heavily on different properties of word-internal fragments, such as their location within a word. As outlined above, studies on sentence-level input processing (VanPatten 1996; Barcroft and VanPatten 1997; Rosa and O'Neill 1998) have demonstrated that (i) not all parts of a sentence are processed equally and that (ii) perceptual salience and allocation of cognitive resources affect which parts of sentences are privileged during processing. Although sentence- and word-level input processing are substantively different cognitive processes, the present investigation examined at the word level parallels of some of the issues previously examined at the sentence level by assessing how different properties of word-internal fragments are affected by allocation of processing resources during the initial encoding of new word forms. By examining partial word form productions, the current study explored whether primacy and recency effects that characterize sentence-level processing also appear L2 vocabulary learning and whether the limited processing resources of beginning L2 learners affect the length and the location of the fragments produced.

In this study, word form production was defined as the ability to recall and spell target word forms correctly. We make the general assumption that one's ability to produce target word form on a posttest, be it partial or full target word form, is a reflection, at least in large part, of the extent to which a learner has attended to and processed the word form, partial or full, during a learning phase. While previous studies have used primarily dichotomous correct/incorrect scoring procedures, the current study used the LPSP-written (Barcroft 2000a), a scoring protocol that is more sensitive to partial word form learning and that allows one to gain insights into the allocation of processing resources during the gradual, bit-by-bit process of word form learning.

The current investigation also expanded on previous studies on lexical word form learning (Barcroft 2000b, 2008) by comparing partial word form production by learners of two different L2s: German, a stress language; and Spanish, a syllable language. Syllables in Spanish tend to be relatively short. Seventy percent of syllables follow simple consonant–vowel (CV) or consonant–vowel–consonant (CVC) structure. In contrast, in German, only 30 percent

of the syllables belong to CV and CVC classes. Therefore, in German, syllables generally have more letters, and in particular, German has more multi-syllabic words (Conrad and Jacobs 2004). As such, the present study sought to test for potential language-specific relationships between word-internal properties and allocation of processing resources and to explore the possibility that some patterns in word-form encoding may be shared and possibly universal. Additionally, although German is considered to be largely a phonemic (based on degree of transparency when going from grapheme to phoneme) language, Spanish is even more so, and this difference in degree of grapheme-to-phoneme transparency may impact upon successful and unsuccessful encoding of target word forms and the nature of partial word forms that learners are able to learn and subsequently produce.

Finally, in this investigation, we also explored the relationship between word length and learning fragments in different word-internal locations. In order to do so, we assessed word fragment production in three different word-internal locations (initial, medial, final) for both two- and three-syllable words. This approach allowed us to examine the extent to which the bathtub effect (Aitchinson and Straf 1981) may be observable in learner-based productions of L2 vocabulary across words of different numbers of syllables. Would word-initial and word-final fragments be learned more readily, as the bathtub effect would predict, or would only word-initial fragments be learned markedly more than other locations, as previous research (Barcroft 2000b, 2008) indicates?

RESEARCH QUESTIONS

The current investigation addressed the following research questions about word learnability by examining patterns in word production after intentional vocabulary learning:

1 Is there a difference between the number of partial words versus whole words produced? If the answer is 'yes':

   (1a) What is the nature of the difference?
   (1b) Is the difference affected by target language (German or Spanish)?
   (1c) Is the difference affected by number of syllables (two or three) in target words?

2 Is there a difference between the general amount of the word (one-quarter, one-half, three-quarters) produced in partial words? If the answer is 'yes':

   (2a) What is the nature of the difference?
   (2b) Is the difference affected by target language (German or Spanish)?
   (2c) Is the difference affected by number of syllables (two or three) in target words?

3 Is there a difference between number of word fragments of a certain length (one, two, three, or four or more letters) produced in partial words? If the answer is 'yes':

   (3a) What is the nature of the difference?
   (3b) Is the difference affected by target language (German or Spanish)?
   (3c) Is the difference affected by number of syllables (two or three) in target words?

4 Is there a difference between the percentage of target letters produced in some locations (word-initial, word-medial, or word-final)? If the answer is 'yes':

   (4a) What is the nature of the difference?
   (4b) Is the difference affected by target language (German or Spanish)?
   (4c) Is the difference affected by number of syllables (two or three) in target words?

Answers to each of these questions helps to provide new information about the general nature of word form learning as well as salience or privileging with regard to attention to word fragments during word-level input processing.

Based on previous research findings, we hypothesized that there would be a large number of partial words and more so than full words, that there would be preponderance of partial words in the one-quarter-word range, that more one- and two-letter fragments would be retrieved than larger three or more letter segments, and that word-initial segments of words would be privileged and appear more frequently than segments in word-medial and word-final positions. We also anticipated that some of the answers to the four primary research questions would be moderated by target language (German, Spanish), number of syllables (two or three), or both, but given that these aspects of the present study were largely exploratory in nature, we sought to allow the data obtained and the results of the study speak to these issues directly without overspeculating at the hypothesis stage.

METHOD

Participants

The original pool of participants eligible for this study were 54 first-semester learners of German and 87 first-semester learners of Spanish from two large universities in the Midwest of the USA. First semester courses are for complete beginners who have never taken any language classes and students who have placed into the course after taking a placement test. Among the L2 German students, data provided by seven students in the German group were excluded because five of these participants correctly translated one or more of the

target words on the pretest and two of these participants did not complete the production test. After these reductions, the remaining sample of L2 German participants was 47. Among the L2 Spanish participants, data provided by 11 participants were excluded because these participants correctly translated one or more of the target words on the pretest; data provided by seven participants were excluded because English was not the native language of these participants; and data from one participant were excluded because the participant did not answer required questions on the language background questionnaire. After these reductions, the remaining sample of L2 Spanish participants was 68.

Materials

The following materials were used to conduct the study: (i) a consent form and a language background questionnaire; (ii) instructions for the experiment; (iii) a pretest with the 24 target words for translating any known words from L2 to L1; (iv) two posttests: a productive test for L1-to-L2 translation and a receptive test for L2-to-L1 translation (data related to the receptive test were not the focus of the analyses of the present study); and (v) a vocabulary learning strategies questionnaire (data from the questionnaire also were not the focus of the analyses of the present study).

Target words

Twenty-four English–German and English–Spanish word pairs were compiled. Each target word was a concrete noun and had a counterpart in the other L2 (Spanish or German) that was equal in number of syllables and number of letters. For example, the Spanish word *borla* 'tassel' had the German word *Kröte* 'frog' as its counterpart. These two words constituted a German-Spanish word pair. Both words had two syllables and five letters. All of the target words appear in Table 1. Each German–Spanish word pair (with the same number of syllables and letters) appears in each row. Some of the target nouns were regional variants, such as the German word *Bulette* 'hamburger' and the Spanish word *chiringa* 'kite'. The length of the target words ranged between five and nine letters (Table 1).

Instrumentation

Pretest

In order to ensure that participants were unfamiliar with the chosen target words, an L2-to-L1 translation pretest was administered. At this point participants were not told that they would be asked to learn these words during the treatment phase that immediately followed the pretest. Participants were provided with a sheet that contained the 24 target words and were asked to

Table 1: Experimental words categorized according to language (German and Spanish), number of syllables (three and four) and number of letters

	Letters	German	Spanish
Two-syllable words	5	Kröte (frog)	borla (tassel)
	5	Erbse (pea)	balde (bucket)
	5	Ziege (goat)	pinza (clothespin)
	5	Kelle (soup spoon)	trompo (spinning top)
	5	Eimer (bucket)	naipe (playing card)
	5	Nelke (carnation)	gaita (bagpipe)
	6	Wurzel (root)	flecha (arrow)
	6	Felsen (rock)	gancho (hook)
	6	Büchse (can)	clavel (carnation)
	6	Glocke (bell)	choclo (corn)
	6	Quaste (tassel)	tuerca (nut)
	7	Rutsche (slide)	plancha (iron)
Three-syllable words	6	Kasuar (ostrich)	arroyo (stream)
	7	Matrose (sailor)	colibrí (hummingbird)
	7	Gebäude (building)	taladro (drill)
	7	Bulette (hamburger)	gorrión (sparrow)
	7	Gebirge (mountains)	volante (steering wheel)
	7	Kolibri (hummingbird)	tenazas (pliers)
	7	Gemälde (painting)	candado (lock)
	7	Perücke (wig)	clavija (plug)
	7	Patrone (cartridge)	Serrate (saw)
	7	Forelle (trout)	toronja (grapefruit)
	8	Radierer (eraser)	chiringa (kite)
	9	Bedienung (waiter)	churrusco (caterpillar)

provide an L1 translation of any word that they knew or thought that they might know. The L2-to-L1 translation task was selected to determine whether learners had a form-meaning link stored in their mental lexicon. The researchers chose to not use an L1-to-L2 production task because one can not exclude the possibility that a participant knew a target word but gave an alternate L2 translation. For example, if a participant had translated 'corn' as *maiz* ('corn' in many Spanish dialects), we could not have been sure that the word form *choclo* ('corn' in an Andean Spanish dialect) was unknown to the participant. Similarly, if a participant had translated 'stream' as *río* ('river' in Spanish), we could not have been sure that the word form *arroyo* 'stream' was unknown to the participant. The words on the pretest appeared in a different randomized

order than the order used in the exposure phase to avoid habituating the participants to the exposure phase order.

Posttest

For the L1-to-L2 production posttest, the participants received a sheet with 24 lines with one line for each target word. Instructions on the posttest encouraged participants to write as much of each L2 word as they could, even if they could not recall the entire word.

Procedure

All data were collected in one approximately 50-min class session in the participants' regular German and Spanish classrooms. The following procedures were followed:

1 Each participant completed the consent form and language background questionnaire.
2 All of the participants completed the pretest.
3 Each participant received general instructions about the procedure. All of the participants were instructed to do their best to learn the 24 German or Spanish words and were informed that there would be a vocabulary test after the learning phase.
4 The 24 target word pairs were presented on a screen at the front of the classroom using a computer presentation program. All word pairs were presented in the center of the screen. In contrast to the Spanish–English pairs where all letters were in lower case, the German nouns in the German–English pairs were capitalized in accordance with the convention of the language. The 24 target word pairs were divided in three groups of eight words. Each group of eight words was presented twice in the same order for 6 s each. The second and the third set of eight words were presented in the same manner. The presentation of each set of eight target pairs was announced by a separate screen display stating that the first second or third group of eight words would be presented next. This display lasted 6 s.
5 One minute after the exposure phase, the L1-to-L2 posttest began. The L1 translations of individual target words were displayed on the screen and participants were asked to write as much of each target word as they could in a line space provided. Two incorrect references in the Spanish version of the presentation program (one case of 'pictures' instead of 'translations' and an incorrect title for the L1-to-L2 production-oriented posttest) were resolved and clarified as needed by the experimenter. The experimenter for the Spanish students was a speaker of both English and Spanish. The experimenter for the German students was a speaker of both English and German. (Note again that a second posttest, an L2-to-L1 translation posttest and a brief learning strategies

questionnaire were also administered after the L1-to-L2 production posttest, but these tasks, all performed after the tasks of interest in the present study, were related to a exploratory investigation, were not related to the present study, and could not have impacted upon the results of the present study based on the L1-to-L2 production posttest, which was completed in full prior to the other tasks.)

Scoring

The L1-to-L2 posttest was scored first using the lexical production scoring protocol (LPSP-written), developed by Barcroft (2000a). Following this protocol, a score of 1 was assigned to any completely produced word. Other scores were assigned as follows: .25 if approximately one-quarter of the word was produced, .50 if approximately half of the word was produced, .75 if approximately three-quarters of the word was produced, and 0 in all other cases.

Analyses

Overall word gain (LPSP-written) for German and Spanish

In order to assess whether the overall performance level of the L2 German and L2 Spanish participants was significantly different, total LPSP-written scores for each participant were included in the statistical analysis. For this analysis, total LPSP-written scores for each participant were submitted to univariate analysis of variance (ANOVA) with language (German, Spanish) as the independent variable and LPSP-written score as the dependent variable. This analysis was helpful in determining whether additional adjustments would be needed to address the research questions of the study. If overall LPSP-written scores of the two groups were significantly different, for example, percentage scores or covariance analyses might have been needed to address the four main research questions of the study.

Partial versus fully produced words

For the analysis of overall partial versus fully produced words (Research Question 1), the number of times each participant scored 1 was compared to the sum of the number of times each participant scored .25, .50, or .75. In order to determine if the number of syllables of a word (two or three syllables) affected full and partial word learning, separate scores were tabulated for two-syllable and three-syllable words.

Sums of partial words and fully produced words were submitted to a repeated measures ANOVA. Type of production (partial, full) was treated as a within-subjects independent variable. Language (German, Spanish) and number of syllables (two, three) were treated as between-subjects independent variables. Number of items produced was the dependent variable.

Amount of partial word produced

For the analysis on amount of word produced in partially produced words (Research Question 2), the number of times each participant scored .25 (one-quarter of a word), .50 (one-half of a word), and .75 (three-quarters of a word) was compared.

Sums of scores of one-quarter (.25), one-half (.50), and three-quarters (.75) were submitted to a repeated measures analysis of variance. Amount of word (one-quarter, one-half, three-quarters) was treated as a within-subjects independent variable. Language (German, Spanish) and number of syllables (two, three) were treated as between-subjects independent variables. Number of items produced was the dependent variable.

Fragment length

For the analysis on fragment length (Research Question 3), tallies were made from the original posttests to determine the number of times each participant produced one-letter, two-letter, and three-letter fragments as well as fragments with four or more letters, in any location of the target word. An overall score for two- and three-syllable words and separate scores for two- and three-syllable words were calculated.

Sums of the number of times each participant produced one-letter, two-letter, and three-letter fragments were submitted to a repeated measures ANOVA. Fragment length (one-letter, two-letter, three-letter, four or more letters) was treated as a within-subjects independent variable. Language (German, Spanish) and number of syllables (two, three) were treated as between-subjects independent variables. Number of items produced was the dependent variable.

Word-internal location

For the analysis on word-internal location (Research Question 4), tallies were made from the original posttests to determine the percentage of letters correctly produced in word-initial, word-medial, and word-final segments of the target words. For words with three syllables: (i) word-initial percentages were determined by dividing the number of correctly produced letters in the first syllable by the total number of letters in the first syllable; (ii) word-final percentages were determined by dividing the number of correctly produced letters in the last syllable by the total number of letters in the last syllable; and (iii) word-medial percentages were determined by dividing the number of correctly produced letters in the rest of the word by the total number of the letters in the rest of the word. Scores for two-syllable words were determined in a similar manner; however, word-initial position was based on the first letter of the word only, word-final position based on the last letter only, and word-medial position based on the percentage of the remaining letters. An alternative way to do this analysis would be to allow for the entire first

syllable and last syllable of two-syllable words to be used to score word-initial and word-final segments. While this option can be explored in future studies, in this initial exploration we allowed for the assumption that attention can, at least potentially, be paid to initial/final letters without necessarily being paid to initial/final syllables of words. An overall score for two- and three-syllable words as well as separate scores for two- and three-syllable words were calculated.

Totals for the percentages of the three locations for all 24 words were submitted to a repeated measures analysis of variance. Location (word-initial, word-medial, word-final) was treated as a within-subjects independent variable. Language (German, Spanish) and number of syllables (two, three) were treated as between-subjects independent variables. Number of items produced was the dependent variable.

Means reported are estimated marginal means. For all statistical analyses, alpha was set at .05.

RESULTS

Overall word gain (LPSP-written) for German and Spanish

Means for LPSP-written scores by language were 10.06 ($SE = .63$) for L2 German students and 10.50 ($SE = .52$) for L2 Spanish students. Results of the ANOVA indicated that the overall word gain of the two groups was not significantly different ($p = .596$). In light of this result, no adjustments were made with regard to the statistical analyses used to address the four main research questions of the study.

Research question 1: Partial versus fully produced words

Means and standard errors for production type (partial word, full word) by language (German, Spanish) appear in Table 2. The substantially lower means in Table 2, as compared with the means above 10 reported earlier, are due to the inclusion of syllable (two and three syllables) as an independent variable and, consequently, the LPSP-written maximum mean having changed from 24 to 12 (maximum of 12 per each of the two levels of the syllable variable). Means and standard errors for production type by number of syllables in target words (two-syllable, three-syllable) appear in Table 2. Results of the ANOVA revealed a significant main effect for production type, $F(1,113) = 27.24$, $p < .001$, $\eta^2 = .194$, and the following significant interactions: (i) Production type × Language, $F(1,113) = 4.17$, $p = .036$, $\eta^2 = .036$; (ii) Production type × Number of syllables, $F(1,113) = 17.34$, $p < .001$, $\eta^2 = .133$; and (iii) Language × Number of syllables, $F(1,113) = 17.33$, $p < .001$, $\eta^2 = .133$. The Production type × Language interaction, which can be seen in Figure 1, was due to the greater difference in the production of partial versus full words among L2 German participants as compared with the L2 Spanish participants.

Table 2: Means for production type in target words by language and by number of syllables

Scoring	Production type[a]					
	Full word		Partial word		Total	
	M	SE	M	SE	M	SE
Language						
German	2.55	0.28	4.47	0.26	3.51	0.18
Spanish	3.05	0.24	3.89	0.21	3.47	0.15
Total	2.80	0.18	4.18	0.17	3.49	0.12
Number of syllables						
Two syllables	3.26	0.24	3.82	0.20	3.54	0.14
Three syllables	2.34	0.18	4.53	0.22	3.44	0.12
Total	2.80	0.18	4.18	0.17	3.49	0.12

[a]$N = 115$ for each cell.

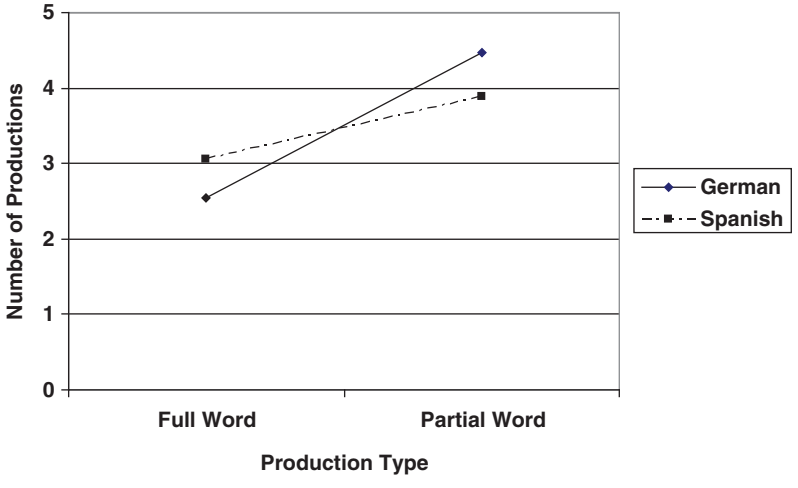

Figure 1: The production type × language interaction

The Production type × Number of syllables interaction, which can be seen in Figure 2, was due to the greater difference in production of partial words for three-syllable as compared with two-syllable target words. The Language × Number of syllables interaction was due to L2 German participants having higher means for overall productions (including both full and partial

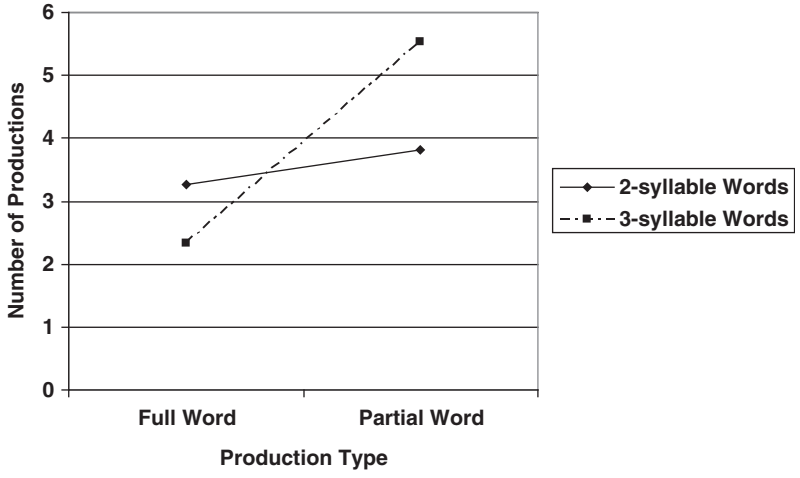

Figure 2: The production type × number of syllables interaction

Table 3: Means for amount of word by language and by number of syllables

	Language						Number of syllables					
Amount	German		Spanish		Total		Two-syllable		Three-syllable		Total	
	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE
0.25	1.16	0.13	0.87	0.11	1.01	0.08	0.87	0.09	1.15	0.12	1.01	0.08
0.50	1.17	0.11	1.15	0.09	1.16	0.07	0.87	0.08	1.45	0.11	1.16	0.07
0.75	2.14	0.17	1.88	0.14	2.01	0.11	2.08	0.15	1.93	0.14	2.01	0.11
Total	1.49	0.09	1.30	0.07	1.39	0.06	1.28	0.07	1.51	0.07	1.39	0.06

$n = 47$ for German; $n = 68$ for Spanish; $N = 115$ for total.

productions) of three-syllable words, in contrast to the L2 Spanish participants' higher means for overall productions of two-syllable words. No other significant main effects or interactions were revealed.

Research question 2: Amount of partial word produced

Means and standard errors for amount of partial word produced (.25, .50, .75) by language (German, Spanish) appear in Table 3. Means and standard errors for amount of partial word produced by number of syllables in target words (two-syllable, three-syllable) also appear in Table 3. Results of the ANOVA

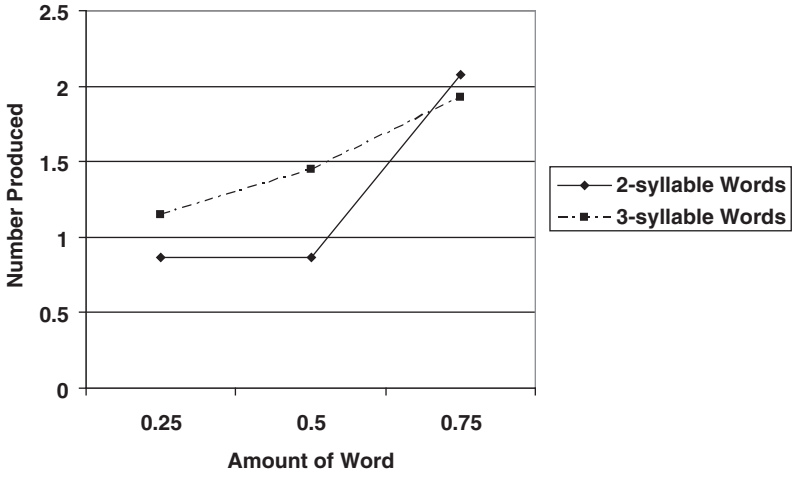

Figure 3: The amount of word × number of syllables interaction

revealed significant main effects for amount, $F(2,226) = 36.66$, $p < .001$, $\eta^2 = .245$, and number of syllables, $F(1,113) = 8.44$, $p = .004$, $\eta^2 = .070$, as well as a significant interaction between amount and number of syllables, $F(2,226) = 6.22$, $p = .002$, $\eta^2 = .052$. The difference in amount of partial word produced for the two languages (German, Spanish) was not statistically significant ($p = .084$). Pairwise comparisons indicated that the .75 level of partial word (approximately three-quarters of a word) was produced significantly more than the .25 level, $p < .0001$, and significantly more than the .50 level. As can be seen in Figure 3, the Amount × Number of syllables interaction was due to the markedly higher number of productions of .75 as compared with productions of .25 and .50 for the two-syllable words, a pattern that differed from that of the three-syllable words. No other significant main effects or interactions were revealed.

Research question 3: Fragment length

Means and standard errors for fragment length (one-letter, two-letter, three-letter, four or more letters) by language (German, Spanish) appear in Table 4. Means and standard errors for fragment length by number of syllables in target words (two-syllable, three-syllable) appear in Table 4. Results of the ANOVA revealed significant main effects for fragment length, $F(3,339) = 48.04$, $p < .001$, $\eta^2 = .298$, and syllable, $F(1,113) = 11.05$, $p = .001$, $\eta^2 = .089$, as well as a significant interaction between fragment length and language, $F(3,339) = 10.75$, $p < .001$, $\eta^2 = .087$. The difference in amount of fragment lengths produced based on language (German, Spanish) was not statistically significant ($p = .088$). Pairwise comparisons indicated that the following

Table 4: Means for fragment length by language and by number of syllables

	Language						Number of syllables					
	German		Spanish		Total		Two-syllable		Three-syllable		Total	
	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE
One-letter	1.96	0.25	3.13	0.21	2.55	0.16	2.39	0.20	2.70	0.21	2.55	0.16
Two-letters	1.60	0.15	1.38	0.21	1.49	0.10	1.26	0.12	1.71	0.20	1.49	0.10
Three-letters	1.19	0.11	1.14	0.09	1.17	0.07	1.04	0.09	1.30	0.10	1.17	0.07
Four or more letters	1.07	0.12	1.12	0.10	1.10	0.08	0.86	0.09	1.34	0.12	1.10	0.08
Total	1.46	0.11	1.69	0.09	1.57	0.07	1.39	0.09	1.76	0.09	1.57	0.07

$n = 47$ for German; $n = 68$ for Spanish; $N = 115$ for total.

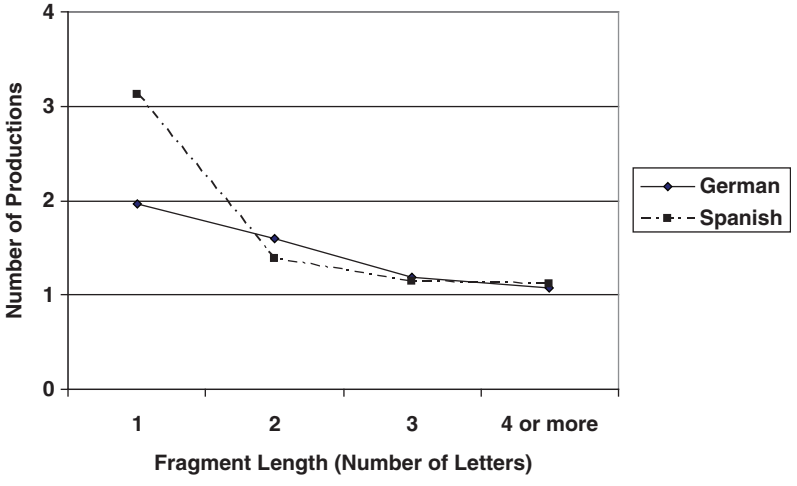

Figure 4: The fragment length × language interaction

differences were statistically significant: (i) one-letter versus two-letter, three-letter, and four or more letters ($p < .0001$ in each case) and (ii) two-letter versus three-letter ($p = .002$) and four or more letters ($p = .0001$). The Fragment length × Language interaction, which can be seen in Figure 4, was due to the markedly higher mean number of one-letter fragments produced by the L2 Spanish participants as compared with the L2 German participants. No other significant main effects or interactions were revealed.

Table 5: Means for word-internal location by language and by number of syllables

Location	Language						Number of syllables					
	German		Spanish		Total		Two-syllable		Three-syllable		Total	
	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE
Initial	1.90	0.29	2.92	0.16	2.41	0.13	2.28	0.16	2.54	0.16	2.41	0.13
Medial	0.45	0.12	1.87	0.16	1.16	0.08	0.95	0.10	1.36	0.11	1.16	0.08
Final	1.06	0.13	1.63	0.11	1.35	0.08	0.97	0.10	1.72	0.13	1.35	0.08
Total	1.14	0.13	2.14	0.10	1.64	0.08	1.40	0.10	1.88	0.12	1.64	0.08

$n = 47$ for German; $n = 68$ for Spanish; $N = 115$ for total.

Research question 4: Word-internal location

Means and standard errors for word-internal location (initial, medial, final) by language (German, Spanish) appear in Table 5. Means and standard errors for word-internal location by number of syllables in target words (two-syllable, three-syllable) appear in Table 5. Results of the ANOVA revealed significant main effects for location, $F(2,226) = 92.50$, $p < .001$, $\eta^2 = .450$, and number of syllables, $F(1,113) = 11.97$, $p = .001$, $\eta^2 = .096$, as well as the following significant interactions: (i) Location × Language, $F(2,226) = 9.29$, $p < .001$, $\eta^2 = .076$; (ii) Location × Number of syllables, $F(2,226) = 4.87$, $p = .009$, $\eta^2 = .041$; and (iii) Language × Number of syllables, $F(1,113) = 8.94$, $p = .003$, $\eta^2 = .073$. The potential Location × Language × Number of syllables interaction was not statistically significant ($p = .060$). Pairwise comparisons indicated that overall means were significantly higher for word-initial location means than for word-medial location, $p < .001$, and word-final location, $p < .001$ and that means for word-final location were significantly higher than for word-medial location, $p = 022$, even though actual means for L2 Spanish were lower in word-final than in word-medial position.

The Location × Language interaction, which can be seen in Figure 5, was due to lower means for medial as compared with final position in L2 German versus lower means for final as compared with medial in L2 Spanish. The Location × Number of syllables interaction, which can be seen in Figure 6, was due to markedly higher means in final over medial position for three-syllable words. The Language × Number of syllables interaction was due to the much higher means for overall productions (including productions determined for all word-internal locations) for three-syllable over two-syllable words for L2 German but not for L2 Spanish. No other significant differences or interactions were revealed.

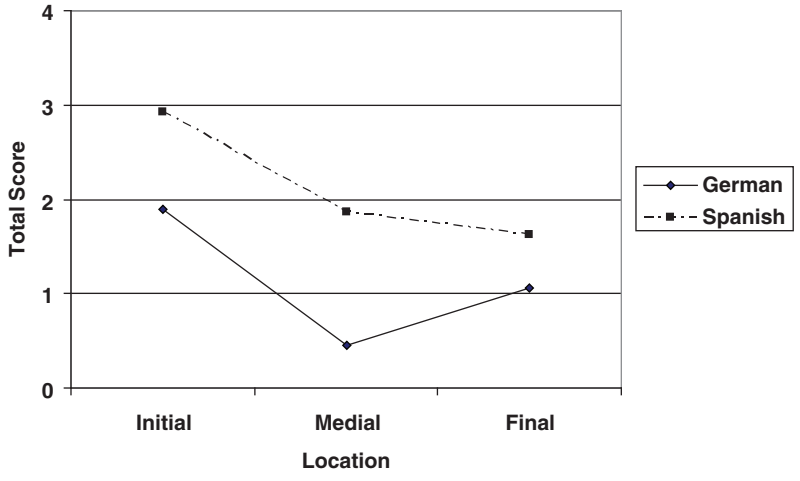

Figure 5: The location × language interaction

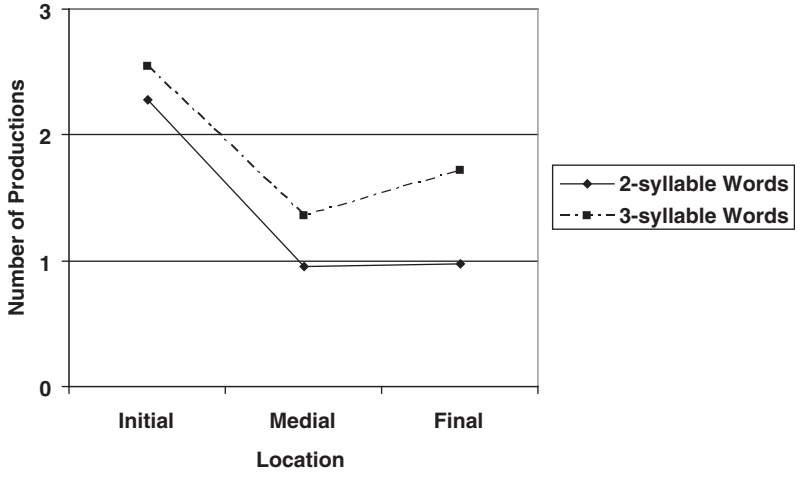

Figure 6: The location × number of syllables interaction

DISCUSSION

The findings of the study can be summarized as follows. (i) Partial words were produced much more often than complete words. Approximately 49 percent more partial words ($M = 4.18$) were produced than whole words ($M = 2.80$). (ii) Two-syllable words were fully produced more often than three-syllable words. (iii) The difference in the amount of partial versus full words was

larger for learners of German than for learners of Spanish. (iv) Three-quarters of a word was produced more often than one-half or one-quarter of a word, and the privileging for three-quarters of a word was more pronounced for two-syllable than for three-syllable words. (v) One-letter fragments were produced much more often than two-letter fragments, three-letter fragments, and fragments with four or more letters. Single-letter fragments were produced 40 percent of the time; two-letter fragments 24 percent of the time, three-letter fragments 19 percent of the time, and four-or-more-letter fragments 17 percent of the time. (vi) Production of target letters was greater in word-initial locations than in other locations. Target letters were produced 49 percent of the time in word-initial position, 24 percent of the time in word-medial position, and 27 percent of the time in word-final position. (vii) The word-initial advantage was more marked for two-syllable words than for three-syllable words. (viii) Production patterns for medial and final position were different for the two L2s. While learners of German produced markedly fewer fragments in word-medial position than in word-final position, this pattern was not maintained for learners of Spanish for whom actual means were slightly higher for word-medial than for word-final position. The implications of these findings are discussed below.

The pervasiveness of partial word form learning

Learners in both languages produced substantially more partial than complete words after engaging in the intentional vocabulary learning task. This finding illustrates the very large extent to which the formal component of L2 word learning is an incremental process. The study revealed evidence that a majority of the L2 word forms were learned in bits and pieces and were not picked up as single entities. Although this finding may be somewhat intuitive, the study provided evidence that to a large extent partial word learning is the norm and not the exception, which leads to the following question. If L2 words are learned incrementally in bits and pieces, is this bit-by-bit incremental learning process random or, alternatively, are there identifiable patterns in the manner in which the bits and pieces, or word fragments, are learned? To clarify our use of the term *incremental* here is no way meant to deny the possibility of different *states* of vocabulary knowledge at different times, including the fact that for a variety of possible reasons, a learner may be able to recall one part of a word form at a given time and then not be able to recall that part at a later time.

The findings of the present study strongly suggest that there are a number of identifiable patterns and that some parts of words are processed more readily than others. Whereas a substantial amount of previous research has focused on the gradual development of semantic and syntactic information during L2 word learning, the present findings demonstrate the need to attend more to the gradual development of knowledge of target word form. Word forms that have been encoded only partially will require additional processing resources

during subsequent encounters with the word. This process of allocating processing resources over time in order to move, incrementally, from partial to complete word form knowledge needs to be considered a central component of L2 vocabulary learning. As such, this form-oriented learning process needs to be given more attention in L2 vocabulary research. Furthermore, given that L2 word learning is incremental both in terms of word form (partial word form learning over time) and word meaning (learning L2-appropriate semantic space and usage over time), tension may arise with regard to the need to allocate resources to learn new bits of word form, on the one hand, and the need to learn new bits of word meaning, on the other hand. Consistent with this view are the increasing number of demonstrations of the potential tension between processing for word form and word meaning during lexical input processing in the research literature (see, e.g. Barcroft 2002, 2003, among others).

The present finding about the pervasiveness of partial word learning also has important implications with regard to testing methods in vocabulary research. The results of the study suggest that productive vocabulary knowledge can be broken down and investigated by analyzing production patterns for both partial and fully produced words that learners have recently attempted to learn. This methodology may be beneficial in future studies with regard to measuring degree of knowledge of the formal component of word knowledge. By encouraging participants to produce partially learned words on their own, one may obtain a more precise measure of the degree to which each target word form has been learned. Additionally, in terms of scoring, a large amount of information can be lost if one scores productions only as 0 or 1 or even as 0, .5, or 1. The present evidence about partial word form learning affirms the need for scoring procedures that go beyond two or three tiers in order to obtain more precise measurements of different degrees of knowledge of individual L2 words. An important issue for future research will be the use of additional analyses to assess the learning of word forms. Using morphemes or syllable boundaries as a unit of analysis may provide additional insights into how L2 learners chunk new word forms. Expanding on the present methodology to examine knowledge beyond base forms, such as systematic knowledge of word inflections and derivations, and vocabulary learning with learners at more advanced levels than that of the participants in the present study, should help to provide new insights as well.

The present study also tested the extent to which learning full versus partial words might be affected by number of syllables in a word, the target L2 in question, or both. The interaction observed between language and production type, complete versus partial words (Figure 1), suggests that beginning learners of German may have more difficulty encoding target words as entire units than beginning learners of Spanish or, alternatively, that beginning learners of German are more capable of picking up partial words.

Our findings on production type, complete versus partial words, also demonstrated a significant interaction between language and production

type (Figure 2). This interaction suggests that attempting to learn words with more syllables (in this case, only one more syllable) yields a greater amount of partial word learning than whole word learning. One possible explanation of this finding is that words with more syllables have more word fragments available to be learned, allowing for a greater number of potential fragments. Another explanation is that learners tend to attend more to shorter two-syllable words overall and therefore learn all of the word fragments within those words more often than is the case with three-syllable words. A third possible explanation would be to combine the first two explanations as both of these factors may contribute to the pattern observed. What is important is that this interaction suggests something about partial word learning that is predictive in nature: learners are more likely to have only partial knowledge of longer words and more likely to have full knowledge of shorter words. The generalizability of this working hypothesis can be examined in future studies on production type (full or partial word) for words with a larger range of word lengths, such as words with one, two, three, four, and five syllables.

Amount of word produced in partial word form learning

The findings on the amount of a target word produced indicate that the learners in both L2s often came close to learning a target word completely by producing more often three-quarters of the target word than one-half and one-quarter of the target word. One important methodological implication of this finding is that the high level of nearly but not completely full word form knowledge observed in the study most likely would not be discernible using a receptively oriented measure of vocabulary knowledge in which the target word form is provided for the learner (e.g. L2-to-L1 translation) because the missing formal knowledge when one knows approximately three-quarters of a word would not prevent one from recognizing the word when it is presented. Arguably, the same may be true for the one-half and even the one-quarter levels of productive knowledge, but most likely not to the same extent as when one is at the three-quarters level. We also should note the possibility of increased confusion between different partially known words when one has learned an increasingly smaller amount of an entire word form. The less overall word form one has learned, the more that word may be confused with other partially learned words, at least potentially.

Additionally, the larger number of productions at the three-quarters level was more pronounced for two-syllable words than for three-syllable words, which yielded the significant interaction between number of syllables and amount of word (Figure 3). One possible explanation of this pattern is that because shorter words tend to be easier to learn (e.g. Ellis and Beaton 1993), learners tend to reach disproportionately higher levels of partial word form knowledge (i.e. three-quarters instead of one-quarter or one-half) for those words.

Fragment length in partial word form learning

Although the participants in the study often reached the level of three-quarters of a word in their productions, they also produced a large number of smaller fragments within target words overall, including an especially large number of single-letter and bigram fragments. One explanation of this finding involves focusing on the incremental nature of fragment learning. Like the larger incremental process of word form learning, fragment learning can be incremental. Given that single letters were the smallest possible fragment in each target word in the present study, there were more opportunities for learners to encode single-letter fragments by default when attempting but failing to learn larger fragments within the word. Additionally, the beginning L2 learners may have lacked familiarity with the phonotactic patterns of their respective L2s that would be required to be more successful at chunking the target words via multi-letter units, such as phonemes, morphemes, syllables and prosodic patterns (Ellis and Beaton 1993; Ellis 2001). This lack of familiarity may have contributed to a greater number of failures at multi-letter chunking, leading to more cases of encoding single letters only.

An interaction between fragment length and language (Figure 4) also was observed in this study. The particularly high number of one-letter fragments among Spanish learners may be related to how many Spanish words contain the letters 'a' or 'o' and how learners of Spanish become sensitive to this pattern, which could have given rise to the higher percentage of one-letter fragments observed for the learners of Spanish as compared with the learners of German. Given that English and German are both Germanic languages, the learners of German may have been more familiar with phonotactic patterns in German than the learners of Spanish, which is a Romance language. From this perspective, the greater phonotactic familiarity of the learners of German may have allowed them to be more effective at chunking multi-letter sequences, thereby having fewer instances of single-letter productions than the learners of Spanish. It is also possible that the activation of the L1 word form influenced processing of the L2 word forms (Sunderman and Kroll 2006). The target words used in the current investigation do not allow the identification of specific processing patterns that may be due to the L1. Future research should assess the effect of the L1 on L2 word processing by manipulating the choice of target words. Additionally, studies should further investigate whether one's level of phonotactic competence develops at the same pace in learners of different L2s and determine the relationship between phonological short-term memory and word form learning. Findings from psychological research suggest that phonological short-term/working memory plays an important role in the acquisition of L2 word forms (e.g. Speciale *et al.* 2004; Kovács and Racsmany 2008). It is assumed that a novice learner comes to the task of L2 acquisition with a particular phonological short-term memory capacity, and it is this that limits their rate of L2 acquisition. Yet, as L2 learners develop phonotactic competence and knowledge of phonological regularities of the L2, phonological

short-term memory capacity increases and subsequently enhances word form learning.

Finally, the data on fragment length also provided some evidence against solely linear processing during the initial stages of word form encoding. The findings suggest that learners did not systematically segment off large fragments of a word in some order of succession in order to encode these fragments before attending to other segments. Instead, it seems that the learners allocated processing resources to various fragments in more of a parallel and interactive manner.

Fragment location in word form learning

The analysis on location provided new evidence in favor of the idea that word-initial position is privileged during the initial stages of L2 word learning, corroborating previous findings (Barcroft 2000b, 2008). The overall percentage of target letters in word-initial positions was greater than percentages in word-medial or word-final positions case for two-syllable and three-syllable words. This result provides new evidence for extending the primacy-effect component of the bathtub effect to the initial stages of L2 word learning (Brown and McNeill 1966). The effect of location in the present study differed from the bathtub effect, however, due to the particularly high means for word-initial location as compared with the other two locations (Figure 5). A more appropriate name for the effects of location in the present study would be *recliner effect*. Whereas the term 'bathtub effect' makes use of the metaphor of someone in a bathtub with their head and feet out of the water, the present findings and those of Barcroft (2000b, 2008) are better depicted by the metaphor of someone in a reclining chair with their head higher than the middle of their body and their feet.

One possible reason that word-initial positions are favored is simply that they are more easily perceived. An alternative, however, concerns efficient parsing. Even if word-initial positions are not perceptually more salient, learners may parse word-initial positions to a greater extent as a strategy that allows for the most efficient word-level parsing overall. A third possibility is that word-initial privileging is due to some combination of both of the above and is in part due to perceptual salience and in part due to parsing mechanisms employed by the learner. To further examine the distinction in pattern between the bathtub effect, previously observed in TOT states in the spoken mode, and the recliner pattern observed in the present study, new research on partial word production in the spoken mode is needed in order to assess further whether the recliner pattern is specific to the written mode.

The interaction between location and language (Figure 5) suggests that English-speaking learners of German processed word fragments in medial and final position differently than learners of Spanish. Learners of German produced substantially fewer fragments in word-medial position than in final

position. Learners of Spanish, however, produced almost equal amounts of word fragments in word-medial and word-final positions. Returning to the recliner metaphor, the learners of German have their feet propped higher than the learners of Spanish in the recliner chair, but note that the head of the recliner remains the highest part of the recliner for both languages. One possible explanation of this finding is, again, that the different learning patterns may be related to the extent to which the English-speaking learners of German were familiar with the phonotactic patterns and other properties of word in German due to English being a Germanic language. Although highly speculative, this higher degree of familiarity among learners of German somehow may have allowed them to attend to patterns in word-final position more readily as compared with the learners of Spanish. The lower degree of familiarity among the learners of Spanish may have decreased their ability to demonstrate a potential word-internal recency effect because processing resources needed to do so were exhausted attending to properties of the Spanish words with which they were less familiar as compared to the case of another Germanic language.

In future studies that expand upon the methodology of the present study, one limitation of the present investigation that can be addressed, albeit perhaps not easily, is that of the lexical characteristics, particularly word frequency, of the target word pairs. Although in the present study Spanish and German words were matched for number of letters and number of syllables, they were not matched according to word frequency in the languages in question (i.e. frequency of the word for *Kröte* 'frog' in German versus frequency of the word *borla* 'tassle' in Spanish and the relative frequency of the English counterparts of these two words in English, the participants' L1). Finding word pairs that match on the formal properties for which they matched in the present study as well as lexical characteristics, such as word frequency, poses a challenging methodological task. One viable option would be to use pseudowords with properties of Spanish and German respectively in order to be able to use the same referent (e.g. *frog*) for both languages. With this option one would no longer be dealing with real words in the target languages, but from a methodological standpoint, it would facilitate matching target words on lexical properties because there would be only one referent for each two varieties of target word form in the respective languages. The issue of creating target pseudowords that are sufficiently 'German-like' and 'Spanish-like', and equally so for each referent in question, would pose another challenge with this option, however.

Another reason that we emphasize the exploratory nature of the present study concerns the potential of how individual-difference variables between the Spanish versus the German learners, such as memory span, may have affected the present results. Future studies might recruit naïve absolute-beginner participants who attempt to learn two sets of vocabulary, one in each language, on two separate occasions, with a rest period in between, and counterbalance learning orders across participants.

Overall, our findings on location and those of Barcroft (2000b, 2008) suggest that privileging for word-initial location may be a general principle of L2 word form learning. Further investigation is needed, however, in order to examine the extent to which word-final position may be privileged over word-medial position in different vocabulary learning contexts and for different L2s. Likewise, it would be helpful to assess in future research the extent to which privileging for word-initial location is maintained with words that contain more than three syllables as word length gradually increases and with learners at increasingly higher levels of L2 proficiency. Additionally, given that other aspects of word knowledge and word learning may come into play, such as degree of knowledge of the L1 word and personal preferences for different types of words, future studies can be designed to assess the independent contributions of factors such as these in word form learning. Finally, control tests such as digit span or English word-form recall can be incorporated to make between-group comparisons, such as between the L2 Spanish and L2 German groups, more meaningful (although perhaps more challenging to do so in classroom-based research). Systematic modifications of this nature in future research should help to test the generalizability of increased learnability of word-initial fragments and other presently identified patterns in partial word form learning.

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