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# Syntactic Priming, Type Frequency, and EFL Learners' Production of *Wh*-Questions

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Previous interaction studies have reported a positive relationship between syntactic priming and English second language (L2) learners' subsequent production of *wh*-questions. Syntactic priming research has shown that a speaker's production of a structure during syntactic priming activities is influenced by the individual lexical items that occur in the immediate discourse context. The current study brings together these 2 lines of research to determine whether variation in the type frequency of the lexical verbs and *wh*-question words targeted in syntactic priming activities impacts learners' subsequent production of *wh*-questions. Thai English as a foreign language learners ( $n = 85$ ) met individually with a researcher for 2 20-minute sessions over a 3-week period during which they carried out pretest, priming, and posttest activities. The sessions were digitally recorded and transcribed, and the transcripts were analyzed in terms of the type and number of *wh*-questions produced by the learners. The results indicated that syntactic priming materials that prompted learners to produce *wh*-questions with a wide variety of lexical verbs facilitated their subsequent production of *wh*-questions. The implications are discussed in terms of the role of type frequency during priming activities in L2 learners' acquisition of *wh*-questions.

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THE CURRENT FOCUS OF MOST INTERACTION research is to identify the interactional features that account for the positive relationship between interaction and second language (L2) learning. Influenced by first language (L1) speech production and acquisition research, interaction researchers have asked whether syntactic priming is one of the interactional features that might help account for this beneficial relationship. Syntactic priming (also referred to as structural priming) is the tendency for a speaker to produce a structure that was encountered in the recent discourse rather than choose an alternative structure. Priming can be said to occur even if the structure encountered in recent discourse and the speaker's subsequent utterance have different topics, lexical items, closed-class elements,

thematic compositions, phonology, or pragmatic features. (For a recent review of structural priming, see Pickering & Ferreira, 2008.)

The basic explanation for syntactic priming is that speakers are more sensitive to experiences with a syntactic structure than they are to experiences with surface-level features and that such sensitivity may be caused by residual activation of the morphosyntactic information stored within individual lexical items. In other words, when a speaker hears or produces an utterance with a specific lexical item in one of its possible syntactic structures, that syntactic information becomes activated and facilitates the subsequent production of the same syntactic structure with other lexical items. For example, when a speaker hears an interlocutor producing a double-object dative (e.g., *Susie baked her daughter a cake*), that speaker is more likely to produce another double-object dative later in the conversation than she is to produce an equally acceptable prepositional

dative (e.g., *John bought a bicycle for his mother*). Syntactic priming has been shown to occur in a variety of populations, including L1 adults, L1 children at various ages, L1 children with specific language impairment, bilingual adults, and L2 learners. Priming also occurs with Broca's aphasics (Hartsuiker & Kolk, 1998), which suggests that it may be a basic component of language processing. However, previous L2 research has suggested that it may not occur with as many structures in L2 speech production as it does in L1 speech production (McDonough, 2006).

The premise of syntactic priming experiments is that participants will produce a syntactic structure that they have just been exposed to in the preceding discourse, even when alternate structures that express the same meaning are available. Consequently, all syntactic priming studies investigate structures for which there are a minimum of two alternate structures. For adult L1 speakers, this involves equally acceptable syntactic structures such as alternation between active and passive constructions or alternation between prepositional and double-object dative constructions. For L2 learners, however, syntactic priming may also involve alternation between a developmentally advanced and simple structure or between a syntactically accurate and inaccurate structure. Although these alternate structures may not be grammatical in the target language, they may be equally acceptable in the learner (or learners') language.

In syntactic priming experiments, researchers first present participants with models of the alternating structures, referred to as primes. Following presentation of the primes, participants are prompted to produce a similar sentence to see whether they use the same syntactic structure that was modeled in the prime. To constrain the participants' production, the experimental materials provide prompts, typically lexical verbs, that can elicit the target structure. (For an overview of priming methods in L2 research, see McDonough & Trofimovich, 2008.) For example, if the target structure is dative alternation, the participant might hear or read the prime *the woman brought her the newspaper* and then be prompted to describe a picture of a man giving a ball to a little boy using the verb *give*. The researchers provide a prompt that could occur with either of the possible structures so that they can determine whether the participants produce a sentence with the structure previously modeled in the prime.

Previous syntactic priming studies have demonstrated that the specific lexical items provided in the primes and prompts can influence the occurrence of syntactic priming. For example, if participants see a picture with a prime sentence that

contains the lexical verb *give* in a prepositional dative structure and then are prompted to describe a new picture using the verb *give*, syntactic priming is greater than if they are prompted to describe the picture with a different verb, such as *show* or *pass*. In other words, prompts that repeat a key lexical item (usually a lexical verb) modeled in the prime elicit greater syntactic priming in the immediate discourse. This effect has been referred to as the *lexical boost* (Pickering & Ferreira, 2008).

A recent study by McDonough and Mackey (2008) reported that syntactic priming facilitated subsequent production when learners produced the target structure with new lexical items. Using Pienemann and Johnston's (1987) developmental sequence of English as a second language (ESL) question formation, they found that learners who produced *wh*-questions with lexical verbs and *wh*-question words that had not occurred in the preceding primes were more likely to advance to a higher stage of question development than learners who repeated the lexical verbs and *wh*-question words modeled in the primes. Taken together, these lines of research suggest that immediate production of the target structure may be enhanced by using the same lexical items in the primes and prompts, but subsequent production may be impacted through greater lexical diversity.

The possible benefit of hearing and producing a structure with diverse lexical items can be understood through reference to usage-based approaches to acquisition, which focus on the acquisition of constructions (see Bybee, 2008; Goldberg & Casenhiser, 2008; Lieven & Tomasello, 2008). Following Goldberg (1995), a construction is defined as a pairing of form and meaning that expresses a proposition. Constructions entail both meaning and form, with both individual lexical items and the construction itself contributing to the overall interpretation of an utterance. For example, the verb *kick* does not necessarily convey transfer of possession (e.g., *he kicked the door*), except when it occurs in the dative construction (e.g., *he kicked the ball to the children*) (Bencini & Goldberg, 2000). Unlike approaches to grammar that emphasize the acquisition of syntactic rules or processing procedures that are independent of the meaning of the individual lexical items in an utterance, construction-based approaches assume that form and meaning are linked and that constructions are acquired through an item-based process, often driven by the syntactic patterns associated with lexical verbs.

In usage-based approaches to acquisition, constructions are acquired through two primary processes: (a) creating an inventory of lexically based frames that occur frequently in the input

and express communicative functions and (b) generalizing through analogy to derive complex abstract constructions from those lexical frames (Rowland, 2007). In the initial stages of acquiring *wh*-questions, a learner may have productive use of the question “*What’s he doing?*” without being aware of the tense/aspect/number features or recognizing that the contracted *-s* represents an auxiliary verb. Over time, the learner may use that basic frame to generate questions with other lexical items filling “slots” in the construction, such as different subjects (*what’s she doing?* *What’s the man doing?*) or different lexical verbs (*What’s he eating?* *What’s he saying?*). Eventually, by hearing and producing multiple exemplars, the learner develops a more abstract schema consisting of [*wh*-word] [be] [S] [V(*progressive*)]. As a result, the learner can produce that construction with the slots filled with a wide variety of lexical items, resulting in a productive use of that construction. As additional *wh*-question frames are acquired, such as *What do you V?* or *What does S + V?*, eventually a learner forms the more abstract *wh*-construction, which consists of [*wh*-word] [aux] [S] [V] (Ambridge, Rowland, Theakston, & Tomasello, 2006). In this framework, moving away from a lexically fixed construction to slotting different lexical items into a construction represents one step in development.

Among other factors, frequency in the input is believed to play an important role in helping learners initially acquire the lexical frames and eventually extend those frames to form generalized abstract representations (Bybee, 1995, 2008; Childers & Tomasello, 2001; Ellis, 2002, 2005; Robinson & Ellis, 2008). In the initial stage, frequency in the form of repeated exposure to numerous occurrences of a single exemplar of a construction (i.e., low type frequency but high token frequency) can help learners detect the lexical frame and subsequently recognize and produce it automatically. For example, repeated exposure to sentences in which the verb *give* occurs in the double-object dative form (i.e., *give me the pencil*, *give me the book*, *give me your homework*) may facilitate the initial detection of the [V] [NP (recipient)] [NP (patient)] construction more effectively than exposure to sentences with a variety of verbs in that structure (such as *show*, *hand*, *pass*, *tell*). Previous experimental studies have demonstrated that input in which a particular construction has low type/high token frequency is more effective for pattern detection than a more balanced input (Casenhiser & Goldberg, 2005; Goldberg, Casenhiser, & Sethuraman, 2004).

In later stages when a learner begins to form more abstract representations, frequency in the

form of exposure to the same construction with a variety of lexical items (i.e., high type frequency) creates opportunities for learners to extend a pattern. Type frequency provides the learner with information about the number of distinct lexical items that can fill the slots in the construction, and it indicates that the construction is productive rather than lexically specific. For example, if learners have acquired the lexical frame “*What’s he doing?*,” then type frequency in the form of exemplars in which the slots in the frame are filled with other lexical types can facilitate the development of a more abstract representation. These exemplars might include different noun phrases (*What’s the dog doing?*), lexical verbs (*What’s he eating?*), *wh*-question words (*When’s he eating?*), or other auxiliary verbs (*What was he doing?*). Through analogy and extension, a learner can move from a limited lexical frame to the more productive abstract schema, eventually recognizing that a wide variety of *wh*-question words, auxiliary verbs, subjects, and lexical verbs are all generated from the same underlying construction.

Although usage-based approaches to acquisition have focused largely on the importance of input features in promoting the initial detection of lexical frames and the acquisition of more abstract constructions, language production may also play an important role in the acquisition of structural patterns. Input features clearly assume a primary role in allowing learners to detect constructions, which is a necessary component of acquisition. However, acquisition also entails the ability to use those constructions to achieve communicative functions, and language production may contribute to this aspect of acquisition in ways that are complementary to input. For example, language production may encourage grammatical processing differently than language comprehension, as understanding message content may not require analysis of its syntactic features (Swain, 1985). Neuroimaging studies involving adult native speakers have shown that producing phrases and sentences that have syntactic relationships activates regions of Broca’s area that are not activated during comprehension of those same utterances. This suggests that speaking requires syntactic processing that may not be necessary during listening (Indefrey, Hellwig, Herzog, Seitz, & Hagoort, 2004). Additionally, whereas a common representational system likely underlies the comprehension and production of constructions, processing mechanisms and the deployment of syntactic information may differ for comprehension and production (Bock, 1995; Huttenlocher, Vasilyeva, & Shimpi, 2004). Because the comprehension and production systems rely on the

same linguistic information, lexical and structural nodes are activated when a speaker hears or produces a structure. Consequently, type frequency that is either present in the input or generated through production may help learners move from lexically specific frames to more abstract representations in which a variety of lexical items can fill slots in a construction. Syntactic priming materials with prompts that “push” learners to produce a construction with a variety of lexical items may help them acquire lexical frames and produce multiple lexical items in those frames, thereby encouraging the development of more abstract representations.

To summarize, previous studies have demonstrated that the lexical items provided in the primes and prompts targeted in syntactic priming materials may impact a speaker’s immediate and subsequent production of the target structures differently. In addition, usage-based approaches to acquisition suggest that type frequency may play an important role in the acquisition of constructions. Furthermore, previous interaction studies have found that producing the target structure with diverse lexical items during syntactic priming activities positively impacts L2 learners’ subsequent production. Therefore, the current study brings together these lines of research to investigate the impact of type frequency involving the individual lexical items in both the primes and the prompts targeted in syntactic priming materials on L2 learners’ subsequent production of *wh*-questions.

The research question was as follows: Does the type frequency provided in syntactic priming materials affect English as a foreign language (EFL) learners’ subsequent production of *wh*-questions? Because frequency in the input is believed to influence the acquisition of constructions (Casenhiser & Goldberg, 2005; Goldberg & Casenhiser, 2008), it was predicted that type frequency in the researcher’s primes would facilitate the subsequent production of *wh*-questions. In addition, based on the previous findings of interaction research (McDonough & Mackey, 2008), it was predicted that type frequency in the learner’s production, achieved by manipulating the prompts, would also facilitate the subsequent production of *wh*-questions.

## THE STUDY

### *Participants*

The participants were 92 Thai EFL learners enrolled in various undergraduate degree programs

at a large public university in northern Thailand.<sup>1</sup> Learners who missed a session were excluded from the analysis ( $n = 7$ ). The resulting participant pool consisted of 85 EFL learners, 55 women and 30 men, who were all native speakers of Thai. Their ages ranged from 18 to 22 years, with a mean of 18.81 years ( $SD = 1.00$ ), and the length of their previous English study ranged from 7 to 17 years, with a mean of 11.00 years ( $SD = 2.49$ ). They were majoring in various degree programs, including English (23), economics (19), education (17), science (12), engineering (8), and social sciences (6). Approximately one third of the learners ( $n = 34$ ) reported knowing other languages in addition to Thai and English, which included heritage languages such as Chinese and Hindi, as well as languages they had studied formally, such as French, German, Japanese, and Korean. Only 5 learners reported having been to a country where English was used as a medium of communication, with their length of residence in those countries ranging from 1 week to 3 months.

### *Design*

The current study used a pretest–posttest design to investigate the role of type frequency in syntactic priming activities on EFL learners’ subsequent production of *wh*-questions. The dependent variable was the learners’ production of *wh*-questions, which was operationalized narrowly as grammatically correct *wh*-questions with inverted auxiliary verbs.<sup>2</sup> Their production of *wh*-questions with inversion was measured in terms of (a) the proportion of correct questions to total obligatory contexts, (b) the occurrence of frame-based *wh*-questions, and (c) the reliance on question frames. The independent variables were type frequency in the researcher’s primes and type frequency in the learners’ prompts. For the researcher’s primes, high-type-frequency materials presented 36 *wh*-questions with 36 lexical verbs and six question words (*who*, *what*, *when*, *where*, *how*, *why*), whereas low-type-frequency materials involved 36 *wh*-questions generated from six lexical verbs and fewer question words (*who*, *where*, *how*, *what*).

Although differing in their theoretical frameworks, several L1 acquisition studies have shown that individual *wh*-question words are associated with different problems in question formation, including auxiliary omission and subject–auxiliary inversion errors (DeVilliers, 1991; Klee, 1985; Rowland, 2007; Rowland & Pine, 2000; Rowland, Pine, Lieven, & Theakston, 2005). Usage-based theories assume that the ability to produce a

*wh*-word in a particular frame, such as *Where's [S] [Ving]?*, does not automatically translate into the ability to produce that frame with different *wh*-words or to produce other *wh*-question frames. Instead, the ability to slot different *wh*-words into an existing frame and to generalize *wh*-words across question frames emerges over time, and input features such as type frequency can facilitate this process. The specific question words included in the primes were selected based on the order of acquisition of *wh*-question words in L1 acquisition (Bloom, Merken, & Wooten, 1982), with the high-type-frequency primes including the first six question words to emerge (*what, where, who, how, why, and when*) and low-type-frequency primes including only the first four question words (*what, where, who, how*).

For the learners' prompts (i.e., words provided in the materials to elicit production of the target structure), type frequency was operationalized in terms of the lexical verbs only so that learners could select *wh*-question words that were appropriate for their communicative intention. Whereas high-type-frequency prompts included 36 different lexical verbs, low-type-frequency prompts repeated the same 6 lexical verbs. The manipulation of type frequency in both the primes and the prompts resulted in the formation of four groups to which participants were randomly assigned, as illustrated in Table 1 (see also Appendix A for a complete list of verbs in each condition). None of the lexical verbs used in the researcher's primes were identical to the verbs in the learners' prompts in order to eliminate the possibility of lexical boost.

### Materials

The materials consisted of communicative activities that provided contexts for a variety of questions types. The activities used in the pretest and posttest included story completion tasks, guessing games, and interview topics. These activities were

not specifically designed to create contexts for syntactic priming, as neither primes nor prompts were provided. Instead, they were used to elicit the learners' production of *wh*-questions in a context in which turn-taking was not strictly controlled and the primary emphasis was on the achievement of a communicative goal. The syntactic priming activities also involved communicative activities (picture question/answer tasks and picture difference tasks), but they were carefully designed to elicit *wh*-questions with inversion. For the picture question/answer task, the researcher had a set of alternating prime cards and picture cards and the learner had a set of alternating picture cards and prompt cards. The information depicted in the pictures was used to answer questions generated by each other. The researcher's primes were *wh*-questions with inversion (e.g., *Where is the teacher writing the report?*), whereas the learners' prompts were subjects and lexical verbs only (e.g., *Mary/open*; see Appendix B for examples). For the two picture difference tasks (a beach scene and a camping scene), the researcher's picture was labeled with *wh*-questions with inversion that revealed differences between the two pictures (i.e., *How much wood does Bill hold?*), whereas the learners' picture was labeled with subject/verb prompts only (e.g., *bull/follow*).

The lexical verbs included in the researcher's primes and the learners' prompts (provided in Appendix A) were initially selected based on their ease in elicitation from picture prompts and then checked for occurrence on the General Service List (West, 1953; adapted by Baumann & Culligan, 1995).<sup>3</sup> Second, the grammatical subjects used in both the primes and the prompts included an equal number of proper names (e.g., *John, Mary*); determiner + noun phrases (i.e., *the teacher, the grandfather*); and pronouns (e.g., *she, he, they*). Finally, the tense and aspect features of the researcher's primes included an equal number of present simple (*Who do they see in the tree?*), present continuous (*Where are the children*

TABLE 1  
Lexical Verbs and Question Words by Type Frequency Groups

Prime Type Frequency	Prompt Type Frequency	
	High	Low
High	Primes with 36 lexical verbs and 6 question words; prompts with 36 lexical verbs ( $n = 19$ )	Primes with 36 lexical verbs and 6 question words; prompts with 6 lexical verbs ( $n = 21$ )
Low	Primes with 6 lexical verbs and 4 question words; prompts with 36 lexical verbs ( $n = 19$ )	Primes with 6 lexical verbs and 4 question words; prompts with 6 lexical verbs ( $n = 26$ )

playing?), past simple (*How did the cat enter the house?*), present perfect (*What has Joy read to the children?*), and future simple (*Who will she follow down the stairs?*) with both singular and plural subjects.

To establish that the materials would successfully elicit contexts for *wh*-questions with inversion, the activities were pilot tested with native speakers (NSs) of English ( $n = 40$ ), all of whom were undergraduate students enrolled at a regional university in the southwest United States. The students met with the first author to carry out a variety of pretest, posttest, and syntactic priming activities. During a 20-minute session, each NS completed two to four activities depending on how long each activity took to complete. Analysis of the NS data indicated that the syntactic priming materials effectively elicited *wh*-questions with inversion, with the NSs' proportion of *wh*-questions with inversion to total *wh*-questions ranging from .94 to .97. Their production of *wh*-questions with inversion was lower during the pretest and posttest activities, .45 and .42, respectively, which was expected, as those materials did not provide any primes or prompts. As a result, the pretest and posttest activities elicited more naturalistic conversation in which the NSs could ask a wider variety of questions, which included yes/no questions, *wh*-questions with the copula, and subject *wh*-questions (i.e., *What happened after that?*). The native English speakers did not produce any non-target-like *wh*-questions in which the auxiliary verb had been omitted (i.e., *Why the man showing his boot?*) or had not been inverted (i.e., *Where the farmer is driving his truck?*).

### Procedure

The learners met the first author for two 20-minute sessions over a 3-week period. In the first session, the learners carried out the pretest and one set of syntactic priming materials. In the second session, the learners carried out the second set of syntactic priming materials and the posttest. While completing the syntactic priming materials, the researcher always spoke first to ensure that the *wh*-question primes were provided before the learners formulated a question based on their prompts. Turn-taking during the pretest and posttest activities was not tightly controlled, but the researcher made sure to ask yes/no questions and *wh*-questions with the copula so that learners would not be primed to produce *wh*-questions with inversion. The interaction between the learners and the first author was recorded using MP3 digital voice recorders, and the audio files

were transcribed by both authors and a research assistant.

### Analysis

The pretest and posttest data were analyzed in terms of the learners' production of *wh*-questions with inversion, which was considered in terms of (a) the proportion of correct questions to total contexts, (b) the occurrence of frame-based *wh*-questions, and (c) the reliance on *wh*-question frames. To obtain the proportion score, the obligatory contexts for inversion in *wh*-questions were totaled for each learner. Single-word *wh*-questions (*What?*), single-phrase *wh*-questions (*What time?*), echo *wh*-questions (*You went when?*), subject *wh*-questions (*Who likes hockey?*), and *wh*-questions with the copula (*Where is it?*) were not considered obligatory contexts for auxiliary inversion. Next, the number of correctly formed *wh*-questions in those obligatory contexts was totaled. Then, a proportion score was obtained by dividing the number of correctly formed *wh*-questions with inversion by the total number of obligatory contexts.

The learners' *wh*-questions with inversion were then analyzed to determine whether *wh*-question frames were produced. The ability to slot a variety of lexical items into question frames is an indication that learners have begun to use a construction productively. A *wh*-question frame was operationalized as a correct [*wh*-word] [aux] [S] [V] sequence in which at least two elements were filled by the same lexical items. In L1 acquisition studies, the fixed elements in the frame have been referred to as the pivot, and for *wh*-questions, the pivot is typically a specific [*wh*-word + aux] combination (Rowland, 2007). For example, a learner in the current study produced four questions in the frame [what] [are] [S] [Ving] in which [what are] represented the pivot and [S + Ving] was variable, which included questions such as *What are these two kids doing?* and *What are they talking about?* However, the current study broadened the definition of pivot to include questions in which any two out of the four elements remained constant. For example, one learner produced multiple questions with [did you] as the pivot and the *wh*-word and lexical verb as variable, such as *When did you go?* and *Where did you eat?* The number of frame-based questions produced by each learner was totaled, and their reliance on those question frames was calculated as a proportion score by dividing the number of *wh*-questions that occurred in frames by the total number of correct *wh*-questions with inversion that had been produced.

All of the data were coded by the first author, and a subset of the data (35%) was coded by the second author. Interrater reliability was obtained using Pearson correlation coefficients, which were .91 for obligatory contexts, .96 for correctly formed *wh*-questions, and .92 for *wh*-question frames. Disagreements were resolved through discussion, generally deferring to the first author, as she had participated in the interaction with the learners. Alpha was set at .05 for all statistical tests.

## RESULTS

Prior to exploring the impact of type frequency on the learners' subsequent production of *wh*-questions, first the pretest data were checked to ensure there were no preexisting differences among the four syntactic priming groups. In terms of the number of contexts for *wh*-questions with inversion, learners generated an equivalent number of contexts with means ranging from 3.15 to 3.88 contexts. Their production of correct *wh*-questions during the pretest was also similar, ranging from a mean of 1.10 to 2.47 correct questions.<sup>4</sup> One-way analyses of variance (ANOVAs) indicated that there were no significant differences in the number of contexts or correct *wh*-questions among the four groups at the pretest. Next, the syntactic priming data were checked to ensure that differences among the groups were based on type frequency rather than differences in total tokens. In terms of the researcher's primes, the high-type-frequency groups were provided with a mean of 32.23 types ( $SD = 4.12$ ) and 40.40 tokens ( $SD = 6.48$ ) of *wh*-questions with inversion, and the low-type-frequency groups were exposed to a mean of 6.56 types ( $SD = 0.76$ ) and 40.16 tokens ( $SD = 6.60$ ).

In terms of type frequency in the learners' prompts, the high-type-frequency groups generated a mean of 28.03 contexts for *wh*-inversion ( $SD = 4.51$ ) involving a mean of 24.21 lexical verbs types ( $SD = 5.60$ ). The low-type-frequency groups generated a mean of 27.32 contexts for *wh*-inversion ( $SD = 6.19$ ), but these contexts involved a mean of 6.15 lexical verbs types ( $SD = 0.63$ ). To summarize the preliminary analyses, there were no existing differences among the groups at the pretest, and the learners carried out the priming material as intended, with differences among the groups based on types rather than tokens.

To address the research question, which asked if type frequency impacted EFL learners' subsequent production of *wh*-questions with inversion, their proportion correct scores during the

TABLE 2  
Postpriming Proportion Scores by Type Frequency Groups

Prime Type Frequency	Prompt Type Frequency					
	High			Low		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
High	19	.56	.30	21	.43	.36
Low	19	.54	.30	26	.37	.33

posttest were analyzed. As shown in Table 2, the learners who carried out the priming materials with high-type-frequency prompts produced a higher proportion of correct *wh*-questions with inversion than learners who completed the materials with low-type-frequency prompts. However, there was little difference in the scores for learners who had carried out the priming activities with high- and low-type-frequency primes.

The learners' scores were analyzed using a  $2 \times 2$  factorial ANOVA to identify the main and interaction effects for prime type frequency and prompt type frequency. The results revealed a significant main effect for prompt type frequency,  $F(1, 83) = 5.52, p = .021, \eta_p^2 = .064$ . There was no significant main effect for prime type frequency,  $F(1, 83) = .685, p = .410$ , and no interaction effect,  $F(1, 83) = .021, p = .884$ .

To gain further insights into potential differences between learners who received high- and low-type-frequency prompts, their production of question frames was compared. As shown in Table 3, learners who received high-type-frequency prompts produced more frame-based questions ( $M = 1.84$ ) than the learners who had low-type-frequency prompts ( $M = 1.00$ ). They also relied on those question frames to generate a greater proportion of their *wh*-questions with inversion ( $M = 0.52$ ) than learners who received low-type-frequency prompts ( $M = 0.29$ ). Because the data did not meet the assumptions of parametric tests, individual Mann-Whitney tests, and nonparametric independent sample *t*-tests were used. The results indicated that the differences between the high- and low-type-frequency prompt groups were significant for frame-based *wh*-questions and the proportion of frame-based *wh*-questions to total *wh*-questions.

Finally, the total number of *wh*-word types and lexical verb types that occurred in the learners' *wh*-questions at the posttest was also compared. As shown in Table 4, learners who received high-type-frequency prompts produced *wh*-questions that had more unique *wh*-words ( $M = 2.18$ ) and

TABLE 3  
*Wh*-Question Frames by Prompt Group

	High Type Frequency ( <i>n</i> = 38)		Low Type Frequency ( <i>n</i> = 47)		<i>Z</i>	<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Frame-Based Questions	1.84	1.93	1.00	1.37	2.09	.037	.50
Proportion of Frame-Based Questions	0.52	0.45	0.29	0.38	2.58	.010	.55

TABLE 4  
*Wh*-Words and Lexical Verbs by Prompt Group

	High Type Frequency ( <i>n</i> = 38)		Low Type Frequency ( <i>n</i> = 47)		<i>Z</i>	<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
<i>Wh</i> -Word Types	2.18	1.09	1.55	1.21	2.45	.014	.55
Lexical Verb Types	2.71	1.70	1.98	1.68	2.00	.046	.43

lexical verbs ( $M = 2.71$ ) than the learners who received low-type-frequency prompts ( $M = 1.55$  and 1.98, respectively). Individual Mann-Whitney tests indicated that the difference between the prompt type frequency groups was significant for both *wh*-words and lexical verbs.

To summarize, the findings indicated that syntactic priming materials with high-type-frequency prompts facilitated the subsequent production of *wh*-questions with inversion, but prime type frequency did not have a significant effect on the learners' subsequent production. Those learners who received high-type-frequency prompts also produced significantly more frame-based *wh*-questions and relied on those question frames to a greater extent than learners who received the low-type-frequency prompts. Their *wh*-questions also contained significantly more unique lexical verbs and *wh*-question words than the questions produced by learners who received low-type-frequency prompts.<sup>5</sup>

To supplement the quantitative results, we present examples from learners that illustrate the predominant outcomes associated with high- and low-type-frequency prompts: Manatchai, who received high-type-frequency prompts, and Ratchanee, who received low-type-frequency prompts.<sup>6</sup> Although there was variation in the specific types of *wh*-questions that each individual learner produced, these 2 learners represent the overall patterns associated with the high- and low-type-frequency prompts groups. In terms of his pretest production, Manatchai produced two *wh*-

questions with inversion, *What do you like to do?* and *How many times have you been there?* During the activity that required questions about the man, woman, and child whose activities were illustrated in a series of pictures, Manatchai did not generate any *wh*-questions with inversion that had third-person singular subjects. Instead, he formed questions with third-person singular subjects using *wh*-copula questions or yes/no questions. During the syntactic priming activities, when he received high-type-frequency prompts, Manatchai produced nine questions using the *wh*-question frame [what does] [S] [V]? In these nine questions, the pivot was the *wh*-word + aux combination of [what does] and the variable slots were [S] and [V]. For example, he used eight different lexical verbs in the [V] slot, which included questions such as *What does Susie wear?* *What does she read?* and *What does the family build?* During the posttest activity that elicited contexts for questions with third-person singular subjects, Manatchai produced two questions based on the same frame he had used during the priming activities, *What does he look like?* and *What does he wear?* and one similar question in which a different question word had been substituted, *Where does Dalai Lama live?* These examples suggest that the priming activities may have helped Manatchai detect and produce a new question frame that he could then apply during the posttest activities.

Despite having a similar profile at the pretest, Ratchanee's production during the priming activities appears to have resulted in a different



outcome. Like Manatchai, she only produced two *wh*-questions with inversion during the pretest, both in contexts that required the second singular pronoun—that is, *What do you like in Thailand?* She also produced *wh*-copula questions and yes/no questions during the pretest activities that generated contexts for *wh*-questions with third-person singular subjects. Additionally, similar to Manatchai, she produced eight questions using the frame [what does] [S] [V]? during the syntactic priming activities. However, those eight questions involved only four lexical verbs: *do*, *give*, *fix*, and *eat*, unlike Manatchai's questions, which had eight different lexical verbs. During the posttest activities, Ratchanee's only *wh*-question with inversion involved the second-person singular pronoun (*How do you contact them?*). In contexts where the [what does] [S] [V]? frame could have been used, she instead produced *wh*-questions without an auxiliary verb (*What it feel?*). Even though the priming activities provided opportunities for Ratchanee to produce multiple exemplars based on a new *wh*-question frame, the repeated use of the same lexical verbs did not appear to facilitate the ability to apply that frame to other lexical verbs during the posttest activities.

As these examples suggest, prompting learners to produce a wide variety of lexical verbs in their *wh*-questions with inversion may help them acquire frames that can be used to generate new questions. An interesting issue that has been raised in the L1 acquisition literature (Rowland, 2007; Rowland & Pine, 2000) is how learners' use of frames can result in the production of incorrect questions. It has been shown that learners tend to make errors involving the variable slots in their question frames rather than the pivot. In other words, learners rely on a specific pivot to generate multiple questions, but when they fill the variable slots with inappropriate lexical items, this process results in ungrammatical questions.

For example, in the current study, Sureeporn generated multiple questions using the frame [what does] [S] [V], in which the pivot was *what does* and the variable slots were [S] and [V]. When in a communicative context in which ongoing action was depicted, she generated the following questions: *What does the squirrel looking for?* *What does John eating?* and *What does Jilly playing?* In all three contexts, Sureeporn applied the pivot of her question frame, but she filled the variable verb slot with a progressive verb, which resulted in an incorrect question. Similarly, Manop produced several questions in the question frame [what is] [S] [Ving], in which the question word + aux-

iliary was the pivot and the subject and progressive verbs were variable. When confronted with a context in which simple present was appropriate, he asked questions such as *Where is Jane teach?* and *Where is he work?* It has been suggested that a learner will rely on the pivot part of her existing question frames until she has acquired "the particular *wh*-word + auxiliary marker around which to base the question she wishes to ask" (Rowland & Pine, 2000, p. 165).<sup>7</sup> Although a comprehensive analysis of the learners' errors involving *wh*-questions with inversion was beyond the scope of the current study, qualitative trends in the data suggest that some errors may be the result of applying existing question frames in contexts that require a frame that the learners may have yet to acquire.

## DISCUSSION

Previous syntactic priming studies have shown that speakers produce more target structures in the immediate context when primes and prompts have identical lexical items (e.g., the lexical boost). Previous interaction studies have shown that syntactic priming materials with lexical diversity facilitate subsequent production of the target structure. The current study confirms the importance of lexical diversity in promoting subsequent production, as learners who received high-type-frequency prompts subsequently produced a higher proportion of accurate *wh*-questions with inversion than learners who received low-type-frequency prompts. The findings also indicated that type frequency in the researchers' primes did not impact the learners' subsequent production. This result was unexpected, as type frequency involving the lexical items that can fill slots in a construction had been shown to play a major role in helping learners recognize the productivity of a construction (Bybee, 2008). One possible explanation of the results of the current study could be that type frequency helped learners initially detect a construction in the input. However, once the construction had been detected, the grammatical processing required for language production might have helped learners build associations between a construction and diverse lexical items. It is also possible that the potential benefits of input type frequency might have remained undetected in the current study because the analysis focused exclusively on learners' production of *wh*-questions over a limited time period. Including other measures in the study, such as reaction times, might have revealed possible benefits for input type frequency, such as facilitating the

ability to process *wh*-questions more quickly and/or accurately.

The findings also indicated that *wh*-question frames may provide insight into the process by which L2 learners acquire *wh*-questions. Similar findings have been previously reported in L1 acquisition studies (Ambridge et al., 2006; Rowland, 2007; Rowland et al., 2005). Similarities between L1 and L2 learners' acquisition of *wh*-questions are surprising in light of differences in their learning environments. Unlike L1 learners, the L2 learners in this study have received instruction that included metalinguistic explanations of the grammatical features of English, including question formation, for an average of 11 years (ranging from 7 to 17 years). More recently, learners had reviewed rules of question formation in a required English course taken the semester prior to data collection. From a strong-interface perspective (DeKeyser, 1997), it is possible that the learners' instructional experiences facilitated the acquisition of some declarative knowledge without providing them sufficient opportunities to develop the procedural knowledge that is required for actual language use. From a weak interface perspective (Ellis, 2005, 2007), it is possible that the learners did not access their explicit knowledge of question formation because they did not perceive any problems with their ability to communicate effectively during the experimental activities. Consequently, they may have relied on their implicit knowledge of *wh*-questions, which included non-target-like features such as auxiliary omission and noninversion.

The findings suggest that syntactic priming materials prompting learners to produce questions with a wide variety of lexical verbs may facilitate the subsequent production of *wh*-questions with inversion. Whereas low type/high token frequency is believed to help learners extract structural patterns from the input, high type frequency may facilitate the acquisition of a productive frame. However, future studies are needed before more general conclusions are drawn. Studies investigating other constructions would be particularly valuable, especially constructions that have been examined within the usage-based approach to L1 acquisition, such as relative clauses and causatives in German (Diesel & Tomasello, 2005; Dittmar, Abbott-Smith, Lieven, & Tomasello, 2008), instrumentals in Polish (Dbrowska & Tomasello, 2008), and English transitives (Childers & Tomasello, 2001).

Because it investigated learners' subsequent production immediately following their completion of syntactic priming materials, the current

study does not provide insight into the longer term impact of syntactic priming. Subsequent research would benefit from the inclusion of delayed posttests that could be used to assess whether the immediate impact of syntactic priming demonstrated in the current study persists over time. In addition, previous interaction-based syntactic priming studies have investigated a narrow range of structures in L2 English, including datives (McDonough, 2006), passives (Kim & McDonough, 2008), and questions (McDonough & Mackey, 2008). Interaction research has relied heavily on question forms due to the availability of developmental sequences that can be used to assess the learners' level and to operationalize development. However, the number of syntactic structures for which developmental sequences exist is rather small. By adopting an analysis of lexical frames, researchers can use a data-driven approach to identify the emergence of lexical frames and the productivity associated with those frames. This approach allows for a greater range of constructions to be targeted in priming and interaction studies, which can help increase their ecological validity.

Another topic for future research concerns the claim that low type/high token frequency in the input (i.e., skewed input) may help learners extract patterns from the input. This claim has been addressed in L1 acquisition studies involving novel constructions in English; however, it has not been tested in L2 acquisition research. L2 research like that of Year and Gordon (this issue) can test this claim by targeting developmentally advanced structures, such as passives or double-object dative constructions that lower proficiency learners have yet to acquire. This line of research would help shed light on the possibility raised in the current study—namely, that input type frequency plays an important role in the initial detection of a pattern (Ellis & Ferreira-Junior, this issue). In addition, the claim that type frequency helps to drive the acquisition of abstract constructions requires further research and involves overcoming methodological challenges in identifying whether learners have abstract constructions. Additional measures may be necessary, beyond production data, to determine how generalized learners' abstract constructions are.

Moreover, more long-term studies are also needed to elicit production data that generates contexts for numerous exemplars of the target structure. It is difficult to determine the existence of lexical frames or the productivity of those frames with limited samples. Because the acquisition of more abstract representations is likely

the result of a lengthy process, more longitudinal studies are needed to capture learners at multiple stages in the acquisition of constructions. Due to the important link between input features such as frequency and the acquisition of constructions, studies that can document the input to which learners have been exposed in their prior learning as well as during the experimental procedure are needed. Finally, additional research is needed to identify whether any individual cognitive factors may be associated with the ability to detect structural patterns in the input and schematize across utterances to form abstract constructions. Hopefully, future research that overcomes methodological challenges and forges connections between related fields may generate new insight about the individual and combined impact of input and output type frequency on the L2 acquisition of constructions.

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#### NOTES

<sup>1</sup>The participants were recruited in two data collection phases that were separated by 1 year.

<sup>2</sup>As an anonymous reviewer pointed out, these types of questions would be classified as Stage 5 questions in Pienemann and Johnston's (1987) developmental sequence of ESL question formation. However, in that framework, a *wh*-question with auxiliary inversion is classified as Stage 5 regardless of its accuracy. In the current study, only accurate *wh*-questions with auxiliary inversion are of interest to facilitate comparison with usage-based L1 acquisition research.

<sup>3</sup>Between the two phases of data collection, 12 verbs were replaced. Nine verbs were replaced because learners who had participated in the first phase requested their meanings (*offer, beg, push, jump, feed, wipe, entertain, explain, and deliver*). Three verbs were replaced because it was discovered that they did not appear on the General Service List (*knit, grab, select*).

<sup>4</sup>There were also no pretest (or posttest) differences in the learners' production of other question types, such as *wh*-questions with the copula, yes/no questions with auxiliary verbs, or yes/no questions with the copula. For those readers interested in Pienemann and Johnston's (1987) framework, there was an equivalent number of learners at Stage 3 and Stage 4 in that developmental sequence in each group at the pretest.

<sup>5</sup>An anonymous reviewer suggested that readers might be interested to know if there was any change in the learners' stage assignment in Pienemann and Johnston's (1987) development sequence at the posttest. Based on a chi-square test, significantly more learners who received high-type-frequency prompts (70%) advanced to a higher stage (Stage 4 or 5 depending on their pretest level) than learners who received low-type-frequency prompts (43%) ( $\chi^2 = 5.08, p = .024$ ).

<sup>6</sup>All names have been changed.

<sup>7</sup>Sureporn and Manop's questions would be classified as Stage 5 questions in the Pienemann and Johnston (1987) framework because accurate agreement between the tense/aspect features of the auxiliary verb and the main verb is not a factor in stage assignment. Considering stage assignment alone can obscure important differences in the types of questions learners produce within a stage as well as overlook the potential role of lexically fixed pivots and variable slots in the acquisition of questions.

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## APPENDIX A

## Verbs Targeted in Syntactic Priming Materials

	High Type Frequency (36 Verb Types)	Low Type Frequency (6 Verb Types)
Primes	Add, call, catch, choose, cover, draw, drink, enter, fall, fight, find, fly, hold, learn, listen, lose, order, paint, play, point, pull, read, rest, return, see, sell, send, serve, show, sing, sleep, spend, stand, use, walk, wash	Get, put, make, watch, follow, hold
Prompts	Ask, begin, break, bring, build, change, come, drive, drop, fill, finish, grow, lay, lead, move, open, pass, pay, reach, rise, run, say, save, set, share, sit, take, talk, teach, tell, throw, touch, visit, write, work, wait	Eat, fix, give, carry, wear, look

## APPENDIX B

## Sample Primes and Prompts in Picture Question/Answer Task

Researcher's Materials	Learners' Materials
Prime: Where has the teacher shown the pictures?	Picture: Teacher holding a book with pictures of dinosaurs so that students can see them
Picture: Mother cleaning up the mess caused when her son knocked over a potted plant	Prompt: he/say
Prime: Where did the woman sell the eggs?	Picture: Various vendors at an outdoor market
Picture: Mother handing an envelope to her daughter	Prompt: mother/save

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## Forthcoming in *The Modern Language Journal*, *Focus Issue*

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## Technology in the Service of Language Learning: Update on Garrett (1991) Trends and Issues

The 2009 *Modern Language Journal* Focus Issue will explore the changes that have taken place in Computer Assisted Language Learning (CALL) since the publication of Nina Garrett's 1991 article "Technology in the Service of Language Learning: Trends and Issues." To accompany a reprint of this original article, the Focus Issue will feature an update by Garrett containing her 2009 perspective on the "big questions" pertinent to trends and issues in CALL. This will be followed by contributions dealing with the following core topics mentioned in Garrett (1991): CALL Research (Carol Chapelle; Joy Egbert, Leslie Huff, Levi McNeil, Cara Preuss, & Joanne Sellen), CALL Technologies and Authorship (Mike Levy; Sue Otto & Jim Pusack), Beyond the Boundaries: Social Networking and Distance Learning (Steve Thorne, Rebecca Black, & Julie Sykes; Robert Blake), and Assessment of Student Outcomes and CALL Scholarship (Gary Ockey; Bryan Smith & Barbara Lafford). Following Garrett's lead, these authors present their own perspectives on the ways in which the field of CALL has been transformed over the last 18 years with regard to these core trends and issues.

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