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The Detection and Primed Production of Novel Constructions

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Situated within second language (L2) research about the acquisition of morphosyntax, this study investigated English L2 speakers' detection and primed production of a novel construction with morphological and structural features. We report on two experiments with Thai ($n = 69$) and Farsi ($n = 70$) English L2 speakers, respectively, carried out an aural construction learning task that provided low type-frequency input with the transitive construction in Esperanto—which is marked by accusative case marking (*–n*) and flexible word order (subject-verb-object and object-verb-subject)—followed by aural comprehension tests and a priming activity (20 primes and 20 prompts). Results of the aural comprehension tests showed that 23% of the Thai participants (16/69) and 50% of the Farsi participants (35/70) detected the target construction in the input. Results of the primed production task revealed that only those participants who detected the target construction were able to be primed. The findings are discussed in relation to the role of speakers' previously learned languages in the detection and primed production of novel constructions.

Keywords low type-frequency input; structural priming; pattern detection; transitive construction; Esperanto

Introduction

The learning of second language (L2) morphosyntax remains an interesting yet challenging area of research that primarily investigates how learners extract, internalize, and subsequently produce various aspects of morphosyntax,

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and whether learners' prior knowledge or individual differences affect their morphosyntactic development (e.g., Ellis, 2012; Lardiere, 2012; MacWhinney, 2012). Among the chief challenges is the issue of how L2 morphosyntax is learned in the earliest stages of learners' exposure to input, on the assumption that learners' initial experience with linguistic input can predict and explain their eventual learning outcomes (Gullberg, Roberts, & Dimroth, 2012; Rast, 2010). Construction learning studies have shown that a completely novel pattern can be detected and elicited even after brief exposure to low type-frequency input (Fulga & McDonough, 2014; Nakamura, 2012; McDonough & Trofimovich, 2013). However, even advanced L2 speakers experience difficulty with novel constructions when they must rely on morphological cues, instead of word order, to assign argument roles (Ferreira, 2003; MacWhinney, 2012).

Furthermore, it is less known whether such brief exposure to novel patterns through aural input leads to the kinds of mental representations that are immediately accessible for production. The structural priming paradigm (Bock, 1986) may shed light on what can and cannot be achieved in terms of production after very short exposure to novel patterns. Designed to address these issues, the current study examined (a) the extent to which L2 speakers can detect a novel morphosyntactic pattern from brief, targeted exposure to input, (b) whether they can immediately access this pattern for production, and (c) whether their prior linguistic knowledge—defined as experience with similar constructions in already-familiar languages—impacts the detection and production of the novel pattern.

Detecting Novel Patterns

Assigning argument roles across L2 structures displaying inflectional morphology represents a well-documented challenge for many L2 speakers, with even advanced learners showing little sensitivity to morphological markings in a variety of tasks (Hopp, 2010; Jiang, 2004, 2007; Kempe & MacWhinney, 1998; Papadopoulou et al., 2011). The apparent difficulty in learning L2 morphosyntax raises an interesting question of how novel morphosyntactic patterns might best be learned. According to frequency-based accounts of language acquisition (Bybee, 2008; Ellis, 2012; Goldberg, 2009; Tomasello, 2003), novel constructions—which refer to pairings of form and function that include both individual words (e.g., *silver*, *car*) and general linguistic patterns (e.g., the ditransitive construction [Subj + V + N_1 + N_2] as in *He read her a story*)—are best abstracted from input that contains low type-frequency (e.g., a set of 12 transitive sentences made from only four verbs: *kick*, *chase*, *wash,* and *paint*).

For instance, Goldberg and colleagues have shown that brief exposure to exemplars created from a limited set of lexical verbs is effective at enabling English speakers to comprehend and produce the novel construction of appearance (N_1N_2V), with the corresponding meaning of N_1 "appears in/on" N_2 (e.g., *the spot the king moopoed*). They found that low type-frequency input in which one lexical item (a verb, in this case) occurred with high token frequency was particularly effective for the so-called fast mapping of new linguistic form on meaning (Casenhiser & Goldberg, 2005; Goldberg & Casenhiser, 2008; Goldberg, Casenhiser, & Sethuraman, 2004; Goldberg, Casenhiser & White, 2007).

L2 research on novel construction learning has similarly yielded positive effects for low type-frequency input. However, unlike the research carried out with English speakers (Goldberg et al., 2004, 2007), the L2 studies have not found that providing a single lexical item with high token frequency is consistently more effective. The L2 studies have targeted several different constructions, including datives (McDonough & Nekrasova-Becker, 2014; Year & Gordon, 2009), the appearance construction used in Goldberg's research (Nakamura, 2012), the Samoan ergative construction (Nakamura, 2012), and the Esperanto transitive construction (Fulga & McDonough, 2014; McDonough & Trofimovich, 2013). Learning these constructions from brief exposure to low type-frequency input was a challenging task, as shown by our previous finding that only about one-fifth of all Thai participants succeeded at extracting the Esperanto transitive construction (McDonough & Trofimovich, 2013). Nevertheless, input that presents numerous exemplars of a novel construction created from a small set of lexical items may help at least some L2 speakers detect the semantic and the structural properties of the underlying construction, facilitating accurate argument role assignment and establishing that the pattern is not unique or limited to a specific lexical item (see McDonough & Trofimovich, 2013, for further discussion). Previous studies of initial L2 learning have also shown that absolute beginners are sensitive to morphological information, provided that the stimulus materials included some basic lexical information, such as translation equivalents (Carroll, 2005), minimal vocabulary instruction (Park & Han, 2008), or visual images (Han & Liu, 2013).

Challenges in Detecting Novel Patterns

One challenge for L2 speakers when learning a new construction is its compositionality, specifically the linguistic information that is most relevant for assigning argument roles. For instance, argument roles in the transitive construction can be assigned through word order (as in *a girl* $_{(S)}$ *carries* $_{(V)}$ *a doll*

(O) in English) or through accusative marking (as in *devochka* (NOM-S) *nesyot* (V) *kuklu* (ACC-O) or *kuklu* (ACC-O) *nesyot* (V) *devochka* (NOM-S) 'a girl carries a doll' in Russian). A speaker whose known languages encode transitivity by means of word order initially may not recognize that a new language assigns argument roles by means of morphology. Upon encountering an object-verb-subject (OVS) sentence in Russian (e.g., *babushku* (ACC-O) *zovyet* (V) *devochka* (NOM-S) 'a girl calls [her] grandmother'), the initial tendency for English speakers, for whom word order is the most reliable cue to transitivity, would be to interpret the first noun as the agent and not the patient, despite a clear accusative case marking (*–u*) on the first noun (e.g., Kempe & MacWhinney, 1998). This explanation is fully consistent with predictions of the unified competition model of language acquisition (MacWhinney, 2012), which holds that learners' L2 comprehension and production are shaped by the competition of all linguistic cues to utterance interpretation, including cues that come from the first language (L1). In essence, L1-based cues are stronger and more reliable than L2-specific cues and will determine learners' linguistic behavior, at least early in the learning process.

An alternative explanation for L2 learners' attested difficulty with processing L2 morphology, often despite similarities in the encoding of L1 and L2 argument roles (Hopp, 2010; Jiang, 2004, 2007; Papadopoulou et al., 2011), is that learners rely on word order as a single "what works best" strategy to process morphology (Ferreira, 2003). For instance, it has been argued that with increased task difficulty, such as in matching aural sentences to pictures (e.g., Papadopoulou et al., 2011), or under time pressure, such as in online reading or listening comprehension tasks (e.g., Hopp, 2010), L2 speakers from various language backgrounds and differing L2 proficiency levels may avoid syntactic algorithms altogether and resort to simple heuristics, favoring word order as a sole cue to assigning argument roles. In fact, interpreting word order as a cue (regardless of any available morphological markings) appears to be a preferred strategy even when the L1 and the L2 share inflectional morphology or when learners are familiar with the case system in the L2, as is the case for advanced learners (Hopp, 2010).

Due to L2 learners' difficulty processing morphological features, even at advanced levels of proficiency (e.g., Hopp, 2010; Jiang, 2004, 2007; Kempe & MacWhinney, 1998), detecting novel constructions whose correct interpretation depends on inflectional marking will be challenging. Low type-frequency input, with its focus on only a few lexical items, may help emphasize the structural properties of the underlying construction. And because it requires that less lexical information be learned and retrieved, low type-frequency input

may also facilitate correct argument role assignment. The reduced lexical diversity may promote detection of recurrent morphemes, allowing learners to draw a relational structure based on the absence or presence of this grammatical feature. In short, low type-frequency input might be sufficiently powerful to enable learners to override their reliance on L1-based processing biases (MacWhinney, 2012) or their use of a general "what works best" heuristic strategy (Ferreira, 2003) when processing novel constructions with morphology.

Producing Novel Patterns

The low type-frequency input studies of novel construction learning have provided evidence that L1 and L2 speakers can map new exemplars of a construction onto its meaning even after brief exposure, which raises interesting questions about whether the novel constructions can be immediately accessed for production. Goldberg and colleagues (e.g., Boyd, Gottschalk, & Goldberg, 2009) reported that adult English L1 speakers could produce the novel construction of appearance immediately after brief exposure to low type-frequency input. However, the appearance construction consisted of two English nouns and an English-sounding nonce verb whose argument roles could be mapped through reliance on word order only (N_1N_2V). Although the verbs had inflectional morphology, the affixes were not necessary to assign argument roles. Consequently, it is not clear whether brief exposure to a novel construction in which morphology plays a key role in argument role assignment would be sufficient for L2 speakers to immediately access the forms for production.

The structural priming paradigm appears to be an ideal methodological tool to investigate L2 speakers' access to novel constructions for production. Structural priming is the tendency to produce a grammatical structure that was present in the recent discourse as opposed to an alternative structure (Bock, 1986). Structural priming experiments typically elicit a speaker's production of two alternative forms, such as active versus passive constructions. The occurrence of structural priming is demonstrated when a speaker produces more active sentences after active primes than passive primes, and produces more passive sentences after passive primes than active primes. An assumption underlying structural priming research is that mental representations of the target structures must exist in order for priming to occur (Conwell & Demuth, 2007; Rowland, Chang, Ambridge, Pine, & Lieven, 2012; Shimpi, Gámez, Huttenlocher, & Vasilyeva, 2007). However, the morphological aspects of prime sentences (such as their number, tense, and agreement features) do not appear to influence the occurrence of structural priming in English (Bock, 1989;

Pickering & Branigan, 1998), which suggests it may operate at the level of the presence/absence or order of constituents, although morphology may contribute to priming in languages like German where both morphological features and the ordering of constituents differentiate alternating structures (Chang, Baumann, Pappert, & Fitz, 2014). L2 priming studies have reported structural priming at the level of constituent order, even though participants produced inaccurate morphological forms, such as subject–verb agreement, tense, and aspect (Kim & McDonough, 2008; McDonough & De Vleeschauwer, 2012).

With respect to L1 learning, structural priming has been particularly useful for investigating the nature of developing linguistic representations in children, such as whether their knowledge of grammatical structures is lexically specific or more abstract. For example, Tomasello and colleagues have shown that in an early stage of linguistic development (about 2 to 2.5 years), children have only weak syntactic representations that are associated primarily with specific lexical items, but over time, based on exposure to target structures in the input, their linguistic representations gradually grow in strength and abstractness (Savage, Lieven, Theakston, & Tomasello, 2003, 2006). Whereas young children produced developmentally advanced structures only when their utterances had the same pronouns (Savage et al., 2003) or nouns (van Beijsterveldt & van Hell, 2009) as the utterances produced by the researcher, older children, much like adults, could produce the syntactic structures spoken by the researcher even when their utterances consisted of entirely new lexical items (Huttenlocher, Vasilyeva, & Shimpi, 2004; Rowland et al., 2012; Shimpi et al., 2007). These findings suggest that older children have developed abstract linguistic representations of the target structures.

Structural priming also appears to be sensitive to the degree to which abstract mental representations are established or how much they are accessed for comprehension or production by adults. Priming has been shown to be greater when speakers know fewer constructions because there is less competition (Hartsuiker & Kolk, 1998; Pickering & Branigan, 1998), when a structure is produced relatively less often, which is referred to as the inverse preference effect (Hartsuiker, Kolk, & Huiskamp, 1999; Hartsuiker & Westenberg, 2000; Scheepers, 2003), when the speakers have less experience with a structure (Nitschke, Serratrice, & Kidd, 2014), or when a mental representation is weak and therefore more susceptible to change (Chang, Dell, & Bock, 2006; Jaeger & Snider, 2013). Nitschke et al. (2014), for example, reported priming effects in comprehension of object relative clauses for L2 learners of German, but not for L1 German speakers, when the participants could rely on the animacy of noun phrases to disambiguate sentence meaning. Compared to L1 German speakers,

L2 learners of German were less sensitive to animacy information as a constraining factor in correct utterance interpretation and therefore demonstrated larger priming effects. In essence, having a smaller set of available linguistic structures to choose from, having access only to infrequent structures, or having less linguistic experience with structures would mean that speakers' language processing is less "precise" and more prone to "error," leading to larger priming effects (Chang et al., 2006).

One conclusion emerging from this line of research is that priming effects depend on the strength of a speaker's linguistic representations, such that priming occurs only for structures with existing linguistic representations. Because current L2 structural priming research has targeted structures that speakers either already knew or were familiar with (e.g., McDonough, 2006; Shin & Christiansen, 2012), as opposed to novel structures, it is currently unclear how soon structures can be primed following initial learning by adults. As discussed earlier, low type-frequency input, with its emphasis on a small set of lexical items, may be a particularly useful method for promoting novel pattern detection and eliciting accurate argument role assignment. It may also facilitate the formation of underlying mental representations that can be immediately accessed for production during structural priming tasks.

The Current Study

The current study investigated the detection and production of novel constructions through two experiments which targeted the learning of the Esperanto transitive construction, addressing three research questions. The first research question was: To what extent can L2 speakers detect the Esperanto transitive construction from low type-frequency input? Consistent with previous L2 research on novel construction learning (Fulga & McDonough, 2014; McDonough & Trofimovich, 2013; Nakamura, 2012), the low type-frequency input in this study involved a distribution of several lexical items (nouns) with equally low token frequency. Although morphological affixes were part of the constructions previously tested in the novel construction learning research (e.g., *–o* with verbs in the appearance construction, *–e* with nouns in the Samoan ergative construction), the meaning of those constructions could be detected through reliance on word order only. In contrast, the accusative marking is a key grammatical cue for assigning correct argument roles in the Esperanto transitive construction due to its flexible word order and its high productivity (i.e., not being limited to a small set of lexical verbs). Based on previous research (Fulga & McDonough, 2014; McDonough & Trofimovich,

2013), it was predicted that there would be considerable variation in the extent to which the L2 speakers would succeed at pattern detection.

The second research question was: Can L2 speakers be primed to produce novel patterns immediately following initial detection? Based on the assumption that speakers must have a mental representation of a construction in order for priming to occur, it was predicted that structural priming would occur only for participants who had detected the Esperanto transitive construction during the construction learning input task. However, because structural priming has been shown to be relatively unaffected by morphological information, such as verb forms and tenses, it was possible that the participants would produce the transitive constructions without accusative case marking.

The final research question was: What is the role of speakers' prior language knowledge in detection and primed production of a novel pattern? This question was addressed through a comparison of two participant groups from different L1 backgrounds: Thai (Experiment 1) and Farsi (Experiment 2). With the specific predictions for each language group outlined separately in each experiment, the general intent was to examine whether exposure to low type-frequency input differentially impacted Thai and Farsi speakers' reliance on either an L1-based processing bias or a general "what works best" heuristic strategy in processing novel morphology.

Experiment 1

Experiment 1 examined the detection and primed production of the Esperanto transitive construction by L1 Thai speakers of L2 English. Both Thai and English rely on subject-verb-object (SVO) word order as the primary cue to sentence interpretation. In order to detect the Esperanto transitive construction, which features variable word order and is marked by the accusative affix *–n*, Thai participants need to abandon a more familiar cue (word order) and attend to a less familiar cue, which is morphological marking. Therefore, because Thai participants have little familiarity with morphological marking as a cue to transitivity in either their L1 or L2, it was predicted that the majority of the Thai participants would be unable to detect the target construction and would make use of word order as the dominant L1-based cue (MacWhinney, 2012) or as the default processing strategy (Ferreira, 2003). With respect to primed production, based on previous structural priming research (Rowland et al., 2012; Shimpi et al., 2007), it was predicted that only the Thai speakers who detected the novel pattern in the input would be subsequently primed.

Participants

The participants were 69 English L2 speakers (34 men, 35 women) enrolled in the Faculty of Medicine at a university in Northern Thailand. They were 1st-year students with a mean age of 18.8 years ($SD = 1.1$). They reported a mean of 13.6 years of prior English study ($SD = 2.1$) within Thailand. Most participants had never visited an English-speaking country (45), but some reported stays of less than a few weeks (14) or greater than one month (10). In terms of their knowledge of additional languages besides Thai and English, 10 students reported having basic knowledge of Chinese (6), Japanese (1), Korean (1), French (1), and Spanish (1). An a priori power analysis was conducted using the software package R to identify an appropriate sample size based on the critical, within-groups interaction between prime and target. The values included in the formula were effect size ($d = .8$) based on previous studies of the Esperanto transitive construction (McDonough & Trofimovich, 2013), probability value ($p = .05$), paired-samples, and the desired power level (.8). The analysis revealed that a sample size of 66 was necessary for a study with a medium effect size and sufficient power to detect relationships if they exist.

Target Construction

The experiment targeted the Esperanto transitive construction, which involves both morphological and syntactic features. In terms of morphology, the suffix *–n* is added to mark nouns as syntactic objects. For example, the word kangaroo (*makropo*) appears without an affix when it functions as the subject, but receives the *–n* suffix when it functions as the object (*makropon*). All nouns in Esperanto are marked with the *–n* suffix when they function as objects, regardless of their other features, such as animacy or definiteness. In terms of syntax, word order in Esperanto transitive constructions is variable, as the accusative suffix differentiates subjects from objects. Although six word orders are possible (SVO, OVS, VSO, VOS, SOV, OSV), the most commonly used are SVO and OVS (Cox, 2011; Harlow, 1995), as in *makropo pelas pilkon* and *pilkon pelas makropo* ('kangaroo chases ball'). The construction was considered novel for the participants because they had no prior exposure to Esperanto, and both Thai and English have SVO word order and neither language has accusative case marking on nouns.

Materials and Procedure

Vocabulary Learning

The vocabulary learning activities targeted the six nouns and two verbs used in the construction learning phase. The six nouns were bull (*tauro*), kangaroo

(*makropo*), cat (*kato*), goat (*kapro*), horse (*cevalo*), and tennis ball (*pilko*), while the two present tense verbs were hit (*batas*) and chase (*pelas*). Each word was digitally recorded by the second researcher using a Plantronics (DSP-300) microphone. For the first vocabulary activity, the participants were shown eight slides (5 seconds per slide) with each word written orthographically above the corresponding picture and each word repeated three times. For the second activity, which was used to assess how well the participants had learned the words, they received a vocabulary checklist containing eight pictures without the orthographic form of the words, and then heard a random sequence of 24 words (8 target words × 3 repetitions) with each new word presented every 5 seconds. The participants numbered the pictures on their checklist to reflect the order in which the words were presented.

Construction Learning

For the construction learning task, the participants were given a handout that contained two pictures, printed side by side and arranged in 24 numbered rows. The task was to listen to 24 sentences (12 SVO, 12 OVS) and to choose which of two images correctly depicted the meaning of each sentence. Across all sentences, each of the six nouns occurred four times as an object, and all verbs were conjugated in present tense, which corresponds to the *–as* inflection (*batas*, *pelas*). Each sentence was audio recorded by the same speaker using the same equipment. The resulting audio files were organized in four sets of six sentences, designed to draw the participants' attention to the objects by directing their attention to different components of the two response pictures. The four construction learning sets manipulated the following features: completely different nouns between the two alternative pictures (Set 1), different verbs (Set 2), different subjects (Set 3), and different objects (Set 4). For example, in Set 1, the sentence *kapro batas tauron* (SVO, 'goat hits bull') was paired with a picture of a goat hitting a bull and a horse hitting a ball. The participants could select the correct picture by relying on their knowledge of even one of the four nouns. In Set 2, the nouns in the two pictures were identical but the verbs differed, so a sentence like *katon batas makropo* (OVS, 'kangaroo hits cat') was paired with a picture of a kangaroo hitting a cat and a kangaroo chasing a cat. Within each set, a sentence was spoken twice and was presented at the rate of 7 seconds per sentence. Before listening to each set of six sentences, the participants were given simple instructions reminding them to pay attention to the sentences in order to be able to identify the images correctly.

Immediate Test

For the immediate test, the participants listened to 6 sentences (3 SVO, 3 OVS) created from the same six nouns and two verbs used in the construction

learning items. They had to select the correct picture, but the two picture options showed reversible events. For example, the sentence *makropo batas cevalon* (SVO, 'kangaroo hits horse') was paired with a picture of a kangaroo hitting a horse and a horse hitting a kangaroo. Unlike the construction learning items, the immediate test items could not be correctly answered through reliance on lexical knowledge only.

Generalization Test

The immediate test was followed by a generalization test to determine whether the participants could generalize any learning of the accusative morphology to new nouns. The generalization test involved six new nouns: zebra (*zebro*), car (*automobilo*), rabbit (*leporo*), tiger (*tigro*), gate (*pordego*), and buffalo (*bubalo*). New nouns were used to ensure that the participants acquired at least some knowledge of the word order and the accusative suffix that was independent of their item-based knowledge of the original six nouns used for construction learning. The six new nouns were presented and then tested through the same two vocabulary activities used to introduce the original six nouns in the learning phase. Immediately after the vocabulary activities, the participants completed a test which consisted of 30 novel sentences (15 SVO, 15 OVS) constructed from the six new nouns and the same two verbs (*batas*, *pelas*). Each noun appeared five times as a subject and five times as an object, and each of the two verbs was used 15 times across all sentences. The participants received a handout with two images printed side by side and arranged in 30 numbered rows. Similar to the immediate test items, all generalization test items showed two images with reversible actions. For example, the sentence *tigron batas automobilo* (OVS, 'car hits tiger') was paired with the images of a tiger hitting a car or a car hitting a tiger. The test sentences were recorded by the same speaker using the same equipment and were organized for presentation in a randomized list with each new sentence presented every 7 seconds. Response consistency (Cronbach's alpha) for the 30 generalization test items reached .90.

Priming Activity

The priming task involved a sequence of 40 items, consisting of alternating primes and prompts. The primes included 20 sentences (10 SVO, 10 OVS), which were all heard previously in the learning or testing phases. Across the 20 prime sentences, each noun was used once or twice in the subject and object positions, with an equal distribution of the two verbs. The prompts were pictures that had either been seen as distractors or were created as new, but had not been heard or elicited before the priming task.[1] There was no overlap in

lexical items between any of the adjacent prime-prompt sentences. For this task, the participants received a handout with a 40-item grid, with alternating prime and prompt images. To ensure that the participants understood prime sentences as intended, a cover task was created in which the participants indicated if the prime sentence correctly matched the picture. Thus, for each prime-prompt sequence, the participants first heard a prime sentence (spoken once), then indicated whether the sentence matched the prime picture by circling "yes" or "no" next to it and finally provided a spoken sentence for the subsequent prompt picture. The prime sentences were played with a 9-second interval, and the participants were given 9 seconds to provide a spoken sentence for each prompt picture.

Construction Awareness and Extension

At the end of the priming activity, two pattern awareness and extension activities were carried out to determine if (a) the participants could explicitly state the morphology and word order rules in Esperanto and (b) they could extend the learned pattern to a novel set of words. On a separate handout, the participants were asked to write down grammar rules (using either Thai or English) for making simple sentences in Esperanto. Then, they were given three new nouns (*knabo* 'boy', *filino* 'girl', *hundo* 'dog') and two new verbs (*mordas* 'bite', *lavas* 'wash'), each depicted in a separate drawing, and were asked to write two Esperanto sentences for four new pictured actions (boy washing dog, dog biting boy, girl washing dog, and dog biting girl).

Task Sequence

The research activities were administered to the participants during several 60-minute group data collection sessions held in a university classroom. After completing the consent form and biographical information questionnaire, the construction learning and immediate and generalization tests were implemented (35 minutes). Before the construction learning phase and the generalization test, the meanings of Esperanto words were introduced by the researcher, who read them aloud from the handouts and PowerPoint slides and provided their English equivalents before starting the slide presentation with embedded audio files. After the input activities were completed, the participants' handouts were collected and the production activities and individual audio recorders were distributed. The researcher reviewed the instructions for the production task prior to starting a PowerPoint slide sequence, again with all audio included in the sequence. Once the production tasks were completed (20 minutes), the audio recorders were collected and the participants were given 5 minutes to

write down their explanation for the grammar rules of Esperanto and to write sentences using the novel nouns and verbs.[2]

Analysis

Construction Learning and Tests

For the forced-choice picture identification items in the construction learning, immediate test, and generalization test phases, d prime (d′; a sensitivity index) was calculated to assess whether the participants acquired the novel construction. Based on Signal Detection Theory (Macmillan & Creelman, 2005), d′ is a measure of sensitivity that takes into account participants' correct discrimination of a pattern (a high 'hit' rate with minimal 'misses') and their bias to report false positives (a low 'false alarm' rate, coupled with a high rate of 'correct rejections'). Because both Thai and English are SVO languages without accusative case marking on nouns, the expected response bias would be for the participants to select the noun before the verb as the subject regardless of its morphological features. Therefore, correct responses for SVO items were coded as 'hits', while incorrect responses for SVO items were coded as 'misses'. For the OVS items, correct responses were classified as 'correct rejections' while incorrect responses were treated as 'false alarms'. For each participant, the resulting d′ sensitivity values were computed as the difference between the proportions of hit (H) and false alarm (FA) responses, expressed as z scores ($d' = z[H] - z[FA]$). High positive d′ values indicated the ability to rely on inflected morphology to interpret transitive constructions (both SVO and OVS items were correct), while values at or near 0 indicated that sentence interpretation was driven largely by a familiar word order cue (e.g., SVO items were correct, but OVS items were wrong). High negative values reflected low accuracy on both SVO and OVS items.

Primed Production

The participants' picture descriptions during the priming phase were classified in terms of their structure using the following coding criteria. First, only responses that contained two nouns and a verb whose meaning accurately reflected the lexical content of the picture were coded. Second, responses that had no accusative morphology or had case marking on both nouns were coded as *bare nouns* and *double affix* categories, respectively. Based on the order of constituents in the utterance relative to the corresponding picture, the agent was identified as corresponding to either the noun before or after the verb. Finally, the coding categories of interest were *accurate transitives* (i.e., marked by *–n*) in either SVO or OVS word order. The researchers coded one

Table 1 Mean accuracy (and standard deviations) for SVO and OVS items by phase

	SVO	OVS	Comparison		
Test phase	*M*	*M*	*t*(68)	*p*	*d*
Learning (24)	11.2 (1.3)	11.0 (1.8)	1.2	.20	.1
Immediate test (6)	2.5 (.8)	1.0 (1.2)	7.5	.001	1.4
Generalization test (30)	12.9 (3.7)	5.3 (6.1)	7.9	.001	1.5

transcript collaboratively, followed by independent coding of two transcripts. After comparing their coding decisions, they resolved any ambiguities and clarified the coding categories. Both researchers then independently coded 35 of the 66 remaining transcripts (53%), with Cohen's kappa reaching .97. Disagreements were resolved through discussion and included in the analysis. The final 31 transcripts were coded independently by the first researcher.

The number of SVO and OVS responses were tabulated for each participant separately as a function of prime (SVO or OVS), using each participant's responses in the cover task to determine how the prime was understood. More specifically, the category of SVO primes included both SVO sentences that were considered to be accurate descriptions of the prime image (i.e., actual SVO primes) and OVS sentences that were judged as wrong descriptions of the prime image (i.e., perceived SVO primes). The category of OVS primes also included both OVS sentences considered to be accurate descriptions of the prime image (actual OVS primes) as well as SVO sentences marked as incorrect prime image descriptions (perceived OVS primes). For all statistical tests, the alpha level for significance was set at .05.

Results

The first research question asked whether low type-frequency input facilitated detection of the Esperanto transitive construction. Descriptive statistics for the Thai participants' performance in the construction learning, immediate test, and generalization test phases are provided in Table 1. During the construction learning phase, when participants could identify the correct picture through reliance on the lexical meaning of the nouns and verbs, their accuracy was similar for SVO and OVS items. However, in the immediate and generalization tests, when correct picture identification required knowledge of the structural and morphological features of the Esperanto transitive, the participants were more accurate with SVO than OVS items.

Table 2 Mean accuracy (and standard deviations) by group, item type, and phase

	Learning (24)		Immediate test (6)		Generalization test (30)		
Group	SVO	OVS	SVO	OVS	SVO	OVS	d′ values
Detection	11.8 (.6)	11.4 (1.2)	2.9 (.3)	2.7 (.8)	14.8 (.5)	14.3 (1.0)	1.95 (.3)
Word order	10.9 (1.4)	10.7 (1.9)	2.9 (.4)	.2 (.7)	14.4 (.8)	.4 (.8)	−.38 (.2)
Low accuracy	11.2 (1.4)	11.0 (2.2)	1.1 (.5)	1.4 (.8)	6.4 (3.8)	8.4 (3.7)	−1.31 (.4)

The d′ values from the generalization test were used to identify which participants had detected the grammatical features of the Esperanto transitive construction. This process resulted in the identification of three groups, whose performance is summarized in Table 2. Sixteen participants (23%) were identified as having detected the Esperanto transitive construction, and were labeled as the detection group. Their accuracy was high for SVO and OVS sentences in both the immediate and generalization tests, and their mean d′ value was 1.95, which indicates that they were able to use morphology, as opposed to word order, to interpret the sentences. Thirty-nine participants (57%) responded accurately to SVO items only, but rarely identified the correct picture for OVS items in the immediate or generalization test. These participants were classified as the word order group, and their mean d′ value was −.38, which suggests that their performance was almost exclusively driven by a word order strategy. Finally, the remaining 14 participants (20%) were classified as the low accuracy group. These participants had low accuracy rates for both SVO and OVS items, and their mean d′ value was −1.31. They did not show a bias toward word order, as their performance was equally low on both item types.

To provide further insight into whether the participants detected the novel pattern, their responses to the pattern awareness and extension questions were considered. The participants in the detection group demonstrated knowledge of both the structural and morphological features of the Esperanto transitive construction by explicitly identifying the two word orders and *–n* suffix or writing accurate SVO and OVS sentences using the novel nouns and verbs based on the new pictures. However, no participants in the word order and low accuracy groups were able to identify both rules (word order and morphology) as well as write accurate sentences for the four pictures. In sum, both the d′ values and the participants' responses to the pattern awareness and extension questions provided converging evidence of their ability to detect the Esperanto transitive construction. Whereas the detection group fully detected the morphological

Table 3 Mean production rates (and standard deviations) for transitives by prime and group

Response	Prime	Detection	Word order	Low accuracy
SVO	SVO	5.6 (2.1)	2.0 (3.3)	.1 (.4)
	OVS	4.4 (2.4)	.4 (1.4)	.3 (.7)
OVS	SVO	1.6 (1.8)	.0 (.2)	.1 (.3)
	OVS	3.0 (2.1)	.1 (.3)	.1 (.3)

pattern and performed accurately regardless of word order, the word order group accurately identified SVO items only. Finally, the low accuracy group did not perform well on either SVO or OVS items.

The second research question asked whether L2 speakers can be primed to produce novel patterns immediately following initial detection. Based on the findings of the first research question, it was predicted that (a) the detection group would be primed for both SVO and OVS transitives, (b) the word order group would be primed for SVO transitives only, and (c) the low accuracy group would not be primed for either SVO or OVS transitives. Separate paired-samples *t* tests for the production of SVO and OVS sentences after SVO and OVS primes were calculated for each group separately, using an adjusted alpha level of .006 (.05/6 comparisons). As shown in Table 3, the detection group produced more SVO transitives after SVO than OVS primes, and produced more OVS transitives after OVS than SVO primes. Paired-samples *t* tests indicated that their production of SVO transitives was not significantly greater following SVO primes than OVS primes, $t(15) = 1.95$, $p = .07$, $d = .60$, but that their production of OVS transitives was significantly higher following OVS than SVO primes, $t(15) = 3.82$, $p = .002$, $d = .73$. For the word order group, the participants produced more SVO transitives after SVO than OVS primes, $t(38) = 3.59$, $p = .001$, $d = .63$, but their production of OVS transitives did not significantly differ by prime, $t(38) = 1.00$, $p = .324$, $d = .08$. Finally, the low accuracy group produced more SVO transitives following OVS than SVO primes, but the difference did not reach statistical significance, $t(13) = .62$, $p = .55$, $d = .26$. Their production of OVS transitives was identical following SVO and OVS primes, so inferential statistics were not necessary.

Discussion

In terms of L2 speakers' ability to detect a novel pattern from low-variability input, the findings of Experiment 1 indicated that approximately one quarter of the Thai participants were able to detect both the syntactic (e.g., variable

word order) and morphological (e.g., accusative case marking) aspects of the Esperanto transitive construction. This supports previous findings from English L2 speakers in Thailand, which also showed that few participants detect novel patterns following brief exposure to low-variability input: 21% for Esperanto transitives (McDonough & Trofimovich, 2013) and 28% for double-object datives (McDonough & Nekrasova-Becker, 2014). For both constructions, detection of the novel pattern requires that Thai L1 speakers overcome reliance on word order. The Esperanto transitive requires detection of a morphological cue (i.e., accusative affix *–n*), which is more reliable and has greater validity than word order. Similarly, for the double-object dative, both Thai and English rely on SVO word order, which can make processing of the SVN_1N_2 ditransitve construction difficult, particularly if animacy is not available as a cue to differentiate between the N_1 recipient (+animacy) and the N_2 patient (-animacy). Taken together, the studies of low-variability input with Thai L1/English L2 speakers suggest that more extensive exposure to low-variability input or more attention-drawing devices (e.g., feedback, textual highlighting, auditory emphasis) may be needed to promote pattern detection.

For primed production, the findings of Experiment 1 confirmed that priming occurs only when constructions have been detected. In other words, if the Esperanto transitive construction remained undetected following exposure to the low type-frequency input, the participants were not primed to produce the construction in either word order (low accuracy group). However, if the participants were successful with items that had familiar word order (SVO), their production of the construction was primed in SVO sentences only (word order group). Because they had not detected the construction in OVS sentences, their production of OVS sentences did not vary by prime type. Finally, when the participants detected the target construction in both word orders (detection group), only their production of the more novel pattern (OVS) was primed. This finding is consistent with the inverse preference effect reported in previous structural priming studies (e.g., Bock, 1986; Scheepers, 2003), in which priming effects are greater for structures that are less frequent or dispreferred.[3] Because Thai and English are both SVO languages, the OVS pattern may have been more novel and less frequent, and therefore more amenable to priming for participants who detected both word orders. Although OVS priming was observable with only a small percentage of learners, its occurrence suggests that form–meaning mapping and the formation of mental representations can indeed occur after very short exposure.

Experiment 2

In order to shed further light on the detection of novel patterns that involve a morphological cue, Experiment 2 examined the detection and primed production of the Esperanto transitive construction by participants from a different L1 background (Farsi). Unlike Thai, Farsi does have accusative case marking on objects in transitive constructions. However, unlike Esperanto, which marks all objects through the suffix *–n*, in Farsi accusative case marking is used primarily when the object is definite (e.g., *the desk*) by adding the case marker *–ra*, but not when it is indefinite (e.g., *a desk*). Within the class of nonspecifics, an object is case marked if it is animate (e.g., the subject is *a desk*, but the object is *a girl*). And in terms of word order, although some variation in word order is allowed, the most commonly used word order in Farsi transitives is SOV, which means that both the SVO and OVS word orders in Esperanto are novel. Although the SVO word order in Esperanto corresponds to English transitives and reflects the general processing tendency to interpret N_1 as the subject, the Esperanto OVS word order mirrors the Farsi pattern for objects to occur before verbs. Nevertheless, due to the difficulty that L2 speakers have shown when learning morphology, even when the L1 and L2 have similar features, and their tendency to rely on word order as a general heuristic input processing strategy, it was predicted that the Farsi participants would show considerable variation in their detection of Esperanto transitives. And in terms of primed production, based on the findings of Experiment 1, it was predicted that only the patterns that were detected would be primed. Because both SVO and OVS Esperanto transitives are both novel word orders compared to Farsi SOV transitives, no predictions were made as to which one might show an inverse preference effect.

Participants

The participants were 70 native Farsi speakers (39 men, 31 women) enrolled in undergraduate (3) and graduate (67) degree programs at English-speaking universities in the Montreal area. The participants, who came from various academic fields including engineering, computer science, accounting, nursing, and architecture, had resided in Montreal for a mean of 1.8 years ($SD = 1.7$) and were on average 27.6 years old ($SD = 2.4$).

Materials and Procedure

The materials and procedures used in Experiment 2 were identical to those used in Experiment 1, with the only exception that Farsi speakers were tested in smaller groups of 6–15 participants at a time in a university classroom.

Table 4 Mean accuracy (and standard deviations) for SVO and OVS Items by phase

	SVO	OVS	Comparison		
Test phase	*M*	*M*	*t*(69)	*p*	*d*
Learning (24)	11.7 (.7)	11.6 (.7)	1.5	.13	.2
Immediate test (6)	2.5 (.9)	1.6 (1.3)	5.0	.001	.8
Generalization test (30)	12.6 (4.2)	9.1 (6.3)	4.5	.001	.7

Response consistency (Cronbach's alpha) for the 30 generalization test items was .95.

Analysis

The same analyses and coding categories used in Experiment 1 were applied in Experiment 2 to analyze the Farsi participants' data. To score the Farsi production data, the first researcher trained a research assistant in the coding procedures by explaining and illustrating the categories, and jointly coding one transcript. The research assistant coded three transcripts independently, which were reviewed by the first researcher, and only one disagreement occurred. The research assistant coded the remaining transcripts ($n = 66$), and the first researcher coded a subset of the data (22/66 or 30%), with Cohen's kappa reaching .96. Disagreements were resolved through discussion and included in the analysis.

Results

The first research question asked whether low type-frequency input facilitated detection of the Esperanto transitive construction. Descriptive statistics for the Farsi participants' performance in the construction learning, immediate test, and generalization test phases appear in Table 4. During the construction learning phase, when they could identify the correct picture through reliance on the lexical meaning of the nouns and verbs, the participants' accuracy rates were similar for SVO and OVS items. However, in the immediate and generalization tests, when correct picture identification required knowledge of the structural and morphological features of the Esperanto transitive, the participants were more accurate with SVO than OVS items.

The d′ values from the generalization test were used to identify which participants had detected the grammatical features of the Esperanto transitive construction, using the same groups as in Experiment 1. As summarized in Table 5, 35 participants (50%) in the detection group accurately interpreted

Table 5 Mean accuracy (and standard deviations) by group, item type, and phase

	Learning (24)		Immediate test (6)		Generalization test (30)		
Group	SVO	OVS	SVO	OVS	SVO	OVS	d′ values
Detection	11.8 (.5)	11.7 (.4)	2.9 (.5)	2.5 (.8)	14.6 (.9)	14.6 (.9)	1.48 (.3)
Word order	11.4 (1.1)	11.3 (.7)	2.6 (.7)	.3 (.7)	14.9 (.5)	.4 (.6)	−.84 (.1)
Low accuracy	11.8 (.5)	11.6 (1.0)	1.6 (1.0)	1.0 (.9)	6.8 (4.1)	6.2 (3.5)	−1.85 (1.3)

SVO and OVS sentences in the immediate and generalization tests. Their mean d′ value was 1.48, which indicates that they were able to use morphology, as opposed to word order, to interpret the sentences. Sixteen participants (23%) in the word order group accurately interpreted SVO items only, but rarely identified the correct picture for OVS items on the immediate or generalization tests. Their mean d′ value was −.84, which suggests that their performance was driven by a word order strategy. Finally, the remaining 19 participants (27%) in the low-accuracy group had low scores for both SVO and OVS items on both tests. Their mean d′ value was −1.85, which indicates that their performance was equally low for both item types.

The participants' responses to the pattern awareness and extension questions provided further evidence that the participants in the detection group demonstrated knowledge of both the structural and morphological features of the Esperanto transitive construction. These participants either explicitly identified the two word orders and *–n* suffix or wrote accurate SVO and OVS sentences using the new nouns and verbs. However, few participants in the word order and low-accuracy groups were able to articulate the rules or write accurate sentences using the new nouns and verbs. In sum, both the d′ values and the participants' responses to the pattern awareness and extension questions indicated that the detection group extracted the Esperanto transitive construction. Whereas the detection group fully detected the morphological cue and performed accurately regardless of the word order, the word order group accurately interpreted SVO items only and the low accuracy group did not perform well on either SVO or OVS items.

The second research question asked whether L2 speakers can be primed to produce novel patterns immediately following initial detection. Based on the findings of the first research question, it was predicted that (a) the detection group would be primed for both SVO and OVS transitives, (b) the word order group would be primed for SVO transitives only, and (c) the low-accuracy

Table 6 Mean production rates (and standard deviations) for transitives by prime and group

Response	Prime	Detection	Word order	Low accuracy
SVO	SVO	5.3 (2.8)	2.2 (2.4)	1.6 (3.1)
	OVS	3.6 (2.3)	.3 (.5)	.8 (1.1)
OVS	SVO	1.4 (1.4)	.1 (.3)	.8 (1.3)
	OVS	2.7 (1.8)	.0 (.0)	1.1 (2.1)

group would not be primed for either SVO or OVS transitives. Separate paired-samples *t* tests for the production of SVO and OVS sentences after SVO and OVS primes were calculated for each group separately, using an adjusted alpha level of .006 (.05/6 comparisons). As shown in Table 6, the detection group produced more SVO transitives after SVO than OVS primes, $t(34) = 4.04$, $p = .001$, $d = .66$, and produced more OVS transitives after OVS than SVO primes, $t(34) = 3.30$, $p = .002$, $d = .77$. The word order group produced more SVO transitives after SVO than OVS primes, $t(15) = 3.22$, $p = .006$, $d = 1.12$, but their production of OVS transitives was similar after OVS and SVO primes, $t(15) = 1.00$, $p = .33$, $d = .34$. Finally, the low accuracy group produced more SVO transitives following SVO than OVS primes and more OVS transitives following OVS than SVO primes, but neither difference reached statistical significance, $t(18) = 1.09$, $p = .29$. $d = .32$, and $t(18) = .55$, $p = .59$, $d = .15$, respectively.

Discussion

In terms of L2 speakers' ability to detect a novel pattern from low-variability input, the findings of Experiment 2 indicated that half of the Farsi participants were able to detect both the syntactic (e.g., variable word order) and morphological (e.g., accusative case marking) features of the Esperanto transitive construction. For primed production, the findings of Experiment 2 confirmed that priming occurs only when constructions have been detected. The participants in the low accuracy group, who had difficulty interpreting SVO and OVS items correctly during the input activities, were not primed to produce Esperanto transitives in either word order. The participants in the word order group, who were able to correctly identify Esperanto transitives in the SVO word order, were primed to produce SVO sentences only. These participants did not comprehend the OVS sentences during the learning phase, and their production of OVS sentences was unaffected by prime type. Finally, the participants in the detection group were primed to produce both SVO and OVS

sentences. Because Farsi transitives are largely SOV, both the OVS and SVO pattern in Esperanto may have been considered novel and less frequent, and therefore may have been susceptible to priming.

General Discussion

The goal of the current study was to explore whether novel patterns could be primed following brief exposure to low type-frequency input, and whether speakers' previously known languages impacted their ability to extract or produce novel patterns. As discussed earlier, low type-frequency input, with its emphasis on a small set of lexical items, was hypothesized to be beneficial for the mapping of morphosyntactic form onto meaning and the development of mental representations which could subsequently be accessed in production.

Novel Pattern Detection

When it comes to novel pattern detection, some participants were able to detect novel patterns through brief exposure to low variability input, which has been shown in previous research (e.g., Boyd et al., 2009; Nakamura, 2012). Across the two experiments, 23% of the Thai participants and 50% of the Farsi participants could interpret Esperanto transitive sentences correctly. This overall low rate for pattern detection for both L1 groups confirms that L2 learners face challenges when learning morphology even when the L1 and L2 share morphological similarities, as was the case for the Farsi speakers (e.g., Hopp, 2010; Kempe & MacWhinney, 1998). Although overall detection rates were low, the Farsi speakers were more successful at detecting the novel patterns than the Thai speakers. The Thai speakers' low pattern detection rate may reflect their lack of experience with case marking as a cue for argument structure interpretation. Because word order is a salient and reliable cue to transitivity in both Thai and English, it is not surprising that the majority of Thai participants persisted in their reliance on this cue when interpreting transitive sentences in Esperanto. This is consistent with prior research conducted within the competition model, showing that L1 children learning languages such as Italian, French, and German initially rely on word order as a cue to utterance interpretation, before switching to using the more reliable and valid morphological cues (e.g., Dittmar, Abbot-Smith, Lieven, & Tomasello, 2008; Devescovi, D'Amico, Smith, Mimica, & Bates, 1998). This finding is also compatible with the idea that word order is preferred as a default sentence interpretation strategy, especially early on in the learning and under demanding input processing conditions (Ferreira, 2003).

There was a relatively large number of the Thai participants placed in the word order group (39/69 or 57%), where case marking was detected only when it appeared in SVO sentences. This suggests that the process of acquiring a more reliable cue (i.e., case marking) through low type-frequency input may involve an intermediary stage. In this stage, case marking is only detected when it does not conflict with the more dominant cue (i.e., word order). If low-variability input plays a role in helping L2 learners depart from ineffective sentence interpretation strategies, then it may need to be enhanced by exposure to additional input, more explicit instructions (as in McDonough & Trofimovich, 2013), feedback, textual highlighting, or auditory emphasis.

For the L1 Farsi speakers, their greater success with the detection of the Esperanto transitive construction may stem from their experience with case morphology in Farsi, which differentially marks objects with *–ra* based on definiteness and animacy features. Nevertheless, the presence of accusative morphology in Farsi was insufficient to ensure that all Farsi participants detected a similar morphological cue in Esperanto, especially when faced with variable word order. At least some difficulty could be attributed to the Farsi participants' extensive experience with English word order as a robust cue to sentence interpretation, which would be consistent with L2 effects on subsequent language learning (see Falk & Bardel, 2010). However, compared to the Thai speakers, fewer Farsi participants (16/70 or 23%) fell into the word order group. Whereas Thai speakers' familiar languages (Thai and English) are both SVO, Farsi speakers' familiar languages involve two different word orders (SOV for Farsi and SVO for English). As a result, they may have been more sensitive to the variation in word order of the Esperanto transitive construction than the Thai speakers.

These findings highlight the complex nature of novel construction learning from auditory input, even in situations where speakers have previous experience with case marking languages. A common finding across the two experiments was the use of word order as a cue to sentence interpretation, although this tendency was higher for the Thai participants. This result is compatible with several existing theoretical views (e.g., Ellis et al., 2014; MacWhinney, 2012; VanPatten, 1996), which posit that L2 learners' initial experience with input is driven by their reliance on a single salient or familiar cue. Although an emphasis on word order would be predicted by transfer from either or both L1 and L2 (Falk & Bardel, 2010), it is plausible that a word order bias in sentence interpretation reflects a more general sentence processing strategy. Ferreira (2003) termed this strategy a "good enough" processing heuristic (p. 195), characterized by language users' tendency to interpret the first noun in a

sentence as the agent and the second noun as the patient. This idea that speakers' sentence interpretation is not always faithful to the precise morphosyntactic input they receive is supported by L1 research (Ferreira, Bailey, & Ferraro, 2002) and by the L2 research cited earlier.

In fact, speakers appear to be surprisingly insensitive to morphology, in L1 or L2 alike, and this difficulty is likely traceable to often heavy demands of real-time comprehension (Ferreira, 2003). For instance, even in the learning task used in this study—one that featured input with little lexical diversity delivered by a single talker in a sequence that progressively emphasized thematic relations between nouns—participants still faced a number of processing demands. They had to detect a morphological marker in the presence of variable word order while trying to map newly learned word forms onto meaning under the constraints of a timed task. It is not surprising, therefore, that so many participants took learning in small increments, focusing on the morphological cue when sentences had a single, familiar word order. These findings suggest that timed exposure tasks, even those featuring low type-frequency input, are demanding for learners.

Primed Production

With respect to primed production, the findings of the current study confirmed that constructions that have not been detected cannot be primed. In other words, speakers can access for production only those structures for which they have a mental representation, which is consistent with the priming shown by participants in the detection groups in both experiments. The Thai speakers' primed production suggested an inverse preference effect (Bock, 1986; Scheepers, 2003), in which only the less preferred and less familiar pattern (OVS) was primed. The Farsi speakers were primed to produce both word orders, which may be because both SVO and OVS can be considered more novel because Farsi transitives are largely SOV. These findings highlight that mental representations formed from brief exposure can be accessed immediately in production tasks. These findings also extend previous developmental research on priming (Messenger, Branigan, & McLean, 2012; Rowland et al., 2012) by showing that priming is involved in language processing from the earliest stages of learners' experience with input.

Although the participants' previously known languages appeared to impact their success at pattern detection, with twice as many participants in the detection group in Experiment 2 (Farsi) than in Experiment 1 (Thai), the only requirement for priming appears to have been the successful detection of the Esperanto transitive. In other words, there were no substantial differences

between the Thai and Farsi participants in the priming behaviors they exhibited, besides the inverse preference effect being specific to the respective L1s. This finding is consistent with previous research on comprehension priming in L2 speakers of Italian and German, where the participants' L1 background influenced their sentence interpretation strategies but had no impact on the strength of priming (Nitschke, Kidd, & Serratrice, 2010). In fact, Nitschke et al. showed that structural priming can override L1 transfer-based preferences, suggesting that L1 transfer need not inhibit the learning of novel structures. Taken together with the current results, these findings suggest not only that structural priming is available to learners in earliest stages of their experience with input but also that structural priming might be a mechanism for helping learners depart from L1 transfer-based strategies in L2 comprehension and production.

The availability of structural priming in early stages of learners' experience with input raises interesting questions about the precise mechanisms underlying priming (for discussion of various explanations for structural priming, see Chang et al., 2006; Pickering & Branigan, 1998, and Reitter, Keller, & Moore, 2011). While the current study was not designed to test competing explanations for priming, the findings nevertheless are suggestive of possible memory underpinnings of L2 structural priming detected here. Priming researchers have suggested at least two contributions to priming, namely, those that reflect implicit learning, which corresponds to a gradual tuning of the language production system as a result of linguistic experience, and those that are rooted in explicit memory and include such phenomena as the lexical and semantic boosts (see Ferreira & Bock, 2006). Recent structural priming studies that included measures of implicit and explicit learning or memory have reported mixed findings, however, with implicit learning measures predicting child L1 speakers' subsequent production of target structures, but not the occurrence of priming (Kidd, 2012a), and with explicit learning measures predicting neither primed production nor subsequent production (Kidd, 2012b). Furthermore, adult L1 speakers can be primed despite manipulation of environmental factors, which is characteristic of tasks that rely on implicit memory processes as opposed to explicit memory (Kutta & Kashak, 2012), but adult L2 speakers' primed production does not appear to be related to their statistical learning ability, which typically reflects implicit learning processes (McDonough, Kielstra, Crowther, & Smith, in press). In sum, implicit and explicit contributions to L2 structural priming remain to be clarified in future research.

Nevertheless, if the explicit-implicit distinction is real, then some of the priming effects detected here may reflect explicit contributions to priming because they developed rapidly, after a handful of learning trials, and because

the participants showing priming could explicitly verbalize target construction rules. However, participants in the word order only group were primed to produce SVO sentences even though they could not articulate the rules of Esperanto or write novel Esperanto sentences, which suggests that implicit learning may have occurred as well. The more robust priming found with the detection groups is compatible with findings of greater structural priming effects following explicit instructions for participants to attend to syntax, compared with instructions to attend to meaning (Bock, Loebell, & Morey, 1992; Marsden, Altmann, & St. Claire, 2013), and our own earlier finding showing that the detection of a novel construction is best when low type-frequency input is paired with explicit (deductive) instructions (McDonough & Trofimovich, 2013). What remains to be investigated, then, is how most optimal distributions of linguistic input could be paired with explicit and implicit learning conditions and opportunities for primed production to help learners succeed in L2 morphosyntactic learning.

Limitations and Future Research

Low type-frequency input studies involving English L2 speakers have determined that a variety of factors influence speakers' ability to extract novel patterns from aural input, including the explicitness of the learning task, the learning setting, and the specific syntactic and morphological features of the target construction (Fulga & McDonough, 2014; McDonough & Nekrasova-Becker, 2014; McDonough & Trofimovich, 2013; Nakamura, 2012; Year & Gordon, 2009). Consequently, it is difficult to identify the precise contribution of low type-frequency input to pattern detection or to generalize across settings, speakers, and target languages. Although the current findings indicated that brief exposure to low type-frequency input was not sufficient for the majority of the Thai or Farsi participants to extract the complete morphological and syntactic features of the Esperanto transitive, this does not warrant the conclusion that such input has limited potential for promoting L2 learning. However, it does suggest that additional steps may be necessary in order for it to facilitate learning on a larger scale. For example, adding a feedback phase following exposure to sentences that require reliance on a morphological cue could help learners realize that they are not employing appropriate sentence interpretation strategies. In future studies, low type-frequency input could be combined with more explicit task instructions or auditory enhancements (such as stress) for key elements, both of which may help draw learners' attention to the role of morphological cues for correct sentence interpretation.

In order to capture the initial stages of L2 learning, the current experiments targeted the transitive construction in Esperanto. Although this decision ensured that the participants had no prior exposure to the target language, it limited the potential usefulness of the findings to classroom settings, as Esperanto is infrequently offered in schools or universities and students in foreign language classrooms are rarely true beginners. To address this issue in future research, we aim to expand the target language from Esperanto to less commonly taught languages, such as Russian, Korean, Thai, and Arabic, which allows for the recruitment of participants with no prior knowledge for laboratory-based experiments, but also creates opportunities for the findings to be applied to foreign language classrooms. In order to explore how input can maximize learning in classroom settings, we aim to investigate a wider range of target constructions, including those that require extension of a known pattern rather than completely novel patterns. Prior studies of novel pattern detection have operationalized novelty in terms of both form and meaning, such as the *appearance* construction invented by Goldberg and colleagues, or largely in terms of form, such as dative and transitive constructions. If a related or similar meaning of the L2 construction exists in a previously known language, then the challenge is to map the meaning onto novel forms, and this process may require additional learning tasks to overcome already-established form-meaning mappings. By investigating these issues in our future research, we aim to contribute to theoretically motivated agendas to identify the contribution of low type-frequency input to L2 learning and to pedagogically oriented efforts to maximize the learning opportunities made available to foreign language learners.

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Notes

1 Two versions of the priming materials were created: low type-frequency prompts (e.g., six unique nouns as objects) and high type-frequency prompts (11 unique nouns as objects), which were randomly distributed to the participants. Because prompt type frequency had no main or interaction effects, it was not considered in any further analyses.

2 Immediately before and after the priming activity, the participants were asked to describe 10 pictures that were not included in the priming activity. Their production of Esperanto transitives during these activities falls outside the scope of the current study, and is reported elsewhere (McDonough & Trofimovich, in press).

3 A reviewer asked whether the Thai participants showed a preference to produce SVO transitives prior to the priming activity. As described in Note 2, analysis of the

participants' baseline and postpriming exposure is beyond the scope of this manuscript, but we can confirm that during the baseline phase, the Thai participants produced more SVO sentences (68) than OVS sentences (42).

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