The Impact of L1 Background and Visual Information on the Effectiveness of Low-Variability Input

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Abstract

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This study investigated whether L1 background and visual information impact the effectiveness of skewed and balanced input at promoting pattern detection. Participants (N= 84) were exposed to Esperanto sentence with the transitive construction under skewed (one noun with high token frequency) or balanced input (equal token frequency) conditions while viewing either colour or black and white visuals. Their ability to detect the relevant morphological and syntactic features of the transitive construction was tested through a forced judgement task using novel nouns. The results indicated no significant main effect for visual information or input type. There was, however, a significant main effect for L1 on learners' capacity to notice the accusative inflection in Esperanto. The implications are discussed in terms of the effect of L1- specific transitive encodings on speakers' ability to abstract a novel transitive construction.

Keywords: skewed input, balanced input, prototypical transitivity differential object marking, the extended argument-dependency model.

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Contribution of Authors

As first author for the included manuscript, Angelica Fulga was the major contributor to the study's conception, design, data collection, and write-up. The organization of the manuscript was jointly developed by Angelica Fulga and Kim McDonough. Angelica Fulga wrote substantive drafts of the manuscript, while Kim McDonough provided extensive feedback on organization and content and re-worded some passages. The majority of the manuscript's conception and content was developed by Angelica Fulga. This contribution is reflected in her status as first author.

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Chapter 1

Situated within the theoretical frameworks of both cognitive and constructionist linguistics, this study views meaning and form as inseparable constituents of language. These two theoretical approaches conceive of grammar as a composite of schematic structures with meaning in their own right (Langacker, 2008), similarly to cognitive categories. From these perspectives, the communication of meaning represents a part of an information processing system for interpreting human behaviour that draws upon both verbal utterances and visual cues in decoding the communicated message (Carston, 2002). While understanding verbal utterances requires knowledge of language-specific form-meaning mappings, understanding visual messages entails the use of general cognitive skills that are language-independent and universal. Influenced by these claims, the purpose of this study was to test the influence of L1 on speakers' ability to abstract novel second language (L2) linguistic structures and the applicability of visual information to the decoding of these structures. The first chapter begins with an overview of linguistic structures and two characteristics that they share with other cognitive categories: partial compositionality and prototypicality.

Linguistic Structures as Cognitive Categories

Linguistic structures are complex assemblies of form-meaning pairings that consist of a fixed, schematic sequence of elements forming a relationship that is governed by phonological and semantic rules (Langacker, 2008). The phonological feature determines segmental and suprasegmental phonological constraints, such as the rules governing the formation of the plural in English, while the semantic feature determines the semantic relationship among the components, as in the use of transitive verbs with passive constructions in English. Constructions can be words, phrases or argument structures; the latter are referred to in this study as syntactic constructions, or constructions that have a predicate. Both the fixed pattern/schematic sequence and the construction itself are symbolic assemblies (Langacker, 2008), with the distinguishing property that the former is schematic and the latter specific. For instance, the covariational conditional structure *the more the merrier* constitutes a construction, while its schematic representation, *X-er the Y-er* (Goldberg, 2009), represents a fixed pattern. Linguistic structures share at least two attributes with other cognitive categories: partial compositionality and prototypicality. Partial compositionality stems from the schematic/symbolic nature of constructions. For instance, the schematic representation of the passive voice in English, *X + be + V-en (+ by + Y)* allows a speaker to easily map onto it a great number of new instances on condition that the verb encodes a transitive event (Bruner, 2001). The second cognitive attribute, prototypicality, is represented by the semantic component of the fixed pattern of a construction, with the various instances of that construction, or its argument structures representing exemplars of that construction. For instance, the fixed pattern *SVO* in English translates semantically as *X acts on Y*, which represents a concept, whereas the instance *the boy hit the ball* constitutes an exemplar.

The verb is believed to play an essential role in the semantic process through which an exemplar/argument structure is assigned to a certain category. More exactly, the argument structure provides the connection between the more specific meaning of the verb and the generalized, prototypical meaning it receives when embedded onto a particular fixed form (Goldberg, 2006). A verb can display a high frequency of occurrence with the same argument structure as indicated by Zipfian distribution, but it can also occur in various other types of constructions (Bencini & Goldberg, 2000). For example, the verb cook, meaning change of state by heat, can represent different prototypical instances in various argument structures. Thus, in the sentence *the strawberries cooked into jam*, further generalized as an intransitive inchoative construction (Goldberg, 2006), its prototypical meaning is *something changing state*, while in the instance *mother cooked us some strawberry jam*, the meaning becomes *someone intending to cause someone to receive something* (Goldberg, 2006), as induced by the ditransitive construction.

To sum up, the two properties of linguistic structures discussed above, partial compositionality and prototypicality give language its creative potential and make linguistic structures sustain categorization. Due to their similarity to categories, constructions are acquired based on the same cognitive processes that govern domain-general category formation: pattern detection and identification of the prototypical meaning. The process of generalization over linguistic constructions is detailed in the next section.

Acquiring linguistic structures. In order to understand how linguistic constructions are abstracted from recurring exemplars in the input, it is necessary to analyze the generalization process within the wider context of the cognitive domain. In this study, the words "generalization," "structure mapping," "structural alignment," "pattern detection" and "abstraction" are used synonymously. They all refer to the process through which exemplars that have common features are abstracted to categories and prototypes. In Gentner and Markman's (1997) view, generalizations take place as a result of analogy and similarity processes, with the distinguishing characteristic that analogy requires only an alignment of relational structures (a bat is a mammal and not a bird because it gives birth to its offspring - a theory-based relation), while similarity necessitates that both relational and concrete object attributes be shared, as in all birds have beaks, claws, feathers and lay eggs. An important element in relation to analogy is systematicity, a property ensuring that higher order connections dominate lower order relations, in which case concrete attributes that are shared, but not connected to the matching system diminish in importance. For instance, a picture depicting a child looking at a snake and another one illustrating another child looking at a fish share the commonality a child looking at a pet (Gentner & Markman, 1997), the comparison being based on higher order connections, with snake-fish forming what the authors called an “alignable difference.” On the other hand, a dresser depicted in both pictures represented in the aforementioned study does not play a role in the abstraction, so this commonality loses its importance and becomes a “non-alignable similarity” (Gentner & Markman, 1997). According to the authors, both similarities and alignable differences are important in generalization processes if they are part of the matching system.

Factors involved in similarity and analogy processes play an important role in generalizations over linguistic constructions as well, and they are determined by the exemplars in the input. The process of generalization over linguistic constructions is detailed in the coming paragraphs.

Generalizing across linguistic structures. Constructions are abstracted from recurring exemplars. Linguistic exemplars, which can be either recurring morphemes (morphological constructions) or recurring argument structures (syntactic constructions) are abstracted to both a schematic form and a prototypical meaning, since meaning and form are inseparable. Generalizing across exemplars with the same morphological feature requires the ability to classify based on similarities by detecting the recurring morpheme and the structural relationship that governs all the exemplars, while generalizing over exemplars with the same syntactic feature implies the ability to classify based on analogy processes.

Categorizations across morphological constructions occur through similarity processes in which attribute similarity is revealed by the re-occurrence of the same morpheme with different instances of a construction, while the relational structures are determined by the relationship between the components of one exemplar and the extrapolation of this relation to the other exemplars. For instance, abstracting the plural in English, schematically rendered as *N-(e)s*, roughly implies detecting the morpheme *–s* across all the exemplars, as in *the apples are on the table*, or *she put four plums on the table* (pattern detection is based here on concrete attribute similarity: the presence of the inflexional morpheme) and finding the relational structure among all the exemplars, or in this case a correspondence between the plural verb are and the noun *apples* and between the plural adjective *four* and the noun *plums*. The relational structure is abstracted based on alignable differences (detecting the fact that all the *N–(e)s* mean plural), whereas the similarity *table* plays no role in the abstraction. It is thus important to note that shared commonalities that do not play a role in the matching system do not contribute to the categorization. On the other hand, categorizations based on syntactic structures such as transitivity are based on analogy processes that involve finding the relationship between the verb and the other elements of one argument structure (exemplar) and extrapolating it to the other exemplars. Since different words can occur with the same argument structure, they contribute to the similarity process as "alignable differences" (for instance various verbs share the same prototypical meaning in the same argument structure), while the recurring fixed pattern represents a shared commonality. As Goldberg (2005) suggested, when dealing with instances that display the same patterns involving different words, similarities should be assigned to the argument structure and differences to the different verbs involved in that structure. For example, the generalized *meaning someone caused someone to receive something* is rendered not only by the verb *give*, but also by other verbs, such as *offer* or *send*: *he gave her a present*; *he offered her a present*; *he sent her a present.*

Even though all the instances of the same construction display concrete similarities (all transitive events in English for instance can be schematically rendered as *SVO*), attribute similarity does not play a role in categorizations over syntactic constructions due to "systematicity." Systematicity involves, in Gentner and Markman's (1997) view, that higher order relations (finding a common relationship among the components of all exemplars) govern lower order ones (shared attributes that do not play a role in the categorization). Thus, the fact that all instances of transitive constructions share the *SVO* word-order is less important in structure mapping than, on the one hand, the relationship between the two arguments of the verb and the meaning mapped onto the verb on the other.

In sum, structure mapping over linguistic constructions is based on general cognitive processes such as analogy and similarity. Both processes require finding a relational structure among the elements of a construction and extrapolating this relationship to all the other similar instances in the input. Although analogy and similarity reasoning are language-independent general cognitive processes, a speaker's ability to detect, or to see linguistic patterns may be influenced by L1-specific form-meaning mappings. More specifically, because languages around the world mark different aspects of an event, when processing linguistic structures, their speakers are used to paying attention to those specific aspects. The next section analyzes how transitivity is encoded across different languages and how language-specific encodings of transitive events may affect speakers' processing of L2 linguistic structures.

L-1 Specific Encodings of the Transitive Construction and Their Effect on Pattern Detection

Languages across the world encode argument-verb relationships differently. For instance, while transitivity in English relies on word-order in rendering the grammatical function of the two arguments, other languages use case marking to disambiguate the agent-patient interaction. In this latter category, there are languages that mark all their direct objects (they are non-restrictive; Sinnemäki, 2009) and languages that mark them differentially (they are restrictive), based on the pragmatic or semantic properties of the arguments, a phenomenon called differential object marking (Aissen, 2003). Case-marking in differential object marking languages depends on degrees of prominence, with the most prominent argument being preferentially marked in order to disambiguate agent-patient roles in the case of non-prototypical constructions (when the agent is inanimate and the patient is animate). On the animate scale, prominence is assessed as Human > Animate > Inanimate, while on the definiteness scale, as Pronoun > Proper Noun > Definite > Indefinite Specific > NonSpecific (Aissen, 2003). As restrictive languages display differences as to which property affects case-marking, Sinnemäki (2009) proposed a further classification of restrictive languages into restrictive based on animacy, restrictive based on definiteness, and restrictive based on both animacy and definiteness. Definiteness languages tend to mark all their definite/specific objects regardless of the animacy/inanimacy property (e.g., Turkish), whereas some animacy languages such as Malayalam case-mark only the objects in non-prototypical instances. Although languages may differ with respect to which aspect they give priority to in case-marking, both characteristics may be used to further disambiguate agent-patient roles. In Farsi, for instance, differential object marking is determined by definiteness/specificity, but within the class of non-specifics, case-marking is determined by animacy, while in Hindi animacy weighs more than definiteness (Aissen, 2003).

The arguments presented above suggest that abstracting a linguistic structure involves different stages of processing based on the availability of cues in the input. In order to account for these processing stages and to present a cross-linguistic unifying model of linguistic processing, Bornkessel and Schlesewsky (2006) proposed the extended argument dependency model. The extended-argument dependency model represents a neurocognitive perspective on the online processing of core relations between arguments, as well as between arguments and their verb in simple sentences (sentences that have only one, two or three arguments). The model proposes three processing phases. In the first phase, word category information is computed, based on morphology. The second phase has two components, Phase 2a and Phase 2b. Properties of the NPs and of the VPs such as tense, aspect, voice and agreement are parsed in Phase 2a. The processing of the NPs entails activating prominence hierarchies based on morphology and argument position. The computation of prominence information as expressed cross-linguistically and argument role assignment takes place in Phase 2b. Finally, Phase 3, Generalized Mapping, repairs and finalizes the argument role assignment by computing information from other domains such as prosody, frequency, plausibility and world knowledge (Bornkessel & Schlesewsky, 2006). Thus, argument role interpretation is initially triggered by L1-specific argument role assignment, with potential discrepancies being corrected only in Phase 3 depending on cue availability.

In sum, finding a relational structure across various instances of a linguistic structure is a complex process that involves general cognitive operations based both on the nature of the construction itself and on the nature of the arguments. Morphological constructions are abstracted based on similarity processes which require detecting a shared concrete element (for instance, a morpheme) and a relational structure across all the exemplars. Syntactic constructions are categorized based on analogy processes which entail finding a relational structure between the two arguments and between the arguments and the verb. Assigning grammatical roles may be influenced in non-prototypical instances by a speaker's L1 differential object marking, at least in the first stages of processing of the extended dependency model. These roles may be re-defined in the third phase of the model depending on cue availability. Since the cues available in the input affect a learner's final decision in categorizations over linguistic structures, in order to facilitate the abstraction of a new construction to an existing category and bypass a possibly negative L1 effect, the input needs to be manipulated so as to allow for a quick re-structuring of the grammatical roles played by the arguments in the final phase of the extended-argument dependency model.

The Role of Input in Generalizations over Linguistic Structures

Input plays an essential role in categorization processes through which linguistic exemplars are abstracted to a prototypical construction. For these categorization processes to take place, however, verbal input needs to be characterized by common features that allow for structure mapping. Researchers have argued that input displaying low variability, or little lexical diversity, with high frequency of a particular instance of a construction influences the abstraction of a new category to an existent concept (Bybee, 2006; Ellis, 2006a; Goldberg, 2006, 2009; Tomasello, 2003). For example, a conversation about hunting might consist of numerous transitive constructions with the verbs *shoot* and *get* and the nouns *duck*, *quail* and *rabbit*. This conversation displays little lexical diversity because only three nouns occur with two verbs across all the exemplars. Such a conversation would display low variability of elements because only three verbs and one noun occur with that particular transitive construction. One way in which low variability input encourages structure mapping across linguistic constructions is by inducing learners to focus on the relationship among the elements of each construction rather than on the elements themselves, which creates room for analogy and similarity judgments required in categorization processes. Studies on children's acquisition of new structures confirmed the fact that first language acquisition is an indeed an exemplar-based type of learning. For instance, by analyzing overgeneralizations of fixed transitivity (singularly intransitive or singularly transitive constructions) to familiar and new verbs, Brooks, Tomasello, Dodson and Lewis (1999) found that young children tend to overgeneralize only the unfamiliar structures, which means that the use of certain forms becomes fixed over time. Similarly, findings in a more recent study on the effect of verb frequency on word order by Matthews, Lieven, Theakston and Tomasello (2005) indicated that older children prefer to use the familiar *SVO* form regardless of the frequency of the verb, while the younger children tend to use the low frequency words with the new strange word order, which suggests that word order develops based on generalization of frequently occurring items. Similarly, Kidd, Lieven and Tomasello (2006) looked at the acquisition of complement clause constructions and found that the frequency with which a complementizer appeared in the construction facilitated memorization and repetition of that construction by young children.

These studies attest to the essential role that low-variability input plays in the acquisition of new form-meaning structures. In light of these results, one may conclude that low variability input facilitates pattern detection by shifting focus from the constituents of the construction to their relationship, which creates room for analogy and similarity processes that induce categorization.

Categorizations from Skewed and Balanced Input

Researchers have proposed that in order to further facilitate categorization over linguistic structures, the distribution of the lexical elements within the low-variability input needs to be skewed in favour of one prototypical word (Casenhiser & Goldberg, 2005; Goldberg & Casenhiser, 2008; Year & Gordon, 2009). A skewed distribution contrasts with balanced input, where there is an equal distribution of tokens across all the exemplars. For instance, if all three nouns in the conversation about hunting occurred with each verb for an equal amount of times, the distribution would be balanced. Conversely, with skewed input, most exemplars are constructed around one lexical item, which has high-token frequency, while the other lexical items have equally low-token frequency. For example, in the conversation illustrated above, the noun *duck* could occur with half of the transitive constructions, while each of the other two nouns would occur only a few times with each verb. Categorizations based on the argument *duck* would include the features [+animated +small -volitional –instigator +affected +/- airborne]. In order to encompass the argument *rabbit* the attribute *airborne* is eliminated and the final category, while including all small animals, may exclude larger animals such as deer or buffalo, since they lack the property *small* and also display the characteristics [+/- volitional, +/- instigator] in different argument structures.

By allowing a learner to focus on the properties of one element, skewed input facilitates detection of relational structures encouraging structure mapping over syntactic constructions. In the case discussed above, a learner would first detect a relational structure between the properties of the element *duck* and its predicates. He or she would then extrapolate this relational structure to the other elements across the exemplars by eliminating the properties that these other elements do not share with the prototypical element. In addition, since skewness creates a disparity of occurrences in favour of one word, the other elements will occur with that construction for a limited number of times, so exemplars that display skewness encourage narrower categorizations, or categorizations that encompass the common semantic properties of a limited number of elements. Balanced input, on the other hand, facilitates abstraction of morphological constructions by encouraging wider categorizations, for an inflectional morpheme needs to be distributed equally across all the argument structures to be abstracted as a concrete similarity.

The analysis has focused so far on input-type as primary factor that facilitates decoding of novel form-meaning mappings. Communication of meaning however, requires reliance on both linguistic and visual cues. Because understanding of visuals is not language-mediated, they constitute an important element in decoding novel linguistic information, but the properties that could further facilitate this decoding have not been analyzed. Characteristics of the visual input that could affect language processing are discussed in the next section.

Properties of Visuals and Their Potential Role in Decoding Linguistic Information

The fact that visuals work in tandem with linguistic input was confirmed by Maguire, Hirsh-Pasek, Golnikoff and Brandone (2008) who found that it was easier for children to categorize intransitivity when the action was performed by a single, rather than by multiple actors, which means that low variability affects not only the decoding of linguistic information, but also that of visual information. Apart from low-variability, other two aspects of visual messages that seem to affect how speakers process them are prototypicality and chromatic information. These effects are discussed in the next section.

Chromatic Information

Whether pictures are colour (chromatic) or monochromatic (black and white) seems to have an effect on memory. More specifically, when compared to black and white visuals, colour visuals positively influence recall, recognition memory and semantic processing (Shaari, 1991; Wichmann, Sharpe, & Gegenfurtner, 2002). One possible reason why chromatic information is decoded more quickly is that colour material, unlike monochromatic visuals, stimulates attentive behaviour as suggested by Cano, Class and Polich (2009). Although it may be suggested that all these effects are due to object familiarity (the world is coloured), studies in which unrealistic colours were used instead of natural colours, such as in colouring line drawings of natural or artificial objects (Dwyer, 1971; Hocking & Price, 2008; Zannino, Perri, Salamone, Di Lorenzo, Caltagirone, & Carlesimo, 2010) revealed that colour does not have to be a natural hue to positively affect memory. In other words, realistic representations of objects (natural or artificial), such as colour photographs do not necessarily represent better stimuli than coloured drawings of those objects.

Considering the fact that coloured simple line drawings depict prototypes (or structural representations of objects, or how objects are stored in long-term memory) and not exemplars (line drawings render only the characteristics necessary to place the object into a certain category, they do not focus on particular details), it may be assumed that it is their resemblance to prototypes that facilitates the semantic processing of these visuals. The potential role of prototypicality in information processing is described in the following section.

Prototypicality in visual information. Prototypicality refers to characteristics of an object that make possible its classification into a category based on functional and visual attributes. For instance, to reiterate an example used above, *all birds have wings, beaks and feathers* represents visual attributes, while *they all lay eggs* constitutes a functional attribute. Prototypes need to be differentiated from exemplars: a prototype of a bird represents any bird, while an exemplar would be a sparrow, for instance. Regarding visual material, a picture of a bird would depict an exemplar (a picture of a sparrow, for example), while a drawing of a bird that depicts only generic attributes of its species would represent a prototype. When a prototype is saved in memory, only general properties which are representative for the category that prototype belongs in are stored. Therefore, visuals representing coloured simple line drawings of objects are easier to process semantically and require less memory load because they match stored prototypes. This implies that learning tasks that employ prototypical visuals to transmit new information would result in better recall of that information , as found by Dwyer (1971), Zannino, Perri, Salamone, Di Lorenzo, Caltagirone and Carlesimo (2010), who suggest that the increased processing speed for colour information may be in fact attributed to colour prototypicality, not colour naturalness. As Zannino et al. (2010) indicated, non-naturalistic colour facilitates image naming because it assists processing at the semantic level, prototypical colours (pink, grey, green) being easier to express in words than their natural counterparts. For instance, “pink” is easier to verbalize than the various shades of pink that a pig’s skin displays in real life.

Although more studies are needed to clarify the impact of visual information on learning, the findings discussed above could have valuable applications for second language acquisition. The fact that colour visual stimuli influence recall, facilitate semantic processing and stimulate attentive behaviour implies that vocabulary learning may be better influenced by conditions consisting of visual and verbal stimuli than by situations where verbal stimuli alone are used. Studies that investigated the impact of visual information on L2 vocabulary learning are reviewed in the following section.

Visual information and L2 learning. Evidence that more words in an L2 language are recalled when the learners are presented with visual stimuli stems from two earlier studies on vocabulary acquisition: Deno (1968) and Webber (1978). Deno (1968), who studied the acquisition of Japanese words by English speakers, employed prototypical visuals and verbal stimuli as cues for vocabulary learning. The visual cues were black and white line drawings, while the verbal clues represented English translations of the Japanese words. The stimuli were classified as conceptually dissimilar and conceptually similar categories (animal, clothing, furniture); this choice of materials was based on the assumption that difficulty in learning conceptually similar words is triggered by their similarity in meaning, or their conceptual similarity (Deno, 1968). The findings indicated that it was easier for the participants to learn the words when they were first represented pictorially, especially in the conceptually related word condition.

The fact that the visual condition, but not the word condition, yielded positive results even in the more difficult situation of conceptually similar words may indicate that words and pictures are not decoded in the same way (Deno, 1968); when words and pictures are combined, semantic mapping may happen in more areas of the brain, with a consequence on processing speed and on working memory, more memory space being allotted to vocabulary storage. Positive evidence for the facilitating role of visuals (black and white line drawings) in learning vocabulary was also presented by Webber (1978), who tested the acquisition of Indonesian words by grade four children. The stimuli were cards on which the Indonesian words (some of them English cognates) appeared either with their visual referent or with their English translation. Although the presence of the English cognates should have represented an advantage for the word group, the visual/word group still out-performed the word/word group. What both studies discussed above have in common is the use of prototypical black and white visuals and of word referents as aids in vocabulary recall. The findings clearly suggested that there is significantly more vocabulary acquisition, at least in the short-term memory, when simple drawings are employed to transmit information. Unfortunately, there are few studies that compared monochromatic and chromatic visuals and their different influence on vocabulary acquisition.

One of the few studies to analyze the impact of verbal and visual information on the acquisition of L2 vocabulary is Altarriba and Knickerbocker 's (2011), who tested priming effects for verbal stimuli with three learning conditions (word, black and white visuals and colour visuals). Their findings indicated faster reaction times for the participants in the word condition during the experimental stage, and across the visual conditions, the black and white stimuli yielded better results than the chromatic ones. These findings seem to contradict the positive effects of coloured visuals on learning found in the other studies analyzed above. However, Altarriba and Knickerbocker's (2011) results may be an effect of the testing condition, in which only verbal stimuli were used as primes. Additionally, the visuals employed in their study were not prototypical images, so the results are not suggestive for the theory on colour prototypical images. Using simple line drawings and non-naturalistic, prototypical colour instead of realistic representations of objects may have yielded different results.

To sum up, the findings in the studies on vocabulary acquisition discussed above suggest that different results are obtained when using pictorial vs. verbal stimuli in word memorization tasks. It seems that verbal stimuli positively affect priming, while monochromatic visual stimuli facilitate vocabulary recall. While the effect of coloured visual information on priming has been previously tested, its effect on learning new linguistic structures has not been studied before. Assembling a study in which verbal and visual messages work in tandem to reveal the meaning of a novel linguistic structure would be a natural undertaking, considering the fact that both elements are constituents of the human information system. In addition, since prototypicality was found to affect the decoding of both visual and linguistic information, it would be important to determine whether or not categorizations over novel linguistic structures can be aided by prototypically rendered visuals in the input.

Summary

In sum, pattern detection across linguistic structures occurs through general cognitive processes based on the learners' L1 and on the availability of cues in the input. In order to bypass a potential negative effect of the L1, the input needs to be manipulated so as to facilitate pattern detection. The effectiveness of low-variability input seems to be affected by the nature of the construction: balanced input affects categorizations of morphological constructions, while skewed input seems to work better in generalizations over syntactic constructions. Pattern detection is also influenced by prototypicality: due to the fact that some tokens manifest high frequency of occurrence with a certain construction, their meaning is often associated with that construction. On the other hand, low-variability input and prototypicality affect not only verbal, but also visual stimuli. Just like verbal input, visual input needs to be contrived based on factors such as the amount of entropy of the system (how many elements are present in the visual), redundancy (low variability and high token frequency) and prototypicality (how close the elements are to stored prototypes). Since visual information plays an important role in transmitting a message, visual and verbal stimuli can be combined when teaching new structures. By controlling the verbal and visual input based on the factors cited above, learners may be able to free working memory and to pay better attention to key features of a structure for pattern detection and eventually bypass the L1 influence in the final processing phase of the extended-argument dependency model.

The following chapter is the manuscript.

Chapter 2

From the perspective of cognitive science, grammar represents an assembly of symbolic schematic structures or constructions with meaning in their own right (Langacker, 2008), similarly to cognitive categories. In this approach, constructions are complex assemblies of form-meaning pairings that consist of a fixed, schematic sequence of elements forming a relationship that is governed by lexical and semantic rules. Constructions can be either words (morphological constructions) or argument structures (syntactic constructions). For instance, the English plural, schematically rendered as *N+s*, represents a morphological construction, while transitivity, schematically represented in English as *SVO*, represents a syntactic structure. Both the fixed pattern or schematic sequence and the construction itself are symbolic assemblies (Langacker, 2008), with the distinguishing property that the former is schematic and the latter specific. For instance, the covariational conditional structure *the more the merrier* constitutes a construction, while its schematic representation, *X-er the Y-er* (Goldberg, 2009), represents a fixed pattern.

Due to their symbolic and schematic nature, linguistic structures share at least two attributes with other cognitive categories: partial compositionality and prototypicality. Partial compositionality stems from the schematic nature of constructions. For instance, the schematic representation of the passive voice in English, *X + be + V-en (+ by + Y),* allows a speaker to easily map onto it a great number of new instances, on condition that the verb encodes a transitive event (Bruner, 2001). The second cognitive attribute, prototypicality, is represented by the semantic component of the fixed pattern of a construction, with the various instances of that construction, its argument structures, representing exemplars. For instance, the fixed pattern *SVO* in English translates semantically as *X acts on Y*, which represents a concept, whereas the instance *the boy hit the ball* constitutes an exemplar.

Due to their similarity to categories, constructions are acquired based on the same cognitive processes that govern domain-general category formation: generalizing, or abstracting over exemplars and prototypes in the input and storing them based on similarities or commonalities with other categories or concepts. Therefore, in order to understand how linguistic constructions are abstracted from recurring exemplars in the input, it is necessary to consider the generalization process within the wider context of the cognitive domain. In this study, the words "generalization," "abstraction" and "categorization" are used synonymously. They all refer to the process through which exemplars that have common features are abstracted to categories and prototypes.

In Gentner and Markman's (1997) view, generalizations take place based on analogy and similarity processes, with the distinguishing characteristic that analogy requires only an alignment of relational structures, while similarity necessitates that both relational and concrete object attributes be shared. For instance, assigning "whale" to the category "mammals," and not "fish" is based on an analogy process, namely that whales give birth to their offspring. On the other hand, assigning "sparrow" to the category "bird" is based on both attribute similarity (all sparrows have beaks, claws, feathers) and relational structures (all sparrows lay eggs). The common attributes and the relational structure shared among exemplars that form a single category are abstracted from an existing prototypical element, an element whose characteristics are generalizable enough to be transferred to the other elements (Posner, Goldsmith, & Welton, 1967). In like manner, structure mapping over linguistic constructions requires detecting the relational structure that connects the semantic characteristics of a prototypical element and its argument structure and extrapolating this relationship to the other elements that play a role in the relational system across the exemplars in the input.

Linguistic constructions associated with morphological and syntactic properties are abstracted based on different mechanisms. Categorizations across morphological constructions require similarity processes in which attribute similarity is revealed by the re-occurrence of the same morpheme with different instances of a construction, whereas the relational structure is determined by the relationship between the prototypical element and its argument structures. For instance, when abstracting the plural in English, the concrete attribute similarity is represented by the inflectional morpheme -*s*, as in *the apples are on the table*, or *she put four plums on the table*, while the relational structure represents the correspondence, on the one hand, between the plural verb *are* and the noun *apples* and between the plural adjective *four* and the noun *plum* on the other. The relational structure is abstracted in this particular case based on what Gentner and Markman (1997) called "alignable differences," as all the different nouns rendered as *N+s* mean plural, whereas the similarity *table* represents what the above-mentioned authors called a non-alignable similarity, playing no role in the abstraction. Conversely, categorizations over syntactic structures such as transitivity are based on analogy processes that entail finding the relationship between a prototypical element and the argument structures it participates in. Since different verbs and arguments can occur with the same fixed pattern, they contribute to the similarity process as alignable differences, while the recurring fixed pattern represents a shared commonality. For instance, the transitive construction, conceptually represented as *X acts on Y* can be rendered by a variety of verbs provided that they are transitive, i.e., they take direct objects (patients).

In sum, structure mapping over linguistic constructions is based on general cognitive processes such as analogy and similarity, which are triggered by the nature of the construction. Both processes require finding a relational structure among the elements of a construction and extrapolating this relationship to all the other similar instances in the input. However, although analogy and similarity reasoning are language-independent general cognitive processes, a speaker's ability to detect, or to see linguistic patterns may be influenced by L1-specific form-meaning mappings. More specifically, because languages around the world mark different aspects of an event, when processing linguistic structures, their speakers are used to paying attention to those specific aspects. For instance, while transitivity in English relies on word-order in rendering the grammatical function of the two arguments, other languages use case marking to disambiguate the agent-patient interaction within non-prototypical transitive instances (e.g., the agent is inanimate, the patient is animate). In this latter category, there are languages that mark all their direct objects (they are called non-restrictive; Sinnemäki, 2012) and languages that mark them differentially (restrictive), based on the pragmatic or semantic properties of the arguments, a phenomenon called differential object marking (Aissen, 2003).

Case-marking in differential object marking languages depends on degrees of prominence, with the most prominent argument being preferentially marked in order to disambiguate agent-patient roles in the case of non-prototypical constructions (when the agent is inanimate and the patient is animate). On the animate scale, prominence is assessed as Human > Animate > Inanimate, while on the definiteness scale, as Pronoun > Proper Noun > Definite > Indefinite Specific > NonSpecific (Aissen, 2003). As restrictive languages display differences as to which property affects case-marking, Sinnemäki (2012) proposed a further classification of restrictive languages into restrictive based on animacy, restrictive based on definiteness, and restrictive based on both animacy and definiteness. Definiteness languages tend to mark all their definite/specific objects regardless of the animacy/inanimacy property (e.g., Turkish), whereas some animacy languages such as Malayalam case-mark only the objects in non-prototypical instances.

Although languages may differ with respect to which aspect they give priority to in case-marking, both characteristics may be used to further disambiguate agent-patient roles. In Farsi, for instance, differential object marking is determined by definiteness/specificity, and within the class of non-specifics, case-marking is determined by animacy. For example, within the class of definite nouns in the sentence *Goat chases ball*, the patient, *ball*, is marked (-raa): *Boz* (goat) *tup* (ball) *raa donbal mikonad* (chases). If the patient is not definite, then –raa is omitted: *Boz* (goat) *tup* (a ball, indefinite) *donbal mikonad* (chases). On the other hand, in Hindi animacy weighs more than definiteness and within the category of inanimate nouns, case marking is possible only for definites (Aissen, 2003): *Ilaa-ne* (Ilaa – e) *ek* (one) *bacce-ko* (child-ko) *uţaayaa* (lift/carry) (Mohanan, 1994, p. 79). The patient *child* carries the accusative marking *–ko* even if it is indefinite, due to its prominence (human, animate). In the example *Ilaa-ne ek haar uţaayaa* (*Ila lifted a necklace*: Mohanan, 1994, p. 79), the patient, *necklace (haar)* is not marked because it is indefinite; *haar* receives accusative marking (-ko) when definite: *Ilaa-ne haar-ko uţaayaa* (*Ila lifted the necklace*: Mohanan, 1994, p. 80).

The information presented above suggests that abstracting a linguistic structure involves different stages of processing based on the availability of cues in the input such as animacy and/or definiteness. In order to account for these different processing stages and to present a cross-linguistic unifying model of linguistic processing, Bornkessel and Schlesewsky (2006) proposed the extended argument dependency model. This model presents a neurocognitive perspective on the online processing of core relations between arguments, as well as between arguments and their verb in simple sentences (sentences that have only one, two or three arguments). The model proposes three processing phases. In the first phase, word category information is computed, based on morphology. The second phase has two components, Phase 2a and Phase 2b. Properties of the NPs and of the VPs such as tense, aspect, voice and agreement are parsed in Phase 2a. The processing of the NPs entails activating prominence hierarchies based on morphology and argument position. The computation of prominence information as expressed cross-linguistically and argument role assignment takes place in Phase 2b. Finally, Phase 3, Generalized Mapping, repairs and finalizes the argument role assignment by computing information from other domains such as prosody, frequency, plausibility and world knowledge (Bornkessel & Schlesewsky, 2006). Based on this model, possible L1 influence on pattern detection of novel linguistic structures may occur in the second phase of processing. At this stage, properties of the arguments typically marked in the L1 may lurk in the background and affect a learner's initial ability to detect a relational structure between the arguments and the verb, with the final decision being influenced in the third phase by cue availability: word-order, animacy, definiteness, real-world knowledge.

In sum, finding a relational structure across various instances of a linguistic structure is a complex process that involves general cognitive operations triggered both by the nature of the construction itself and by the nature of the arguments. Morphological constructions are abstracted based on similarity processes which require detecting a shared concrete element (for instance, a morpheme) and a relational structure across all the exemplars. Syntactic constructions are categorized based on analogy processes which entail finding a relational structure between the two arguments and between the arguments and the verb. Finding this relational structure may be influenced in non-prototypical instances by a speaker's L1 differential object marking, at least in the first stages of processing of the extended argument dependency model. These roles may be re-defined in the third phase of the model depending on cue availability. Because the cues available in the input affect a learner's final decision in categorizations over linguistic structures, the input needs to be manipulated on the one hand to allow for a quick re-structuring of the grammatical roles played by the arguments in the final phase of the extended-argument dependency model and on the other, to bypass a possibly negative L1 effect.

Researchers have argued that input displaying low variability, or little lexical diversity, with high frequency of a particular instance of a construction influences the abstraction of a new structure to an existent concept (Bybee, 2006; Ellis, 2006a; Goldberg, 2006, 2009; Tomasello, 2003). For example, a conversation about hunting might consist of numerous transitive constructions with the verbs *shoot* and *get* and the nouns *duck, quail* and *hare.* This conversation displays little lexical diversity because only three nouns occur with two verbs across all the exemplars. Low-variability input encourages generalizations across linguistic structures by inducing learners to focus on the relationship between the arguments of a construction rather than on each argument individually (Brooks, Tomasello, Dodson, & Lewis 1999; Kidd, Lieven, & Tomasello, 2006; Matthews, Lieven, Theakston, &Tomasello, 2005), which in turn facilitates analogical reasoning. For instance, to abstract transitivity based on the examples mentioned above, a learner would have to find a relational structure between the attributes the three nouns share [-volitional – instigator +animated +affected] and the two verbs.

Researchers have also proposed that in order to further facilitate categorization over linguistic structures, the distribution of the lexical elements within the low-variability input needs to be skewed in favour of one prototypical word (Casenhiser & Goldberg, 2005; Goldberg & Casenhiser, 2008; Year & Gordon, 2009). A skewed distribution contrasts with balanced input, where there is an equal distribution of tokens across all the exemplars. For instance, if all three nouns in the conversation about hunting occurred with each verb for an equal amount of times, the distribution would be balanced. Conversely, with skewed input most exemplars are constructed around one lexical item, which has high-token frequency, while the other lexical items have equally low-token frequency. For example, in the conversation illustrated above, the noun *duck* could occur with half of the transitive constructions, while each of the other two nouns would occur only a few times with each verb. Categorizations based on the argument *duck* would include the features [+animated +small -volitional – instigator +affected +/- airborne]. In order to encompass the argument *hare* the attribute *airborne* is eliminated and the final category, while including all small animals, may exclude larger animals such as *deer or buffalo*, since they lack the property *small* and also display the characteristics [+/- volitional, +/- instigator] in different argument structures. By allowing a learner to focus on the properties of one element, skewed input facilitates detection of relational structures encouraging structure mapping over syntactic constructions. In the case discussed above, a learner would first detect a relational structure between the properties of the element *duck* and its predicates. He or she would then extrapolate this relational structure to the other elements that contribute to categorization across the remaining exemplars by eliminating the properties that these other elements do not share with the prototypical element. In addition, since skewness creates a disparity of occurrences in favour of one word, the other elements occur with that construction for a limited number of times, so exemplars that display skewness encourage narrower categorizations, or categorizations that encompass the common features of a limited number of elements.

Apart from low-variability, another input factor that encourages generalization is the occurrence of a prototypical element whose properties are broad enough to include additional elements in a relational structure across exemplars in the input. For instance, in the conversation about hunting illustrated above, the word *duck* is prototypical because it has properties that encompass all the three nouns [+animated +small -volitional – instigator +affected' +/- airborne], while the argument *hare* is not prototypical because it is not inclusive enough, i.e. it does not display the property +/- airborne, thus excluding the elements *duck* and *quail.* Thus, by finding a relational structure between the argument *duck* and its argument structure, a learner whose L1 is an SOV language with differential object marking for instance would be able to detect that transitivity in English is rendered by means of transitive verbs and fixed word-order only.

In conclusion, categorizations over syntactic constructions are facilitated by low-variability input that displays high frequency of one prototypical element. Low-variability input encourages abstractions over linguistic constructions by shifting the focus from the arguments themselves to their structural relationship. In categorizations over syntactic constructions, this relationship is detected based on analogy processes through which a relational structure is found on the one hand between the prototypical element and its argument structure and on the other, between the general characteristics of the prototypical element and the characteristics it shares with the other elements that play a role in the abstraction process. The more encompassing these characteristics are, the easier it is to generalize them across exemplars. Conversely, categorizations over morphological constructions occur through similarity processes which require finding a concrete attribute, usually a recurring morpheme, and a relational structure across all the exemplars, a process that is facilitated by balanced input.

The effectiveness of skewed input in pattern detection over syntactic structures has been affirmed in studies on the acquisition of novel constructions by both English L1 children and adults (Casenhiser & Goldberg, 2005; Goldberg, Casenhiser, & Sethuraman, 2004; Goldberg, Casenhiser, & White, 2007). These experimental studies employed the prototypical meaning *appearance* embedded on the fixed form *NPtheme – NPlocation – VP-o*, as in the example *the spot the king moopoed* (Goldberg et al., 2004*).* Subsequent experimental studies targeted the acquisition of the ditransitive construction in English (Year and Gordon, 2009; McDonough & Nekrasova-Becker, 2012), the novel construction of appearance used in Casenhiser and Goldber's (2005) study (Nakamura, 2012), the Samoan ergative construction (Nakamura, 2012), or the transitive construction in Esperanto (McDonough & Trofimovich, 2012). These studies found either no significant differences in the effectiveness of skewed over balanced input (Year and Gordon, 2009, Nakamura, 2012), or a facilitating effect for balanced input (McDonough & Nekrasova-Becker, 2012; McDonough & Trofimovich, 2012). The researchers attributed these contradictory results either to external factors such as learning environment, which included formal classroom settings, the participants' previous exposure to the construction, or to internal factors such as adults' tendency to rely on explicit learning (Nakamura, 2012).

However, there are some other limitations related both to input and to methodology that may have played an equally important role in these outcomes. For instance, the input in the Year and Gordon (2009) study contained ditransitive and prepositional dative constructions, the *give*-type and the *throw*-type. While *give* encodes the meaning *to cause someone to receive something*, the *throw*-type verbs encode the meaning *displacement of object by means of a path*, so the verb *give* is not prototypical for both instances. Likewise, Nakamura (2012) tested two different constructions, the *appearance* construction and the Samoan ergative construction, which may have overloaded attention and short-term memory. As regards the methodological limitations, McDonough and Nekrasova-Becker (2012) tested the participants' ability to make broad generalizations when the input consisted of verbs that induced narrow generalizations. Whereas the treatment task presented ditransitive constructions with human characters as indirect objects (recipients or beneficiaries), the comprehension test contained inanimate nouns for both the recipient and the object being transferred. However, with some of the constructions, the beneficiary could be metonymically understood as being human (e.g., *company* could be represented as the people who work in a company; McDonough & Nekrasova-Becker, 2012), and the skewed groups did well only in those instances. Other methodological limitations may have influenced the results of McDonough and Trofimovich's (2012) study, which reported a positive influence of balanced input when the participants received deductive instruction. The study tested the participants' ability to identify the object nouns of the transitive construction in Esperanto rather than their knowledge of the construction itself, and the participants in the deductive group were told that the object nouns were inflected, so this group had an advantage over the inductive group. On the other hand, the skewed instruction group may have had difficulty detecting the object nouns because morpheme occurrence is easier to detect based on balanced input, as discussed above and confirmed by Krajewski, Siebenborn and Lieven (2011), who analyzed structure mapping across morphological constructions.

All of the studies discussed above indicate that low-variability input affects structure mapping across morphological and syntactic constructions. The analysis of the factors that facilitate form-meaning mappings has focused so far only on the nature of the linguistic input while the role of the visual stimuli in promoting construction learning has not been analyzed. Visuals constitute an important element in decoding novel linguistic information due to their direct connection to concepts. While decoding language structures requires complex cognitive processes which are both general in nature and language dependent, the language of visuals is universal. Therefore, pictures have been used in both first and second language acquisition studies to promote interpretation of novel linguistic messages, but the exact contribution of visual stimuli to the decoding of novel linguistic input is not entirely known. Since visual clues can facilitate the decoding of a linguistic message, it is necessary to analyze the factors affecting the processing of visual information by the human cognitive system, and how these factors relate to the decoding of verbal messages. Two aspects of visual messages that seem to affect how speakers process them are prototypicality and chromatic information.

Prototypicality refers to characteristics of an object that make possible its classification into a category based on functional and visual attributes. For instance, all birds have wings, beaks and feathers (visual attributes) and lay eggs (functional attributes). Prototypes need to be differentiated from exemplars: a prototype of a bird represents any bird, while an exemplar would be a sparrow, for instance. Regarding visual material, a picture of a bird would depict an exemplar, such as a picture of a sparrow, for example, while a drawing of a bird that depicts only generic attributes of its species (i.e., it lacks redundant detail) would represent a prototype. When a prototype is saved in memory, only general properties which are representative for the category that prototype belongs in are stored. Therefore, visuals representing coloured simple line drawings of objects are easier to process semantically and require less memory load because they match stored prototypes. This implies that learning tasks that employ prototypical visuals to transmit new information would result in better recall of that information. The fact that lack of redundant detail has a positive effect on pattern detection when visuals are paired with skewed input was acknowledged by Goldberg et al. (2007), who proposed that the participants in their earlier study, Goldberg et al. (2004), were better at abstracting the appearance scenes than the participants in the Goldberg et al. (2007) study due to the fact that the films in the earlier study contained more scenes of appearance that were prototypical, i.e., which did not encode a particular manner.

Whether pictures are colour (chromatic) or monochromatic (black and white) seems to have an effect on memory. More specifically, when compared to black and white visuals, colour visuals positively influence recall, recognition memory and semantic processing. Evidence on the facilitating effect of coloured visuals on information processing comes from studies comparing the effect of black and white and colour images on attentive behaviour, recall and recognition memory (Cano, Class, & Polich, 2009; Shaari, 1991; Wichmann, Sharpe, & Gegenfurtner, 2002), with the findings suggesting that coloured visuals facilitate these general cognitive processes.

Although it may be argued that the positive effect of colour observed in these studies is due to object familiarity (the world is coloured), studies in which unrealistic colours were used, such as in colouring line drawings of natural or artificial objects (Dwyer, 1971; Hocking & Price, 2008; Zannino, Perri, Salamone, Di Lorenzo, Caltagirone, & Carlesimo, 2010) revealed that memory is not positively affected by the resemblance to the real world, but by prototypicality in both terms of colour and shape. This confirms Travers's (1964) hypothesis which holds that efficient transmission of information through visual mediums takes place only when the visual message is non-redundant (i.e., lacks realistic detail). This is due to the fact that having to switch between auditory and visual channels requires time and has a negative effect on learning due to cognitive overloading. For all these reasons, when presenting information through visuals, these aspects need to be taken into account.

The effect of visuals on language learning has been studied with regard to vocabulary acquisition only. This line of research has already confirmed that more words in an L2 language are recalled when learners are presented with monochromatic visual stimuli (Deno, 1968; Webber,1978), but there is not much evidence for the influence of coloured prototypical visuals in the acquisition of L2 structures. The effects on vocabulary acquisition of both coloured and black and white visuals as compared to those of verbal stimuli have been analyzed before (e.g., Altarriba & Knickerbocker, 2011), but only with respect to verbal primes, with the results favouring the verbal condition. There are no studies on the combined effect of coloured, prototypical visuals and that of linguistic prototypicality in structure mapping over linguistic constructions.

Influenced by the positive results found in earlier studies on the effect of skewed input on generalizations over linguistic constructions and by the theoretical tenets regarding the both the processing of linguistic structures and the visuals described above, this study aims to test the effect of prototypical coloured drawings as opposed to prototypical black and white drawings on the effectiveness of skewed and balanced input at promoting acquisition of the transitive construction in Esperanto. The target construction presents novelty in terms of not only syntax, but also morphology. While word-order is flexible in Esperanto, the object noun is inflected, receiving the accusative marking *–n.* Based on the description of language typology with regard to object marking, Esperanto is a restrictive language that marks all its objects. As detailed in the section on categorization as a general cognitive process, the abstraction of Esperanto transitivity requires similarity reasoning which entails finding both the attribute similarity *–n* and a relational structure across all the exemplars. As transitivity is encoded in some languages based on word-order (i.e., English, Thai) and in others based primarily on animacy (Hindi, Punjabi) or definiteness/specificity (Farsi), the participants' L1 will impact their ability to draw a relational structure across the transitive instances in Esperanto. For all these reasons, performing similarity reasoning will tax attentional resources and will affect working memory. However, by manipulating both the linguistic and the visual input, working memory space could be freed to allow the learners to focus on the particularities of Esperanto transitivity. More specifically, the use of low-variability input and that of prototypical, coloured visuals may facilitate pattern detection of the transitive construction in Esperanto.

As regards the type of low-variability input, it is not clear whether similarity reasoning associated with pattern detection across morphological constructions will be positively affected by balanced input, as argued above, or by skewed input as the transitive construction in Esperanto is a syntactic structure, albeit presenting elements of morphology. In the case of syntactic constructions, the relational structure needs to be drawn across all the elements in the transitive instance, and not only across the morphologically marked arguments and the verbs as in the case of abstracting the plural in English. The following research question was proposed: What is the effect of L1 background and visual information on the effectiveness of low variability input at promoting pattern detection of the transitive construction in Esperanto?

Method

Participants

The participants were 88 English L2 speakers of different L1 backgrounds who were enrolled in various degree programs at Concordia University, including engineering, computer sciences and telecommunication. The speakers L1s were Farsi, Punjabi, Tamil, Gujarati, Hindi, Arabic, French and Spanish. Based on Sinnemäki's (2012) data these languages were classified into two main categories: restrictive based on animacy, and restrictive based on definiteness, as shown in Table 1

Table 1

L1 distribution based on differential case marking

Animacy group	Definiteness group
French	Arabic
Gujarati	Farsi
Hindi	Tamil
Punjabi	
Spanish	
Telugu	

The participants in both language groups were paid for their participation. Four participants were excluded from the study for failing to learn the meaning of the target Esperanto words prior to the construction learning task (below 90% on the learning task and below 70% on the vocabulary knowledge test). The final participant pool consisted of 84 participants (17 women, 67 men) randomly distributed across the eight treatment groups as shown in Table 2

Table 2

Participant distribution across the eight treatment groups

Group	N	Gender	Age Mean/SD
Skewed/color/animacy	10	9 M 1 F	25.2/1.03
Skewed/black and white/animacy	10	10 M	23.7/1.05
Skewed/colour/definiteness	11	10 M 1 F	25.3/2.33
Skewed/black and white/definiteness	10	6 M 4 F	26.1/3.87
Balanced/colour/animacy	11	8 M 3 F	23.2/1,73
Balanced/black and white/animacy	11	11 M	23/1.41
Balanced/colour/definiteness	10	6 M 4 F	26.9/3.1
Balanced/black and white/definiteness	11	7 M 4 F	24.5/2.58

Target Construction

The target construction was the transitive structure in Esperanto, characterized by morphological features and flexible word order, the most common being SVO and OVS (Cox, 2011; Harlow, 1995). All the nouns in Esperanto end with the vowel *o,* and the noun functioning as object is indicated through affixation, the morpheme *–n.*

For instance, in the construction *Pilkon batas tauxro*, the noun *pilko* functions as an object, which is indicated by the *–n* affix.

The target nouns, *pilko* (tennis ball), *tauxro* (bull), *kapro* (goat), *cevalo* (horse), *kato* (cat) and *makropo* (kangaroo), *zebro* (zebra), *bubalo* (buffalo), *automobilo* (car), *tigro* (tiger), *leporo* (hare) and *pordego* (gate) were chosen based on phonological principles and prototypicality. Regarding phonology, words containing nasals within the word were avoided due to articulatory considerations. Because objects in Esperanto acquire a word final *–n,* the latter could go unnoticed as a result of progressive assimilation, in which the nasality moves onto the following vowel (all nouns end in the vowel *o* in Esperanto). For instance, the word *azeno* becomes *azenon* in object position, but the final *–n* could be mistakenly interpreted as nasalization of the vowel *o.* Regarding prototypicality, the transitive prototype requires that the participants are perfectly individuated and distinguishable from the background (Næss, 2007). The agent displays the characteristics [+volitional, +instigator, -affected], while the patient features [-volitional, -instigator, + affected]. Therefore, the noun *pilko* (tennis ball) was considered the noun whose properties were the most encompassing of the patient feature and was chosen as the high token frequency noun in the skewed input condition.

Design

This proposed study employed a factorial design to test the effectiveness of low-variability input (Skewed vs. Balanced), L1 perspective (Animacy vs. Definiteness) and visual information (Black and White vs. Colour) at promoting pattern detection of the transitive construction in Esperanto. The dependent variable was the accuracy with which the participants could identify the picture that corresponded to the sentence they heard. The participants' L1s were divided into two groups: restrictive based on animacy (Hindi, Punjabi, Telugu, Gujarati, French and Spanish) and restrictive based on definiteness (Tamil, Arabic and Farsi).

In terms of low-variability input, both the balanced and the skewed input consisted of 30 sentences created with only six nouns and two verbs, with 15 sentences per word order for the skewed input, while the balanced input contained 16 sentences with the OVS word-order and 14 sentences with the SVO word-order (see Appendix 1 for the distribution of nouns across the two conditions). While the balanced input featured each noun with equally low-token frequency in object position, the skewed input presented one prototypical noun, *pilko*, with high token frequency. The sentence presented prototypical and less prototypical relationships, with the participants in the skewed group experiencing more examples of prototypical occurrences and the learners in the balanced group receiving a balanced distribution of prototypical and less prototypical occurrences. In order to assess if learning has generalized and transferred to both prototypical and less prototypical transitive constructions, the testing phase was designed to represent both events that are likely to happen in real life, as in *a tiger chases a zebra,* and unlikely events, as in *a zebra chases a tiger*, with both word-orders (SVO and OVS).

As regards the visual images, they were characterized by both prototypicality and low variability. Prototypicality with regard to the characters was achieved by depicting them as simple line drawings preserving only the characteristics that enabled viewers to identify the noun, without any other details. To determine which colour best represented each of the nouns, the researcher consulted the "Google Images" database to determine which colour occurs the most often with that particular noun. Additionally, when naming each noun for the artist creating the visuals, the artist was asked to quickly conjure up the colour that came to mind when the noun was named. If the artist's colours did not match the colours found by the researcher, then the research and the artist agreed on the colour that best represented that particular object. Both the characters and their environment were drawn without extra details and without variation from one drawing to the other. Thus, the background, which represented a natural environment, depicted grass (rendered as basic shape and colour) and blue sky. Prototypicality with regard to the actions performed by the nouns (chase or hit) was achieved by rendering these actions in the same manner throughout the visuals. For example, *chase* was depicted as the same type of motion, with the character chasing running behind the chased character, while the action for the verb *hit* encoded the same manner throughout the pictures, i.e., it was depicted as being performed by the characters with their head.

Additionally, the orientation of the action was back/front or front/back, with the character representing the object being always in the front. For example, a visual depicting a horse kicking a gate displayed the gate in the foreground and the horse in the background, hitting the gate with its head. The position of the characters was slightly diagonal in order to ensure clear visibility of both characters. This orientation avoids visual linearity or bias towards the SVO order (the character on the right is the agent, the one on the left is the patient), or towards the OVS order (the character on the right is the patient), which could occur as a result of participants' previous experience with word-order either trough an L1 or through an L2. When faced with both word orders and front/back or back/front visuals, the learners were not able to rely on linearity, but on the verbal clues to identify the object.

Materials and procedure

Vocabulary learning

The materials for the first vocabulary learning task consisted of PowerPoint slides containing the drawings of the 6 nouns and the 2 verbs. Each drawing was presented twice, once with the written form of the word it depicted, and once without. For the second vocabulary learning activity, each participant received a checklist containing pictures of the eight words in the first row followed by 24 rows with the written form of each word (8 words x 3 = 24), as shown in Appendix 2 . The verbs were written in the present tense form and the nouns in their base form without suffixes. For the second vocabulary task all participants received a checklist containing the pictures of the nouns and the three verbs without the orthographic form, as shown in Appendix 3. For the last two vocabulary activities, audio files were used for the aural input. Each word was individually recorded directly onto a computer by a female native speaker of Spanish using a Realtek High Definition Audio Microphone and the program Audacity. The files were exported as a digital audio list and inserted in a PowerPoint presentation, with each word spoken once, separated by a 7000 ms pause.

Construction learning

All participants received a checklist of pairs of pictures, one depicting the action in the aural input and the other one acting as distractor, as shown in Appendix 4. The numbers of each pair of pictures corresponded to the number of the sentence in the aural input. The participants had to circle or tick the picture that depicted the action described by the sentence they heard. The information that the learners could use to select the appropriate picture was graded. Thus, to be able to identify the right picture of the first pair, the participants needed to rely only the meaning of the nouns; for instance, if the transitive utterance described the action *a bull chases a ball*, the pair of visuals represented a picture depicting the correct transitive instance and a distractor depicting the same transitive instance (chase) but performed by different characters. The levels of difficulty started from reliance on vocabulary (four sentences) and ended with reliance on morphology (eight sentences), a stage in which the pairs of visuals depicted fully reversible actions. The groups in the colour and in the black and white conditions received handouts that corresponded to their condition.

The difference between the skewed and the balanced conditions consisted of the fact that the participants in the former condition listened to an input in which one prototypical noun, *pilko*, appeared as object in half of the utterances (15 times, with both word-orders), the other nouns occurring as objects three times each. Conversely, the participants in the balanced condition listened to input in which each noun appeared as object for an equal amount of time, five times, with both SVO and OVS word-orders.

Test materials

The aural input consisted of 30 sentences representing both the SVO and the OVS word-orders. Each sentence was repeated twice, with a 5000 ms pause between the first and the second utterance and with a 10000 ms pause between each second utterance of the previous sentence and the next sentence. Six new nouns were used with the same two verbs: *zebro* (zebra), *bubalo* (buffalo), *automobilo* (car), *tigro* *(*tiger), *leporo* (hare) and *pordego* (gate). (See Appendix 5 for samples of testing sentences) The handout represented pairs of pictures depicting fully reversible transitive instances such as *a ball hits a gate/a gate hits a ball*, as shown in Appendix 6. Each pair of pictures was numbered and respected the order of the audio input.

Procedure

For the first vocabulary task, all the participants were told in English that they were going to learn six nouns and two verbs in Esperanto. Drawings of the six nouns and of the actions described by the two verbs were projected on a screen together with their written forms. The researcher pronounced the words and asked the participants to repeat them. Then the nouns and the verbs were displayed randomly and the participants were asked to name them. The researcher repeated the activity until the participants identified the pictures correctly. The participants were then referred to the two vocabulary activities on their handouts. For the first activity on their handout, the participants were told that they would hear an audio recording of the 8 words they learned and that each of those words would be said three times randomly during the whole activity. They were told to circle the orthographic form of the word next to its corresponding number each time they heard it. For the second vocabulary activity on the handouts, the participants were told to listen to the audio recording and write the number of the word they heard above its corresponding picture. Each item was read once and there was a 7000 ms pause between the words.

For the construction learning task, all the participants were told that they would hear sentences in Esperanto, and that their task was to circle the picture corresponding to each sentence. They were told that there were two pictures for each sentence, but that only one was the correct representation of the sentence. The participants were further advised that the information they could use to identify the picture had different levels of difficulty, ranging from very easy to difficult and that they needed to pay careful attention to the sentences to be able to correctly identify the pictures throughout the activity. They were also told at the beginning of the construction learning task that word order was flexible in Esperanto and that they had to pay attention to the noun endings to be able to choose the right picture. The participants were informed that the presentation would be stopped before each change regarding the level of information and that they would be reminded to listen carefully to the sentences and try to understand them. The participants were told to pay attention to the noun endings only once, at the beginning of the construction learning phase. Each time the level of difficulty changed, the presentation was stopped and the participants were only reminded to listen to the sentences carefully.

For the testing phase, which was administered immediately, the participants were told that they would need to use what they learned about Esperanto sentences to identify one last set of pictures and that at the end of this activity, they will need to write down what they learned about sentences in Esperanto. They were told that they needed to learn 6 new nouns first and that the verbs were the same. They were then showed the new nouns projected on a screen in a PowerPoint presentation. The nouns were said by the researcher and the participants were asked to repeat them. The test itself was carried out after the participants were familiarized with the nouns. The participants were then told that they would hear another 30 sentences in Esperanto and that they would again need to circle the picture that corresponded to each sentence.

Analysis

The vocabulary activities were scored to determine if there were participants that failed to learn the vocabulary. The participants that failed to achieve a score of 90 % on the first vocabulary test (approximately 22 out of 24 words) and 70 % on the second vocabulary test (approximately 6 out of 8 words) were excluded from the analysis.

As regards the test items, each correct identification of the picture corresponding to the aural input received a score of 1, while each misidentification received a 0. d' values were used as the dependent variable in order to account for response bias (choices made based on the SVO or SOV word orders, corresponding to the participants' L1s). Based on Signal Detection Theory (Macmillan & Creelman, 2005), d' is a measure of sensitivity that takes into account participants' correct discrimination of a pattern (i.e., ideally, a high 'hit' rate with minimal 'misses') and their bias to report false positives (i.e., ideally, a low 'false alarm' rate, coupled with a high rate of 'correct rejections'). Since in both English and the participants' L1s transitive constructions the agent is expressed by the first NP, the expected response bias was for the participants to select the first NP 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]). d' values above 1 indicate increasingly greater sensitivity to inflected morphology, with little bias to rely on the familiar SVO word order as a cue. In contrast, values at or near 0 suggest that any discrimination is largely cancelled out by the response bias, while values below zero suggest that performance is largely driven by participants' bias to rely on the SVO word order. For the statistical test reported below, the alpha level for significance was set at .05. The effect sizes reported below are partial eta squared (η_p^2), calculated by dividing the effect sum of squares by the effect sum of squares plus the error sum of squares.

Results

The research question asked whether there was an effect of L1 background (animacy languages vs. definiteness languages) and visual information (colour vs. black and white) on the effectiveness of low variability input at promoting pattern detection of the transitive construction in Esperanto.

Table 3 summarizes the mean d' values as a function of L1 (Animacy vs. Definiteness).

Table 3

Mean d' Values by L1 (Animacy vs. Definiteness)

L1	*M*	*SD*
animacy	-.420	.172
definiteness	.406	.172

These data were analyzed using a 3 × 2 analysis of variance (ANOVA), which revealed a significant main effect of L1, F (1, 76) = 11.538, p <.05, $\eta p^2 = .132$.

Table 4 summarizes the mean d' values as a function of input (Skewed vs. Balanced) and images (Black and White vs. Colour).

Table 4

Mean d’ values by Input (Skewed vs. Balanced) and Images (Black and White vs. Colour)

Input	Images	*M*	*SD*
Balanced	Black and White	.255	.237
	Colour	-.101	.243
Skewed	Black and White	-.346	.249
	Colour	.163	.243

There was no significant main effect for input, F (1, 76) = .480, p = .490, ηp^2 = 0.06, or for images, F (1, 76) = .098, p = .755, ηp^2 = .001. The input*images interaction approached significance, F (1, 76) = 3.156, p = .080, ηp^2 = 0.40.

Discussion

The research question asked whether there was an effect of L1 and visual information on the effectiveness of low-variability input, and the findings revealed a main effect for L1 background. More precisely, the definiteness group did significantly better than the animacy group although both L1 groups and the target language use case-marking. The main difference between Esperanto and the participants' L1s is that Esperanto is a non-restrictive language (all the direct objects are marked) with flexible word-order, while both the animacy and the definiteness language groups are restrictive and use differential case-markings, with relatively fixed word-order. The positive results observed with the definiteness language speakers may be explained with reference to the extended argument dependency model (Bornkessel & Schlesewsky, 2006).

As explained above, word category information, including elements of morphology, is processed in Phase 1 of the model. Within the definiteness group, this is where the accusative marking *–n* in Esperanto may have been attributed to object definiteness. On the other hand, within the animacy group, the morpheme *–n* may have been interpreted as object marking in non-prototypical sentences (with animate patient, inanimate agent). However, the transitive instances of this study presented both animate and inanimate nouns in object position, with all object being marked regardless of the animacy/inanimacy features. This, coupled with the fact that word-order is flexible in Esperanto, may have made it difficult for the speakers in the animacy language group to detect the transitive pattern in the target language. More exactly, argument processing was probably impacted in Phase 2, where initial word category processing based on morphology (Phase 1) had to be dropped to accommodate the Compute Prominence stage, where information on animacy was not reliable (both the animate and the inanimate patients in the input were case-marked). No other cues being available (word-order was flexible, world knowledge was not reliable), during the repair process in Phase 3, the animacy language speakers may have fallen back either on word-order, or on the passive structure thus interpreting the OVS structures as passive constructions.

These results suggest that transitive prototypicality may not help learners identify patterns in a language whose argument marking is different from their L1s. Transitive prototypicality is not in fact a universal, but an ideal situation, as real life presents a learner with both prototypical and non-prototypical instances and languages have different ways to encode and disambiguate the agent-patient relationship. Therefore, although the skewed input presented learners with fifteen prototypical instances in which *pilko* (ball) occurred as patient and it was case-marked in Esperanto (it received the accusative marking *–n*), L1 animacy learners failed to detect the pattern because an inanimate patient would not be marked in their L1s unless it was definite. In other words, the skewed input failed to “force” these participants to identify a novel relational structure between the arguments. This study used a “skewed random” type of input; it is possible that a “skewed-first” type would have yielded better results by forcing the animacy language speakers to identify the novel relational structure. Apart from the type of skwedness, another reason why there was no main effect of input type on pattern detection may be that pattern detection is not facilitated by input alone, but by a combination of factors such as learning tasks (deductive vs. inductive: McDonough & Trofimovich, 2012), learning environment (classroom setting, which favours explicit learning vs. laboratory setting, favouring implicit learning: McDonough & Nekrasova-Becker, 2012; Nakamura, 2012; Year & Gordon, 2009), the nature of the construction (morphological vs. syntactic: Siebenborn & Lieven, 2011).

Lack of significant effects for input type in this study may be also due to the dual nature of the targeted construction, a syntactic construction realized by means of morphological marking. The morpheme –n does not carry the meaning of the construction itself as in the case of verbs that are morphologically marked for tense, aspect, person, for instance. The meaning of a transitive construction is represented by the relational structure between the two arguments and between the arguments and the verb, the role of the morpheme being that of disambiguating this relationship in non-prototypical instances. Therefore, although by attending to balanced input a listener may be able to easily detect the morpheme *-n*, he or she would still have to find relational structure between the two arguments on the one hand and between the arguments and the verb on the other in order to abstract the linguistic category. Because detecting a relational structure across the elements in the input is part of both analogical and similarity reasoning, any of the input types associated with these types of reasoning would be beneficial.

Another factor that may have influenced the results is the classification of the learners' L1 into animacy and definiteness groups. This classification was based on properties of arguments that these languages use for object identification, but there are also exceptions to the rule. Hindi, for instance, marks all the human referring objects, but some animals too are treated as human (Aissen, 2003). In addition, Hindi marks objects based primarily on animacy, but within the animacy group, definite nouns are also marked, while Farsi marks all definite patients, but uses animacy to further disambiguate the argument interaction. The fact that the transitive instances in the input featured both animate and inanimate objects did not seem to affect the definiteness language speakers because differential object marking in their language is not affected primarily by animacy, but by definiteness. In other words, their working memory was not taxed by the animacy/inanimacy contradiction, so they were able to detect the pattern of Esperanto transitive sentences.

As regards the effect of visuals on input type, the results failed to reach significance, but there was a positive trend towards an interaction between input and images, with colour images affecting the skewed input and black and white images positively affecting the balanced input. Although more studies are needed to further explore this effect, the finding suggests that colour images may benefit categorizations by allowing a learner to draw relational structures across exemplars in the input due to processing ease, which would confirm the findings in experimental studies on the effect of colour on memory and attention (Shaari, 1991; Wichmann et al., 2002). Colour information may also help learners detect new patterns with skewed input, a type of input that does not facilitate similarity reasoning, (the detection of a shared concrete element) because it stimulates attentive behaviour (Cano et al., 2009) which in turns may facilitate finding a relational structure across the exemplars in the input. On the other hand, the fact that the balanced group was positively affected by the black and white image may suggest that both black and white images and balanced input allow for more abstract, analytical thinking, which may be due to the fact that the same area of the brain (the left antero-medial temporal area) is involved in decoding both linguistic information and black and white images, as suggested by the findings in Hocking and Price (2008).

There are some other factors that probably affected pattern detection and they relate to the design of the study. The input was created so as to focus on the object nouns, whereas the subject nouns were equally important in helping learners find a relational structure between the arguments. While an equal distribution of nouns in object position was respected, the same nouns did not appear in subject position for an equal amount of time. The reason behind this drawback was that plausibility was misinterpreted as prototypicality. For instance, a tennis ball does not usually act as a subject in real-life situations and even when it does so, it happens in a causative manner (the ball has to be hit by an animate being to be set in motion). However, as the extensive argument dependency model suggests, real –life interpretation occurs only in the third phase of processing, while the first and probably the most important two phases of interpretation are influenced by L1 specific encodings. In other words, from a linguistic perspective, prototypicality is language-dependent, not a universal ideal. In this case, an input type that featured each noun in both subject and object position equally may have been more helpful for pattern detection. The use of prototypical instances may also be the reason why there was not interaction effect of input type (skewed vs. balanced). Input type did not affect the speakers' ability to find a relational structure between the arguments because the prototypical instances with *pilko* in object position reflected plausibility, not language-specific encodings. If the word *pilko* had been used equally in both subject and object position, the speakers in the animacy group may have been able to detect the transitive pattern in Esperanto.

In conclusion, detecting morphemes in categorizations over novel linguistic structures may seem an easy task for speakers of L1s that use case markings, but word-category identification based on morphology represents only one step in pattern detection, and it occurs in the first phase of the argument dependency model

(Bornkessel & Schlesewsky, 2006). As argued in the section on categorizations over linguistic structures as a general cognitive process, pattern detection over constructions that are morphologically marked is done by means of similarity reasoning through which not only concrete attributes (the recurring morpheme) but also a relational structure (assigning agent-patient roles) have to be found. Finding this relational structure may be affected by L1-specific encodings of the agent-patient interaction.

The purpose of this study was two-fold: to shed light on the cognitive processes involved in categorizations over linguistic structures and to analyze factors that may affect the effectiveness of low variability input. Future research on the effect of low-variability input in pattern detection over linguistic structures needs to further analyze the role of prototypicality in terms of the speakers' L1, as well as the potential role of coloured visuals in reducing processing load.

Chapter 3

Linguistic knowledge is acquired by means of general cognitive processes which require abstracting or generalizing over exemplars in the input in order to detect recurring linguistic patterns. Pattern detection is facilitated by low-variability input in both balanced and skewed forms. The nature of the construction determines which type of input would lend the construction to an easier generalization process. Skewed input seems to work better in abstractions over syntactic constructions, but this is not a sine-qua-non condition. Other factors may play en equally important role in generalizations over syntactic constructions. One such factor is a learner's L1. Although similarity and analogical reasoning are universal processes, speakers may be biased with regard to the details they pay attention to.

Although it is not clear whether it is language that influences thought or vice versa, L1-specific encodings of argument properties may lead their speakers to pay attention to those specific aspects in the initial phases of categorization, and these aspects can affect pattern detection regardless of input quality. It is important to understand that categorizations over linguistic structures are dealt with in terms of both form and meaning, and form-meaning mappings require more than attention to input, with detection of meaning being influenced by a speakers' L1. For instance, the prototypical meaning of the transitive construction, *X acts on Y* is identical across languages, but it is only an abstraction that does not always correspond to real life situations.

Although only word-order is used to disambiguate the agent-patient relationship in English, other languages mark more aspects onto linguistic structures than just agent-patient interactions, and animacy-inanimacy is only one aspect of this complex encoding. In Tamil, for instance, a language with free word-order classified in this study as a definiteness language, there is interdependence between definiteness and the meaning encoded on the noun. However, nouns are not classified into animate and inanimate, but into rational and non-rational, the former category including only deities, humans and demons (Muralikrishnan, 2011). Therefore, the Tamil speakers in this study were not negatively affected by the interplay between animate and inanimate nouns, as none of the NPs used was human or demon/deity. On the other hand, agent animacy triggers case marking in Hindi, so the Hindi speakers in this study were negatively impacted by the flexible word-order on the one hand and by the animacy/inanimacy factors. These facts lead to a new understanding of the role of prototypicality in pattern detection.

Prototypicality was defined in this study as representing a situation in which the patient displays the properties [+ affected, - animate, -volitional] and it was believed to help learners abstract the transitive meaning easily so they could focus on the novel patterns. However, as meaning and form are inseparable constituents of the linguistic structures, prototypicality only induced the animacy language speakers to rely on their L1 encodings in abstracting the novel pattern. Therefore, for the testing part, which contained fully reversible transitive instances, they either relied on word-order or interpreted the *–n* marking as a passive-voice indicator. For this reason, in order to facilitate novel pattern detection, prototypicality needs to be defined based on L1-specific encodings and not as plausible events in the real world. More specifically, in the case of animacy language speakers, a prototypical instance would be defined as a syntactic encoding in which the object is animate and case-marked. Thus, in the skewed condition, skewedness would have helped if it was in favour of an animate patient noun. In addition to the linguistic input, the use of prototypical colour visuals may have increased the negative effect of animacy L1s on their speakers' ability to detect the novel pattern.

A last factor that may play a decisive role in category formation is instruction. In this study, instruction was inductive in the sense that the learners were told in the beginning that word order is flexible in Esperanto and that they needed to pay attention to the noun-endings. Although these instructions were only given once, knowing about word-order flexibility may have helped the definiteness language group to detect the pattern in Esperanto. These particularities being dealt with through instruction, the definiteness language speakers were able to focus their full attention on the Esperanto transitive pattern.

In conclusion, categorizations over linguistic structures require general cognitive processes such as similarity and analogical reasoning, but these processes are dependent, in the first stages of pattern detection, on the speakers' L1. Characteristics of the arguments such as animacy or definiteness may lurk in the background during the initial stages or processing with possible corrections taking place only in the third phase of the extended argument dependency model. In order to help learners detect novel patterns, careful attention needs to be given to their L1 specific encoding of that structure, in terms of form-meaning, and not just as form. While novel schematic forms can be easily detected in the input, complex semantic relationships such as the argument interactions are difficult to abstract. So far, the studies on low-variability input have mainly focused on English L1 speakers. The studies conducted with Thai speakers (McDonough & Nekrasova-Becker, 2012, McDonough & Trofimovich, 2012) were also irrelevant with respect to various L1 effects on novel pattern detection because Thai, just like English, is a fixed word-order language. Future research needs to take into account the fact that meaning encoding is a complex phenomenon across world languages and it can influence a speakers' attention to linguistic categories.

Consideration needs to also be given to the nature of the visual input. Visuals and language work in tandem in communication, so categorizations over novel structures can be aided or hindered by the quality of the visuals. Thus, low variability needs to characterize both the linguistic and the visual input. Although the impact of visuals on input type was not confirmed, a more careful design and a more careful categorization of L1s may yield different results. There is a trend for colour images to speed up processes and this effect needs to be further investigated.

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Appendix 1

Construction Learning: Skewed condition

Word	SVO		OVS	
	subject	object	subject	object
pilko	0x	Makropo batas pilkon. Cevalo pelas pilkon. Cevalo batas pilkon. Kato pelas pilkon. Cevalo pelas pilkon Tauxro batas pilkon. Kapro batas pilkon	1x	Pilkon batas tauxro. Pilkon pelas kato. Pilkon pelas tauxro. Pilkon batas cevalo Pilkon pelas kato. Pilkon pelas kapro. Pilkon batas cevalo. Pilkon batas kapro.
makropo	2x	Tauxro batas makropon Cevalo batas makropon	0x	Makropon pelas kapro
cevalo	5x	Tauxro batas cevalon Makropo batas cevalon	3x	Cevalon batas kapro
kato	1x	Cevalo batas katon Kapro pelas katon	3x	Katon pelas tauxro
tauxro	4x	Kapro batas tauxron.	4x	Tauxron batas cevalo Tauxron pelas kato
kapro	3x	Tauxro batas kapron.	4x	Kapron pelas tauxro Kapron batas pilko

Construction learning: Balanced condition

Word	SVO		OVS	
	subject	object	subject	object
pilko	1x	Tauxro batas pilkon	1x	Pilkon pelas kapro
		Kapro batas pilkon		Pilkon pelas tauxro
				Pilkon batas tauxro
makropo	1x	Cevalo batas makropon	2x	Makropon batas tauxro
		Cevalo batas makropon		Makropon pelas tauxro
				Makropon pelas kato
cevalo	4x	Tauxro batas cevalon	1x	Cevalon batas pilko
		Kato pelas cevalon		Cevalon batas makropo
		Tauxro batas cevalon		
kato	1x	Pilko batas katon	3x	Katon batas makropo
		Tauxro batas katon		Katon pelas tauxro
		Cevalo batas katon		
tauxro	5x	Makropo batas tauxron	6x	Tauxron pelas kato
		Kapro batas tauxron.		Tauxron batas kapro
				Tauxron batas cevalo
kapro	2x	Tauxro batas kapron	2x	Kapron batas tauxro
		Cevalo batas kapron		Kapron batas tauxro
				Kapron pelas kato

Appendix 2

Vocabulary learning task

You will hear the 8 Esperanto words shown below. Each word will be said three times. For each item, circle the word you hear.

1. tauro	cevalo	makropo	kato	pilko	kapro	pelas	batas
2.	......	.....	....	....	.....	....	.....
24. tauro	cevalo	makropo	kato	pilko	kapro	pelas	batas

Appendix 3

Vocabulary test task

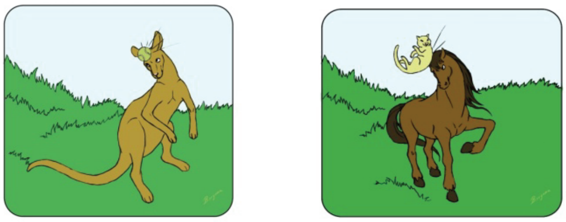
Now you will hear the 8 words only. Each word will be said one time. For each word you hear, write its number above the correct picture.

Appendix 4

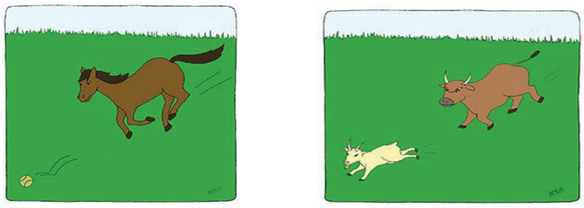
Construction learning task

Now you will hear sentences in Esperanto. Each sentence will be repeated twice. The number of each pair of pictures corresponds to the number of the sentence you hear. Write the number of the sentence above the correct picture.

1



2



Appendix 5

Test sentences

SVO	Meaning
Automobilo batas pordegon.	A car hits a gate.
Pordego batas leporon.	A gate hits a hare.
Bubalo pelas tigron.	A buffalo chases a tiger.
Bubalo batas pordegon.	A buffalo hits a gate.

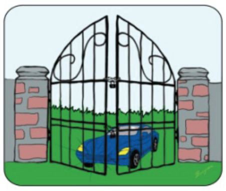
OVS	Meaning
Automobilon batas pordego.	A car is hit by a gate
Zebron batas pordego.	A zebra is hit by a gate.
Pordegon batas automobilo.	A gate is hit by a car.
Tigron pelas automobilo.	A tiger is chased by a car.

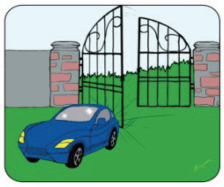
Appendix 6

Test task

Now you will hear Esperanto sentences with the same two verbs and six new nouns. Based on what you have learned about the grammar of Esperanto, decide which picture corresponds to the sentence you hear. The number of each pair of pictures corresponds to the number of the sentence you hear. Write the number of the sentence above the correct picture.

1





2